8564605

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

January 23, 2025

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APPLICATION NUMBER: *18/424,696*
FILING DATE: *January 26, 2024*
PATENT NUMBER: *12156781*
ISSUE DATE: *December 03, 2024*

Certified by

ACTING DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

PTO/AIA/15 (03-13)
Approved for use through 01/31/2014. OMB 0651-0032
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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No.	SDC012
First Named Inventor	Brandon Dale Kofford
Title	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
Express Mail Label No.	

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. ☐ **Fee Transmittal Form** (PTO/SB/17 or equivalent)
2. ☑ **Applicant asserts small entity status.** See 37 CFR 1.27
3. ☐ **Applicant certifies micro entity status.** See 37 CFR 1.29. Applicant must attach form PTO/SB/15A or B or equivalent.
4. ☑ **Specification** [*Total Pages* 52] Both the claims and abstract must start on a new page. *(See MPEP § 608.01(a) for information on the preferred arrangement)*
5. ☑ **Drawing(s)** (35 U.S.C. 113) [*Total Sheets* 26]
6. **Inventor's Oath or Declaration** [*Total Pages* 4] *(including substitute statements under 37 CFR 1.64 and assignments serving as an oath or declaration under 37 CFR 1.63(e))*
   a. ☑ Newly executed (original or copy)
   b. ☐ A copy from a prior application (37 CFR 1.63(d))
7. ☑ **Application Data Sheet** ** See note below.* See 37 CFR 1.76 (PTO/AIA/14 or equivalent)
8. **CD-ROM or CD-R** in duplicate, large table, or Computer Program (*Appendix*)
   ☐ Landscape Table on CD
9. **Nucleotide and/or Amino Acid Sequence Submission** (*if applicable, items a. – c. are required*)
   a. ☐ Computer Readable Form (CRF)
   b. ☐ Specification Sequence Listing on:
      i. ☐ CD-ROM or CD-R (2 copies); or
      ii. ☐ Paper
   c. ☐ Statements verifying identity of above copies

ADDRESS TO: **Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450**

ACCOMPANYING APPLICATION PAPERS

10. ☐ **Assignment Papers** (cover sheet & document(s))
    Name of Assignee _____
11. ☐ **37 CFR 3.73(c) Statement** (*when there is an assignee*) ☑ **Power of Attorney**
12. ☐ **English Translation Document** (*if applicable*)
13. ☐ **Information Disclosure Statement** (PTO/SB/08 or PTO-1449)
    ☐ Copies of citations attached
14. ☐ **Preliminary Amendment**
15. ☐ **Return Receipt Postcard** (*MPEP § 503*) (*Should be specifically itemized*)
16. ☐ **Certified Copy of Priority Document(s)** (*if foreign priority is claimed*)
17. ☑ **Nonpublication Request** Under 35 U.S.C. 122(b)(2)(B)(i). Applicant must attach form PTO/SB/35 or equivalent.
18. ☑ **Other:** Track One AIA0424

Note*: (1) Benefit claims under 37 CFR 1.78 and foreign priority claims under 1.55 **must be included in an Application Data Sheet (ADS).
(2) For applications filed under 35 U.S.C. 111, the application must contain an ADS specifying the applicant if the applicant is an assignee, person to whom the inventor is under an obligation to assign, or person who otherwise shows sufficient proprietary interest in the matter. See 37 CFR 1.46(b).

19. CORRESPONDENCE ADDRESS

☑ The address associated with Customer Number: 112823 **OR** ☐ Correspondence address below

Name					
Address					
City		State		Zip Code	
Country		Telephone		Email	

Signature	/Daniel John Whittle, #54,537/	Date	01-26-2024
Name (Print/Type)	Daniel John Whittle	Registration No. (Attorney/Agent)	54537

This collection of information is required by 37 CFR 1.53(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: PA..
Document Description: Power of Attorney

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TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	
Filing Date	2024-01-26
First Named Inventor	Brandon D Kofford
Title	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
Art Unit	
Examiner Name	
Attorney Docket Number	SDC012

SIGNATURE of Applicant or Patent Practitioner

Signature	/Daniel John Whittle, #54,537/	Date (Optional)	
Name	Daniel John Whittle	Registration Number	54,537
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Doc Code: PA..
Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 000112823

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 000112823

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☑ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☐ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	/Charles Albert Rudisill/	Date (Optional)	
Name	Charles Albert Rudisill		
Title			

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 2 forms are submitted.

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POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number

Privacy Act Statement

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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

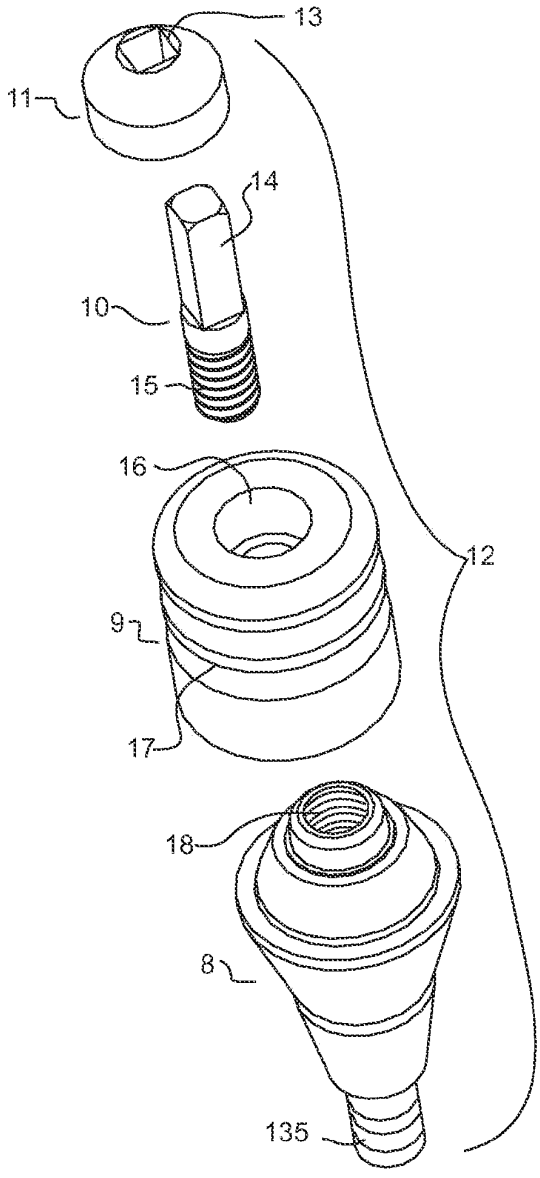


FIG. 1

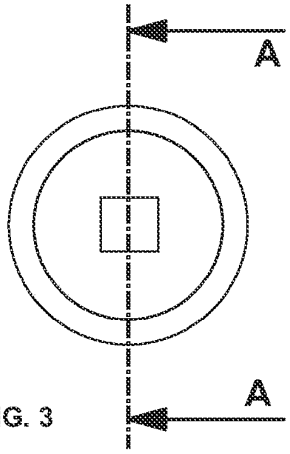


FIG. 3

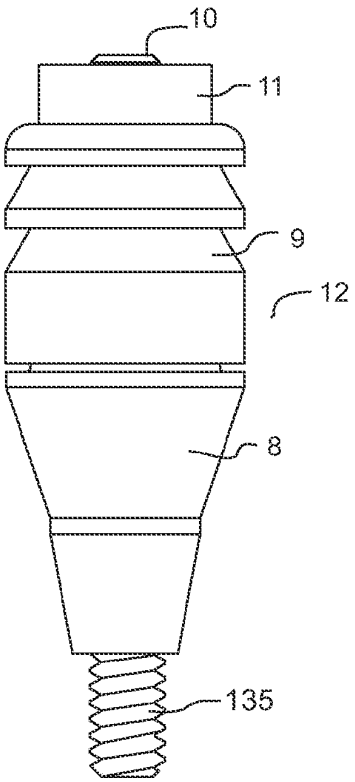


FIG. 2

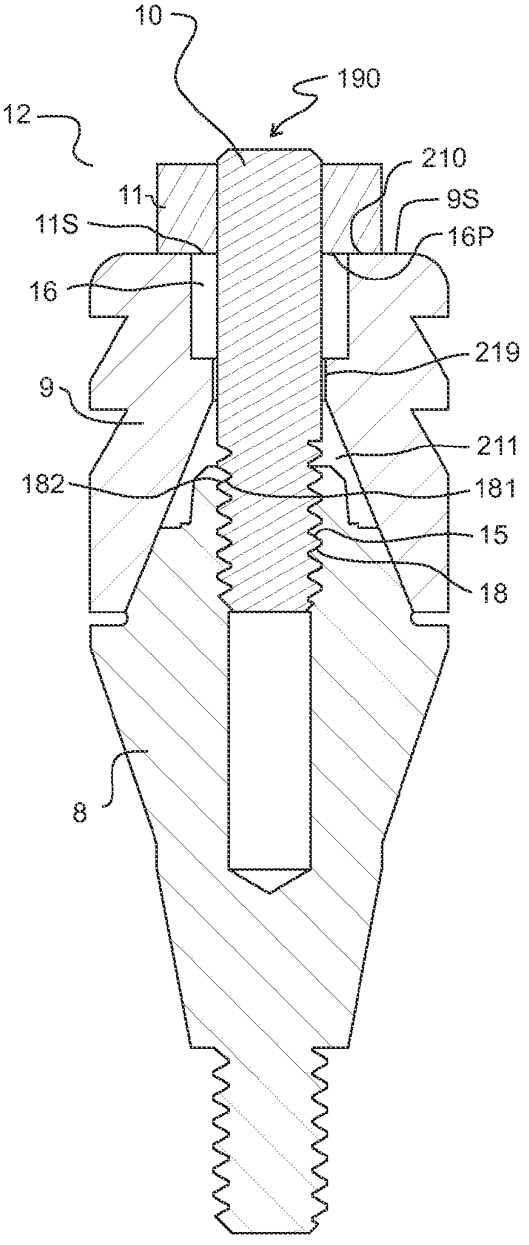


FIG. 4

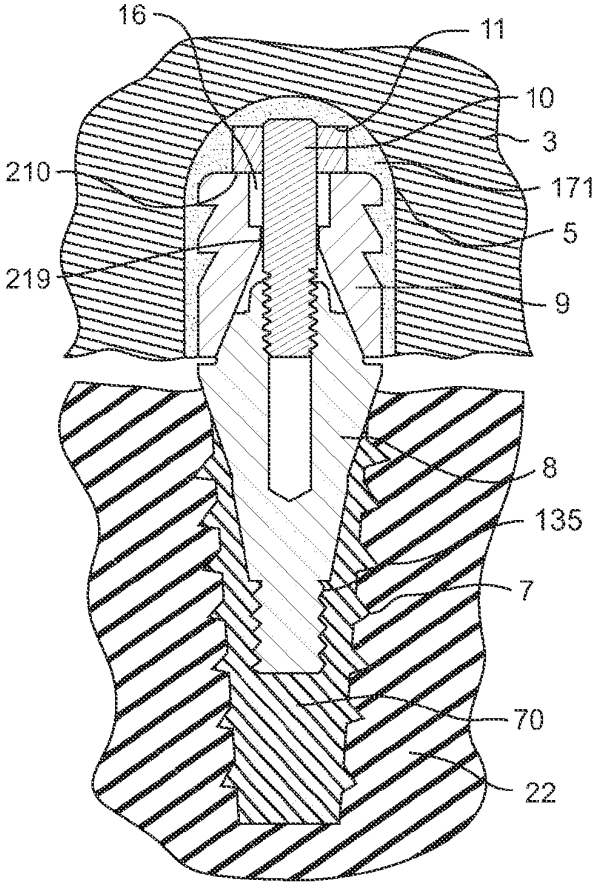


FIG. 5

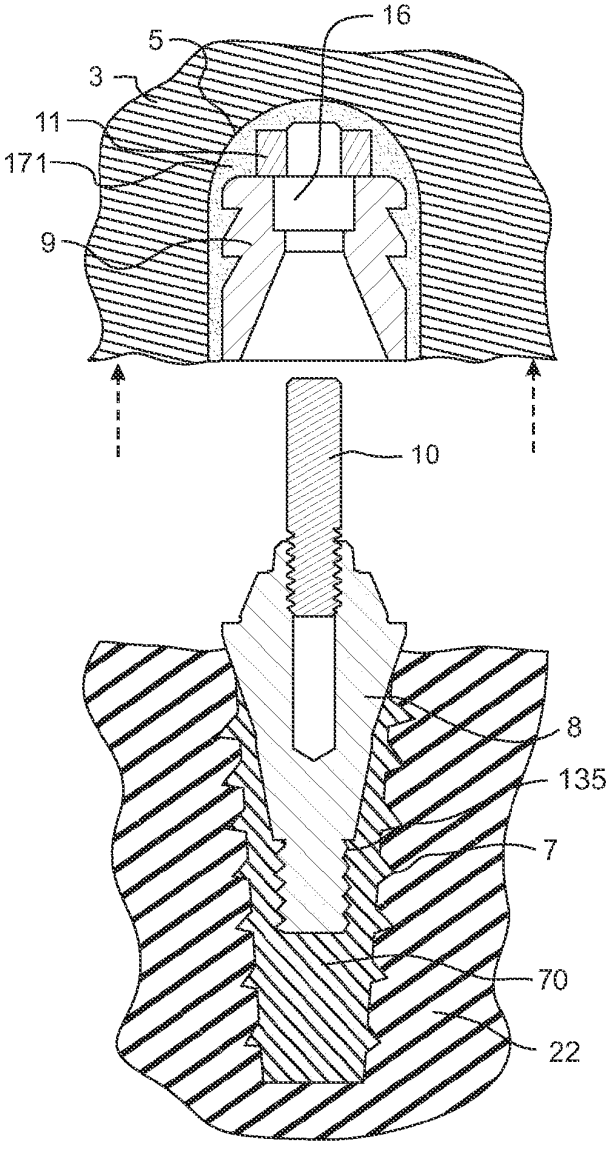


FIG. 6

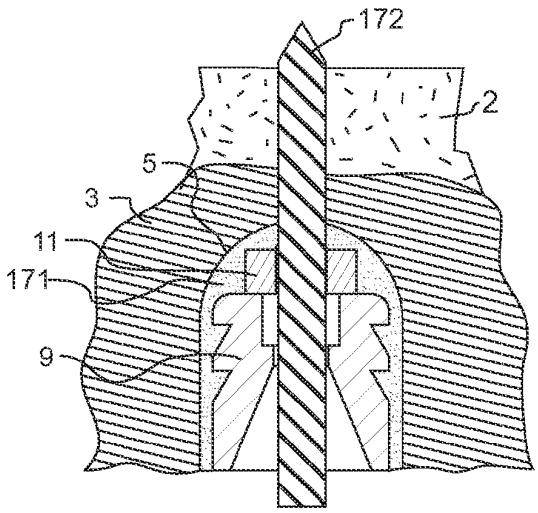


FIG. 7

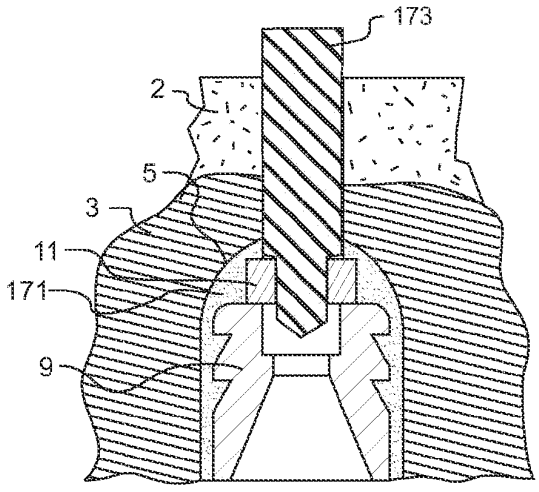


FIG. 8

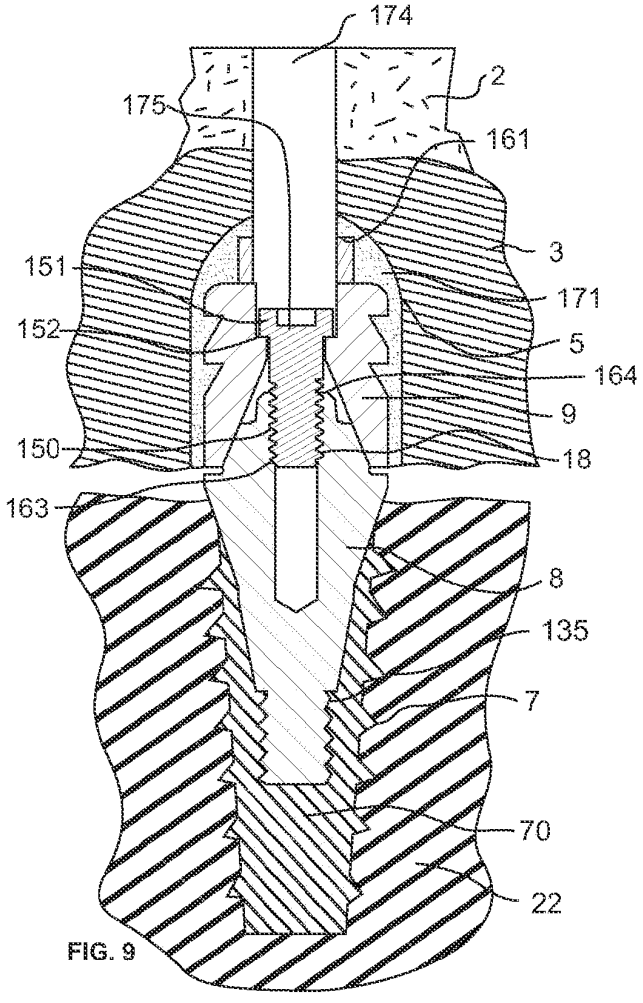


FIG. 9

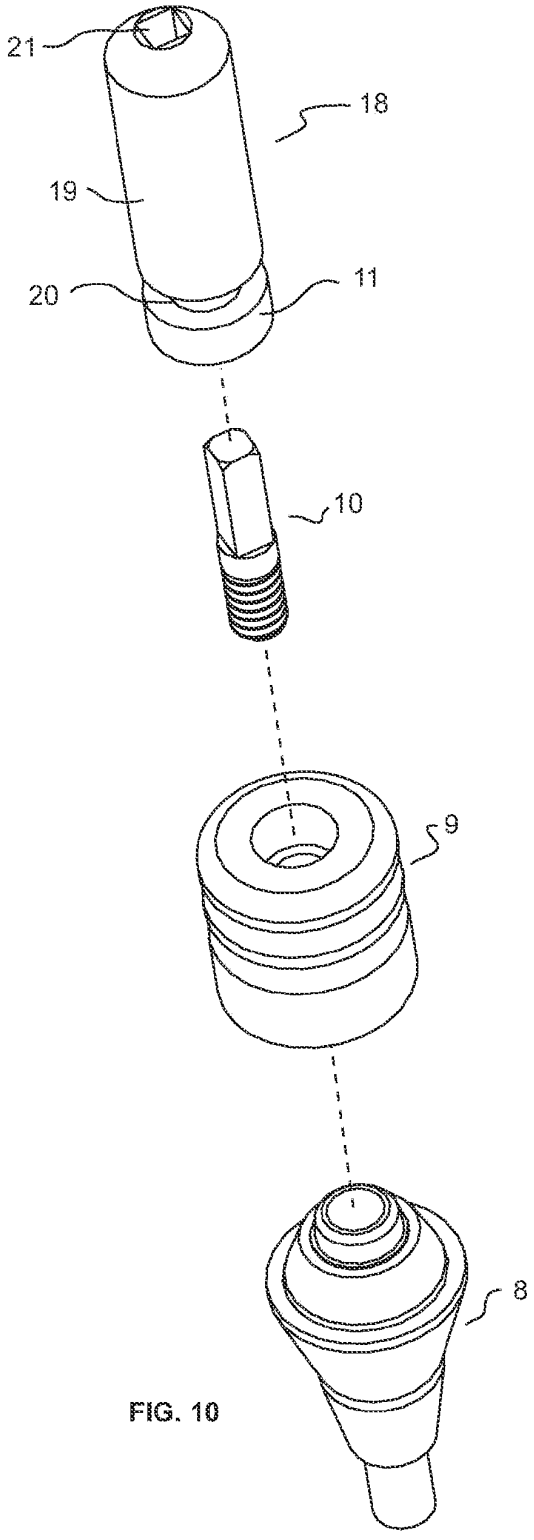


FIG. 10

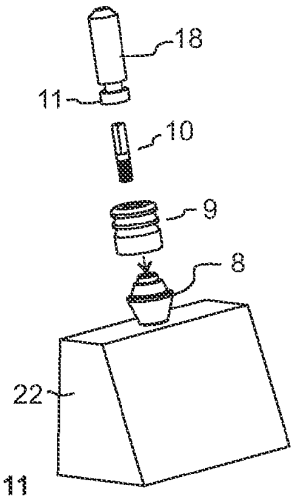


FIG. 11

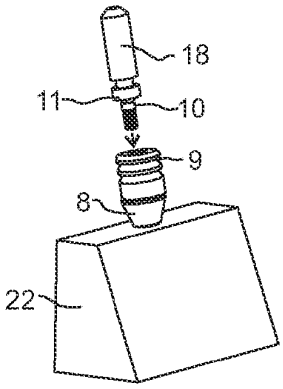


FIG. 12

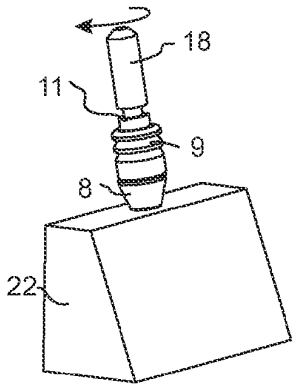


FIG. 13

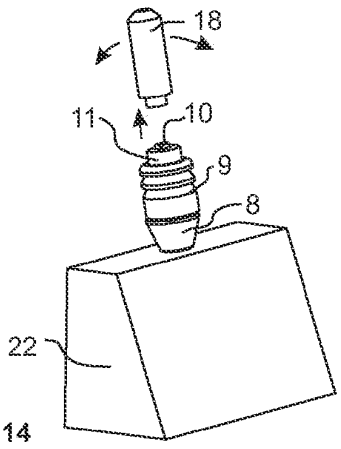


FIG. 14

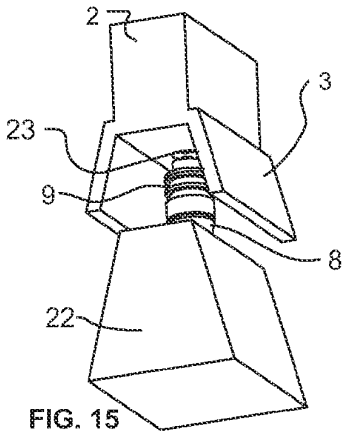


FIG. 15

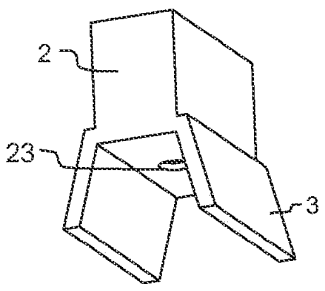


FIG. 16

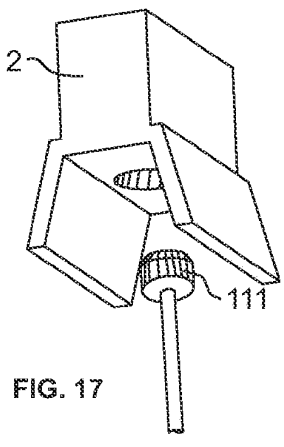


FIG. 17

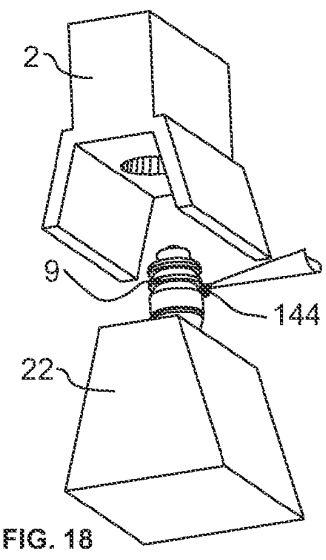


FIG. 18

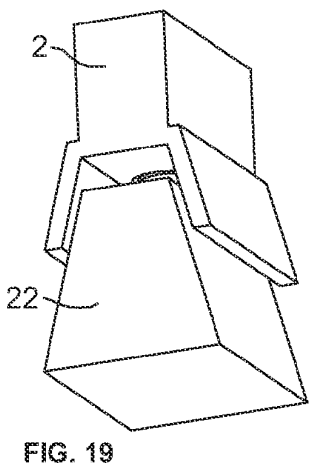


FIG. 19

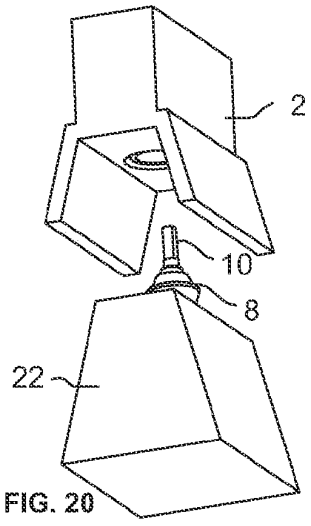


FIG. 20

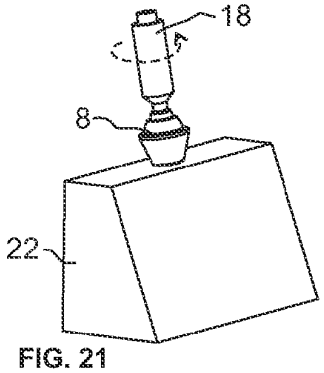


FIG. 21

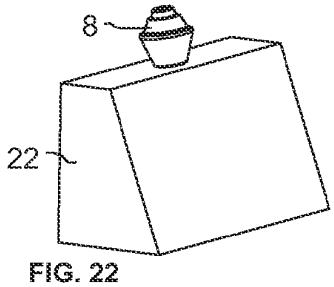


FIG. 22

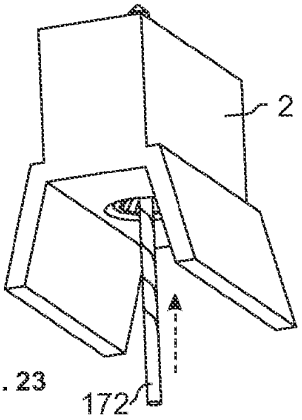


FIG. 23

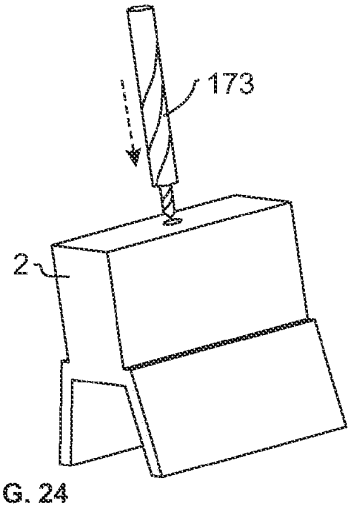


FIG. 24

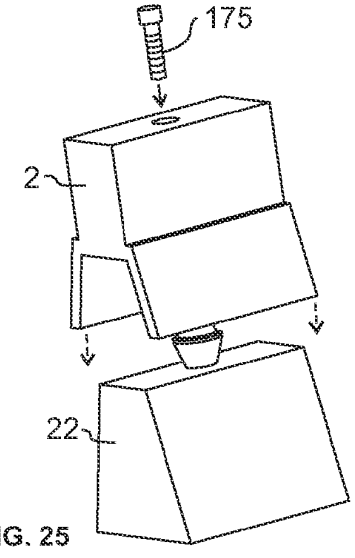


FIG. 25

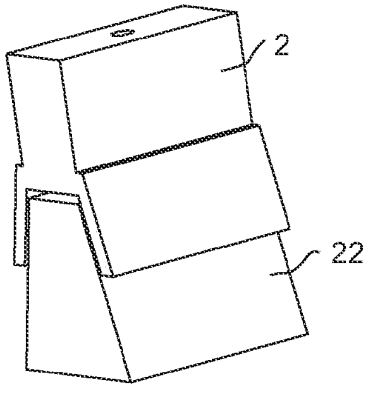


FIG. 26

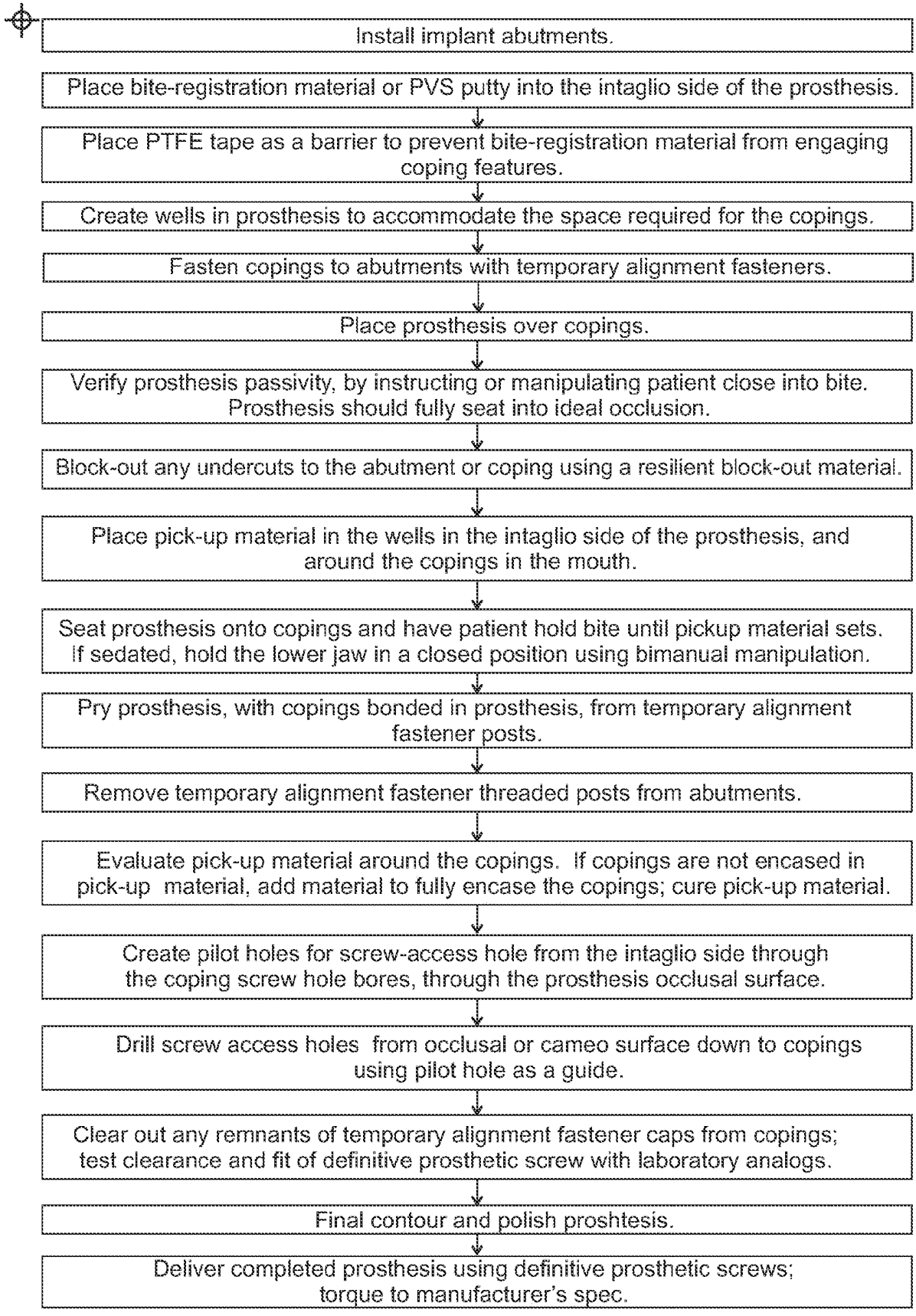

Install implant abutments.
Place bite-registration material or PVS putty into the intaglio side of the prosthesis.
Place PTFE tape as a barrier to prevent bite-registration material from engaging coping features.
Create wells in prosthesis to accommodate the space required for the copings.
Fasten copings to abutments with temporary alignment fasteners.
Place prosthesis over copings.
Verify prosthesis passivity, by instructing or manipulating patient close into bite. Prosthesis should fully seat into ideal occlusion.
Block-out any undercuts to the abutment or coping using a resilient block-out material.
Place pick-up material in the wells in the intaglio side of the prosthesis, and around the copings in the mouth.
Seat prosthesis onto copings and have patient hold bite until pickup material sets. If sedated, hold the lower jaw in a closed position using bimanual manipulation.
Pry prosthesis, with copings bonded in prosthesis, from temporary alignment fastener posts.
Remove temporary alignment fastener threaded posts from abutments.
Evaluate pick-up material around the copings. If copings are not encased in pick-up material, add material to fully encase the copings; cure pick-up material.
Create pilot holes for screw-access hole from the intaglio side through the coping screw hole bores, through the prosthesis occlusal surface.
Drill screw access holes from occlusal or cameo surface down to copings using pilot hole as a guide.
Clear out any remnants of temporary alignment fastener caps from copings; test clearance and fit of definitive prosthetic screw with laboratory analogs.
Final contour and polish proshtesis.
Deliver completed prosthesis using definitive prosthetic screws; torque to manufacturer's spec.

FIG. 27

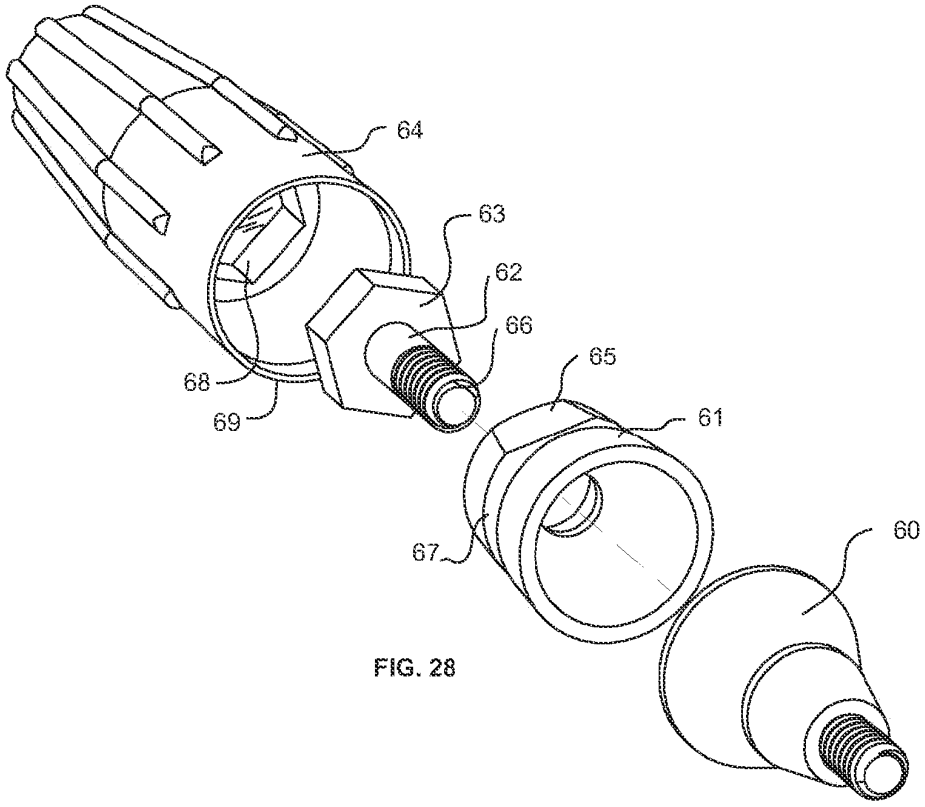


FIG. 28

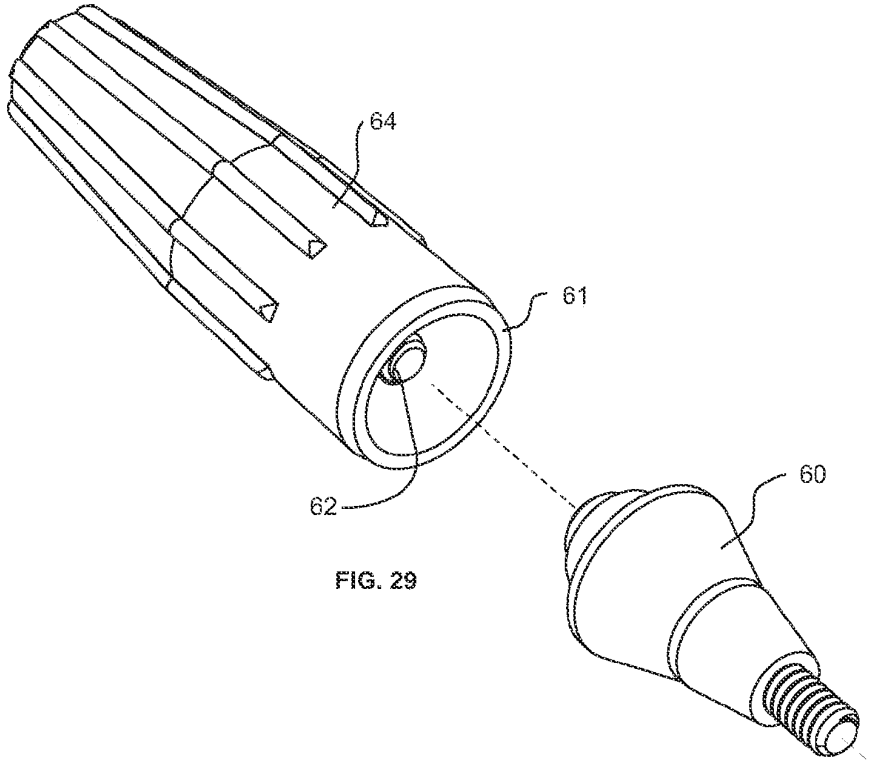


FIG. 29

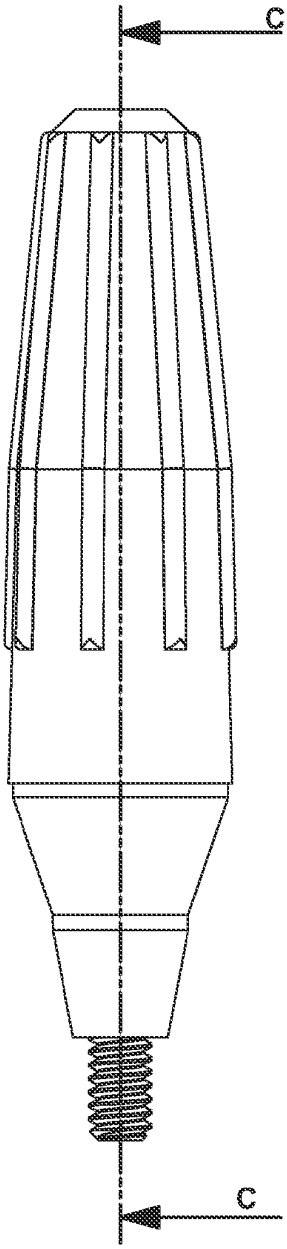


FIG. 30

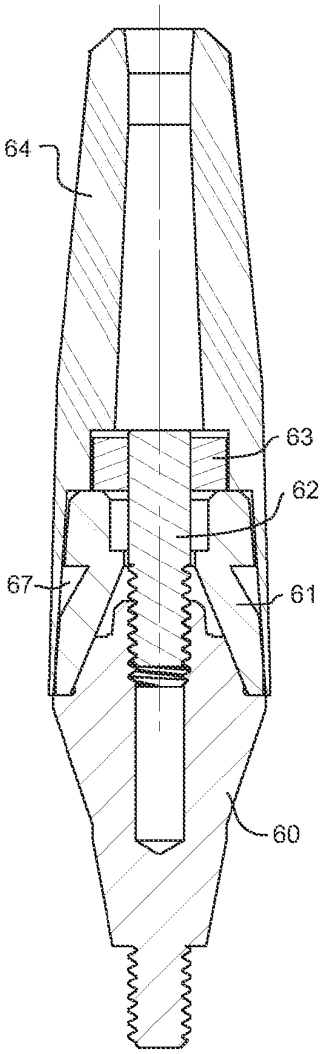


FIG. 31

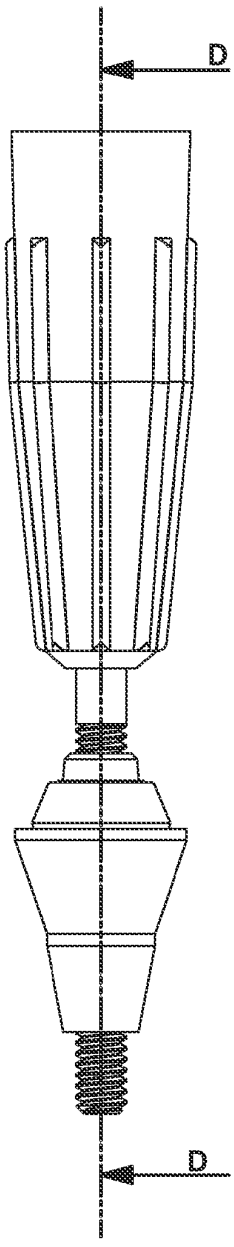


FIG. 32

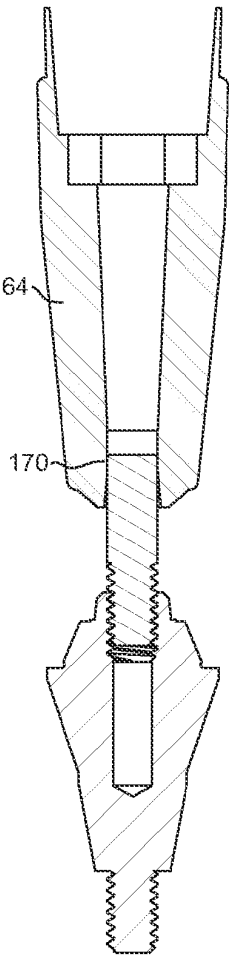


FIG. 33

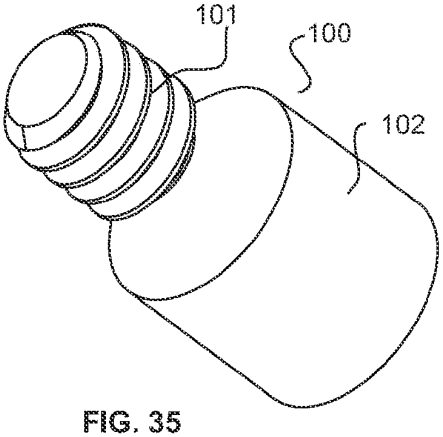


FIG. 35

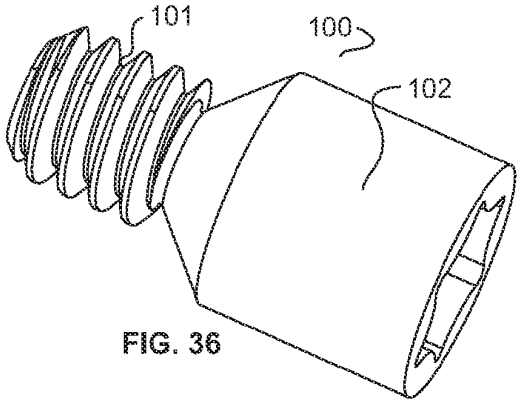


FIG. 36

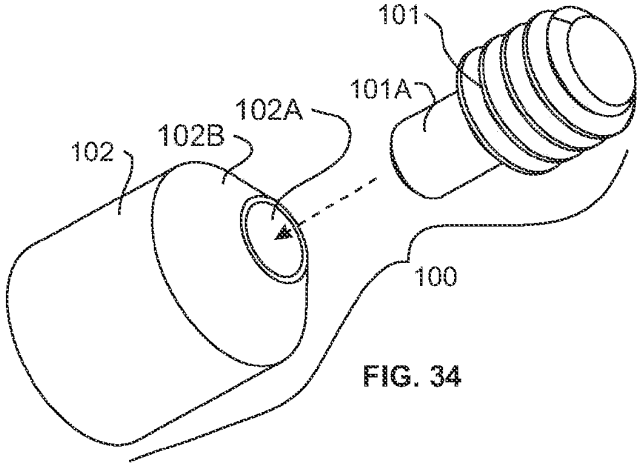


FIG. 34

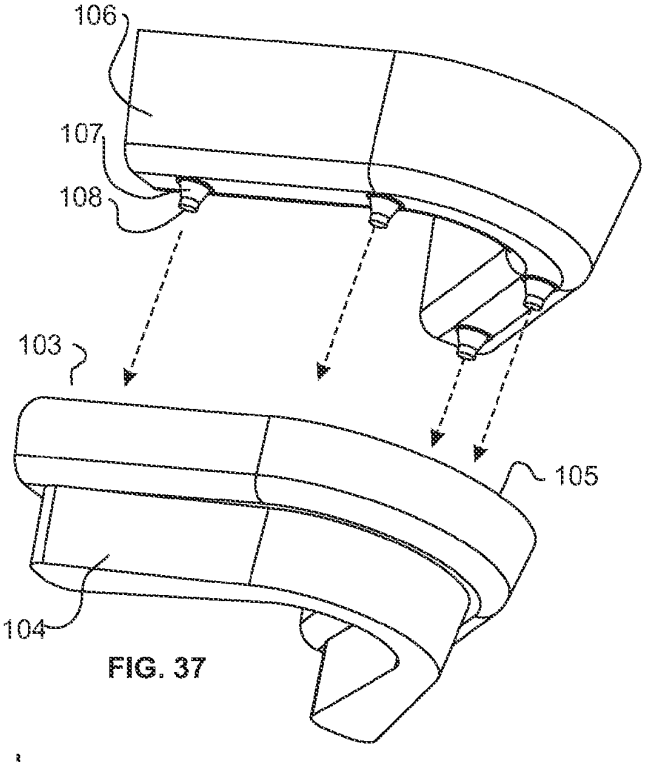


FIG. 37

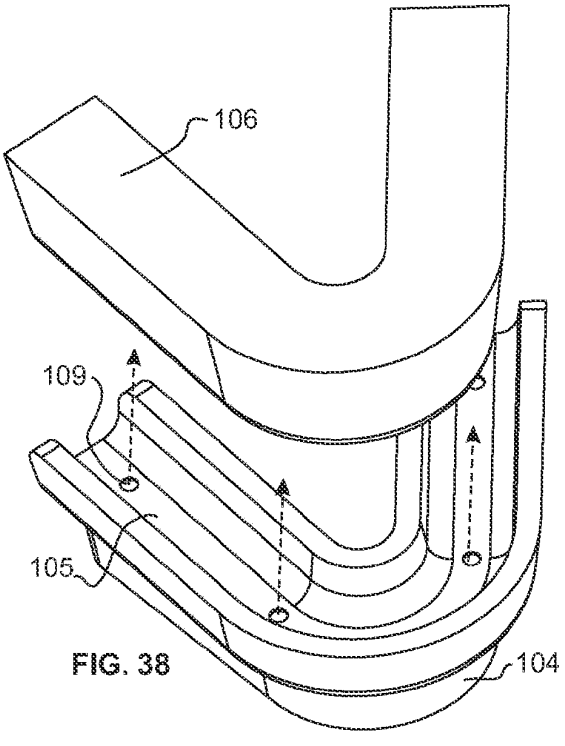


FIG. 38

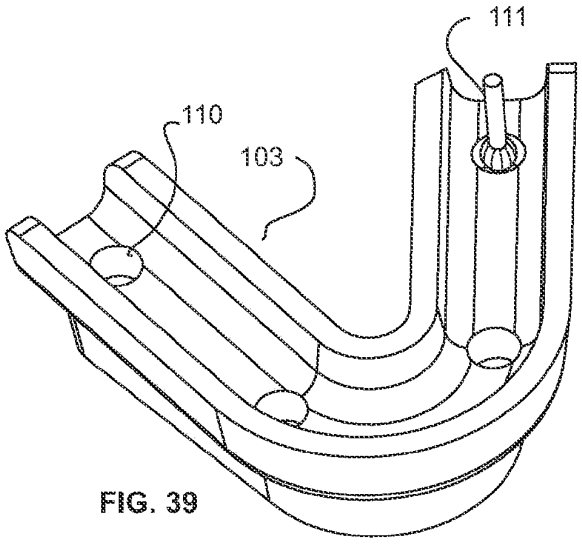


FIG. 39

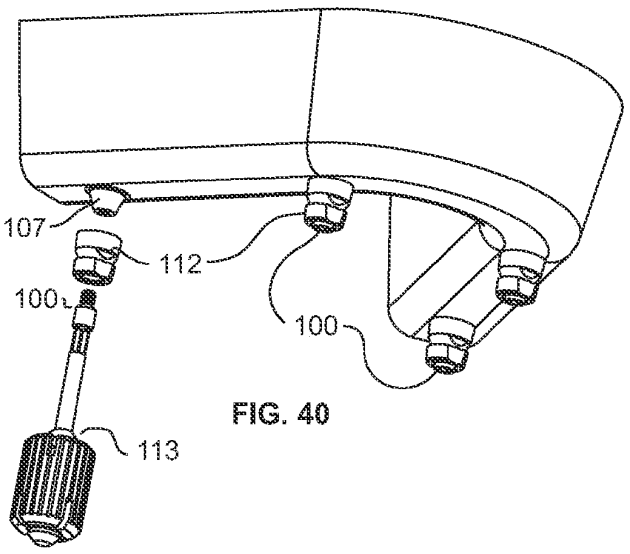


FIG. 40

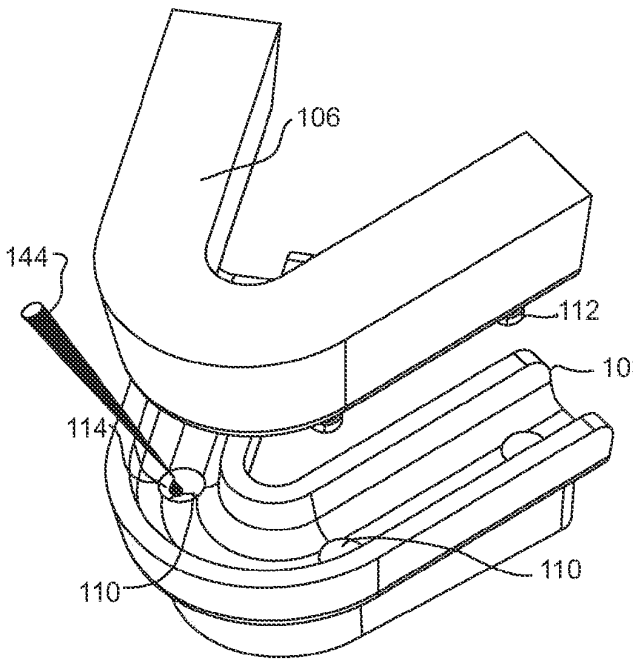


FIG. 41

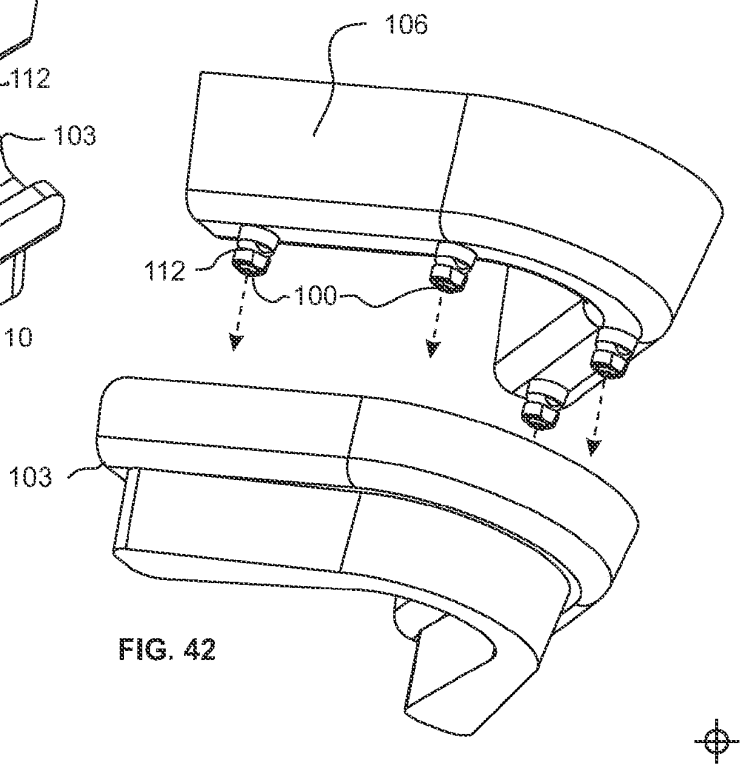


FIG. 42

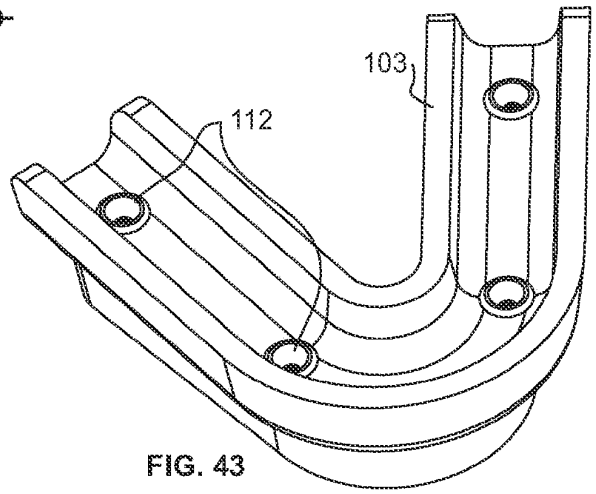


FIG. 43

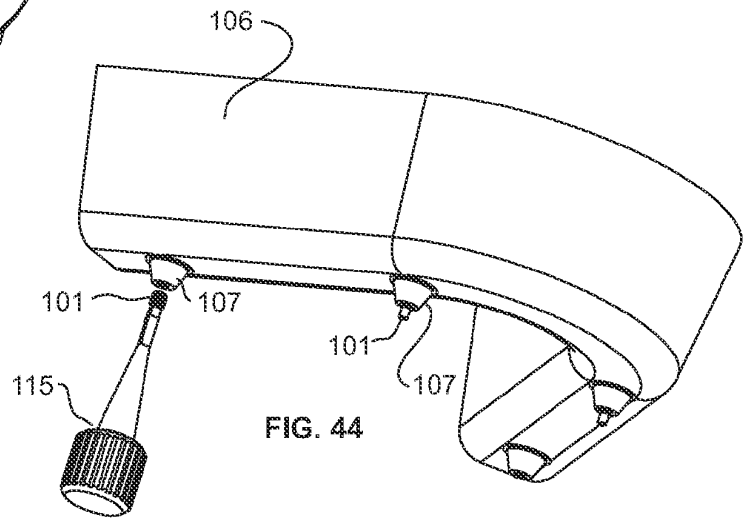


FIG. 44

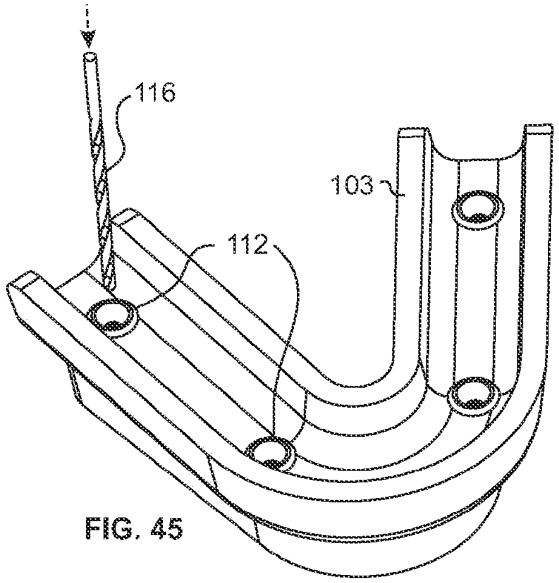


FIG. 45

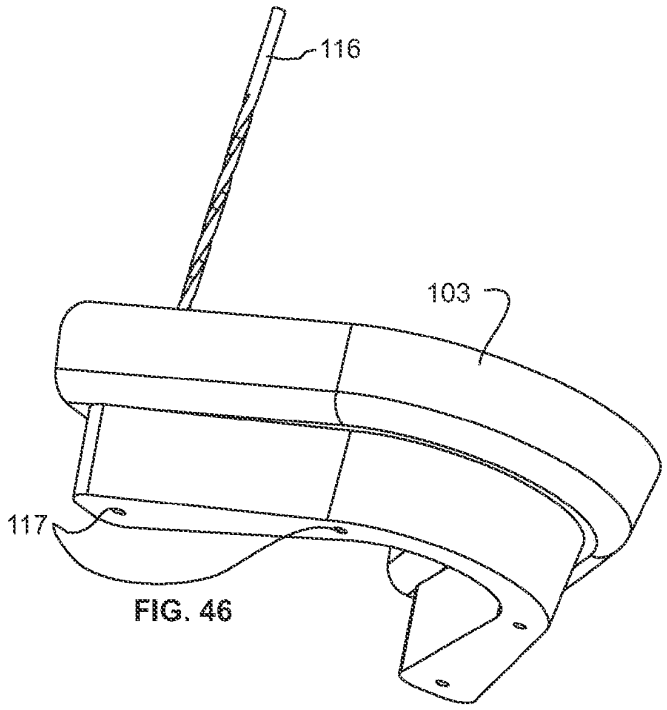


FIG. 46

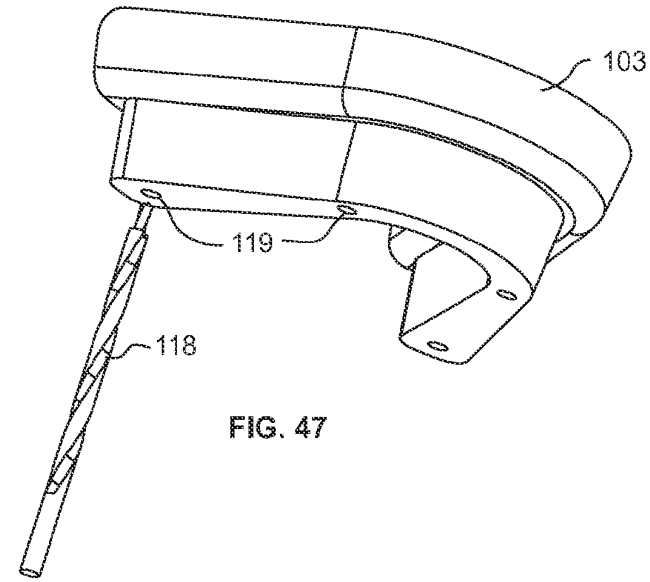


FIG. 47

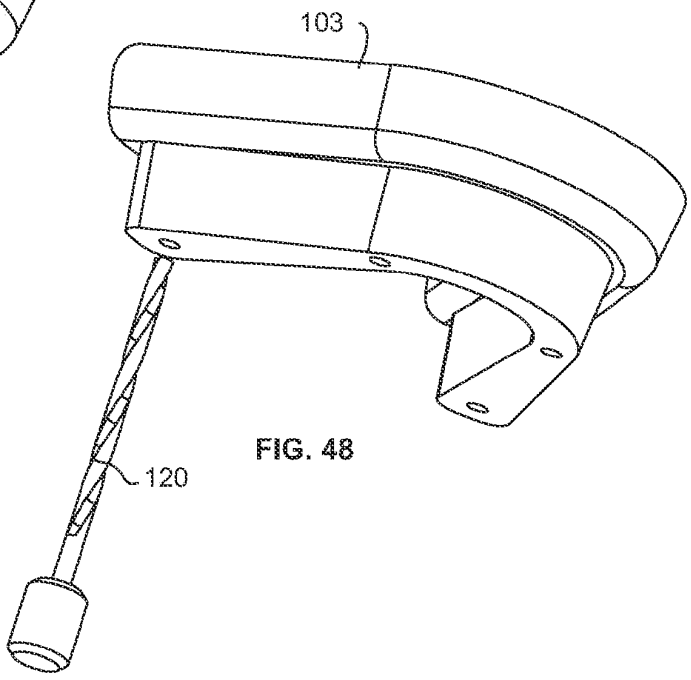


FIG. 48

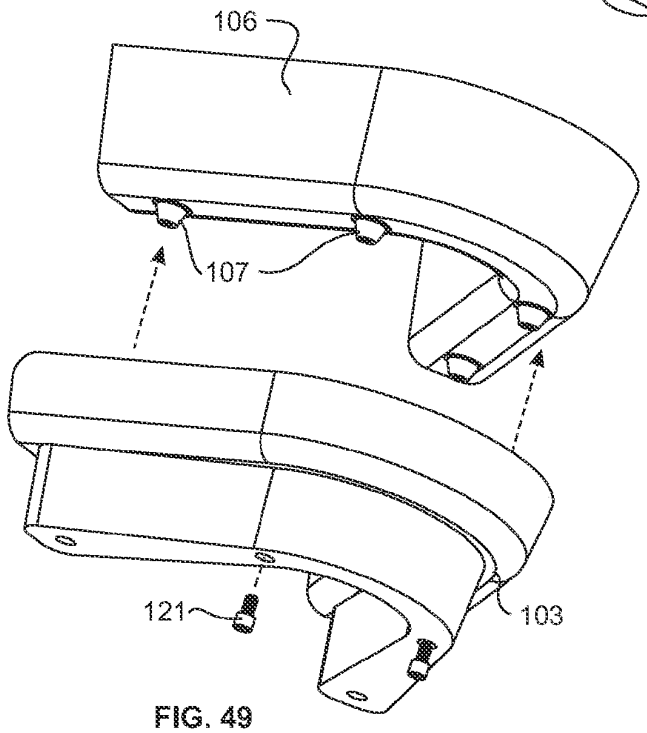


FIG. 49

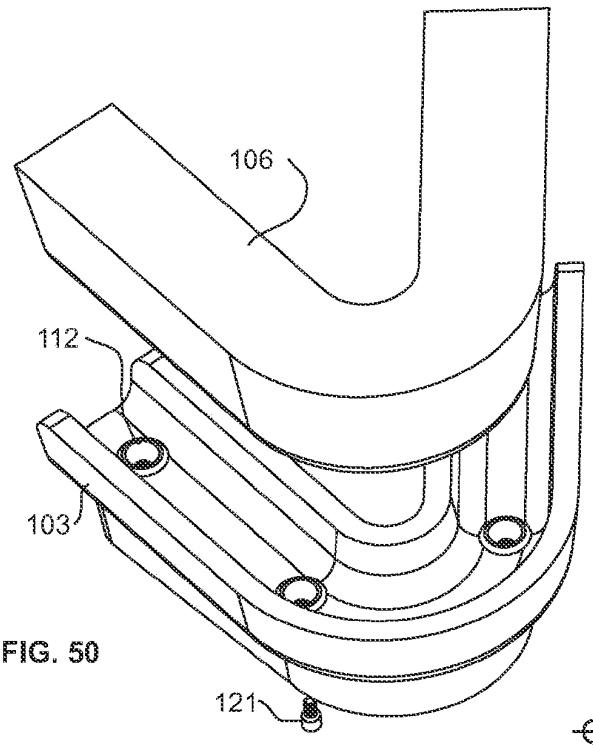


FIG. 50

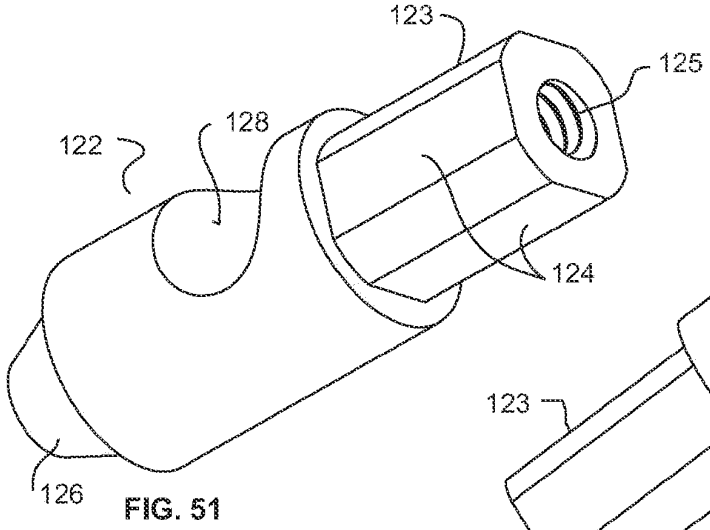


FIG. 51

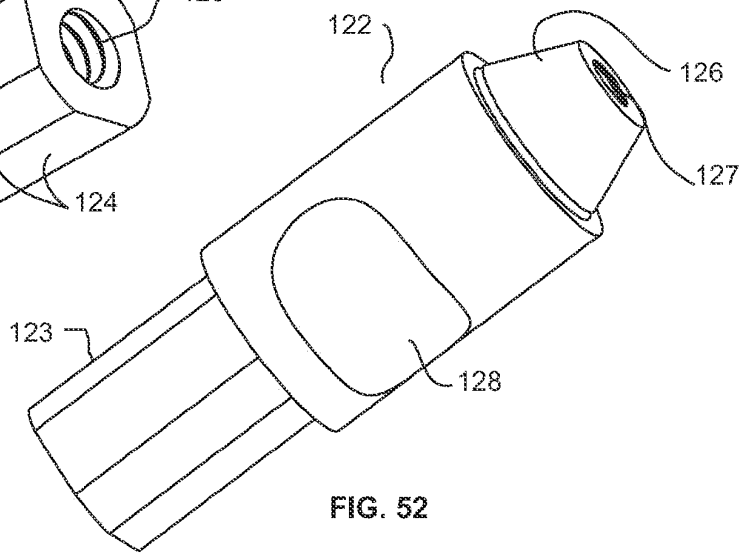


FIG. 52

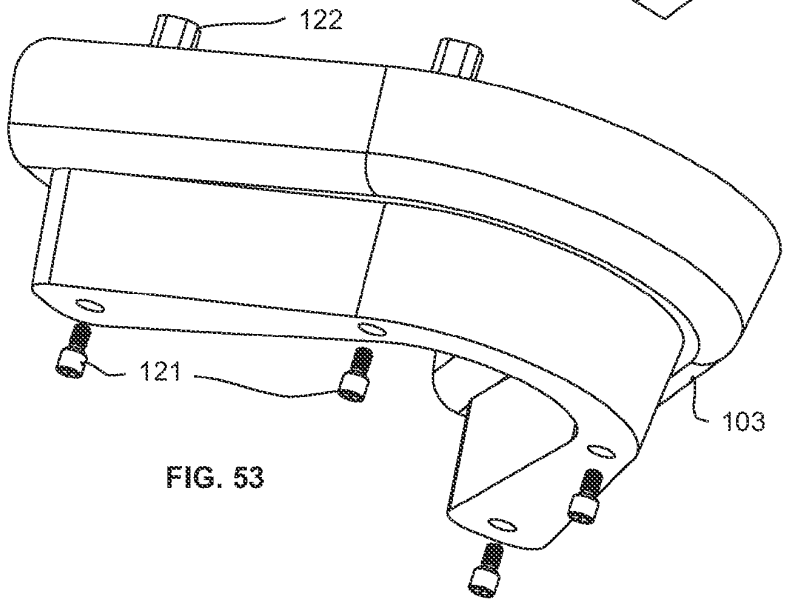


FIG. 53

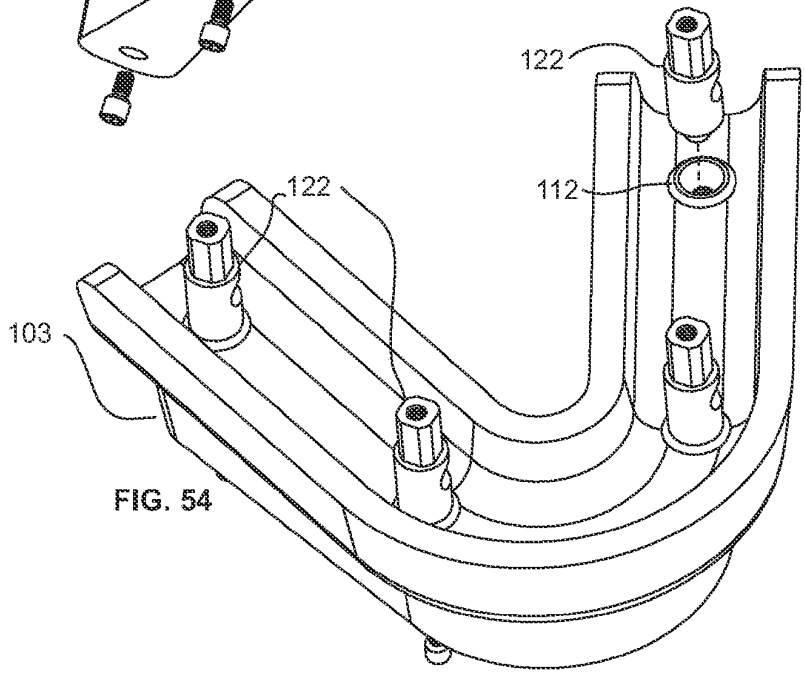


FIG. 54

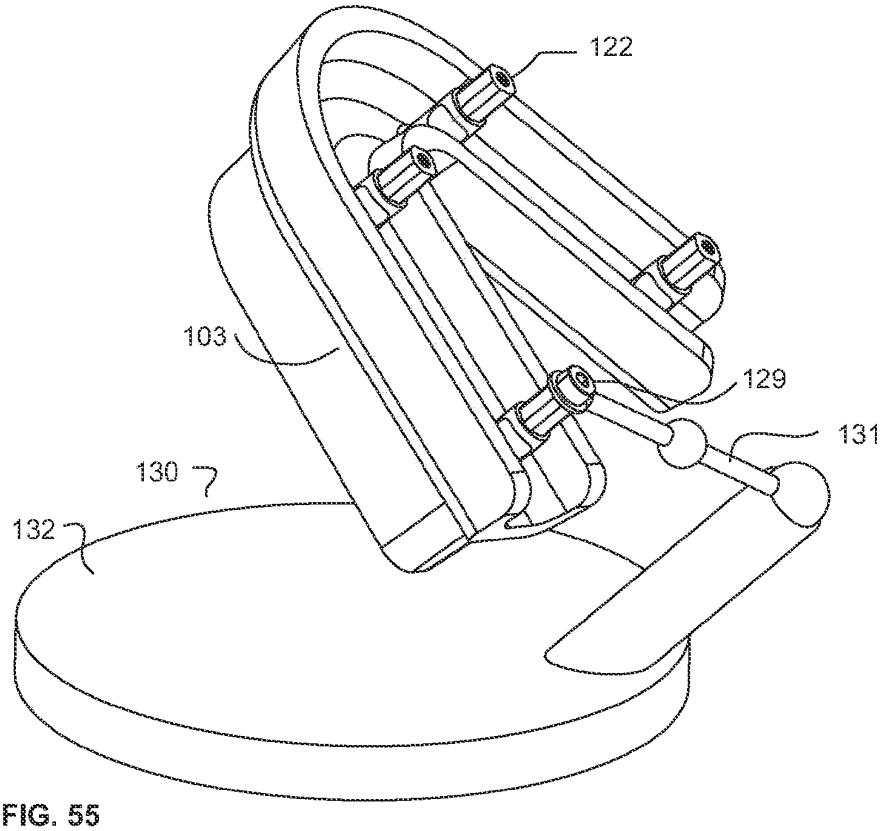


FIG. 55

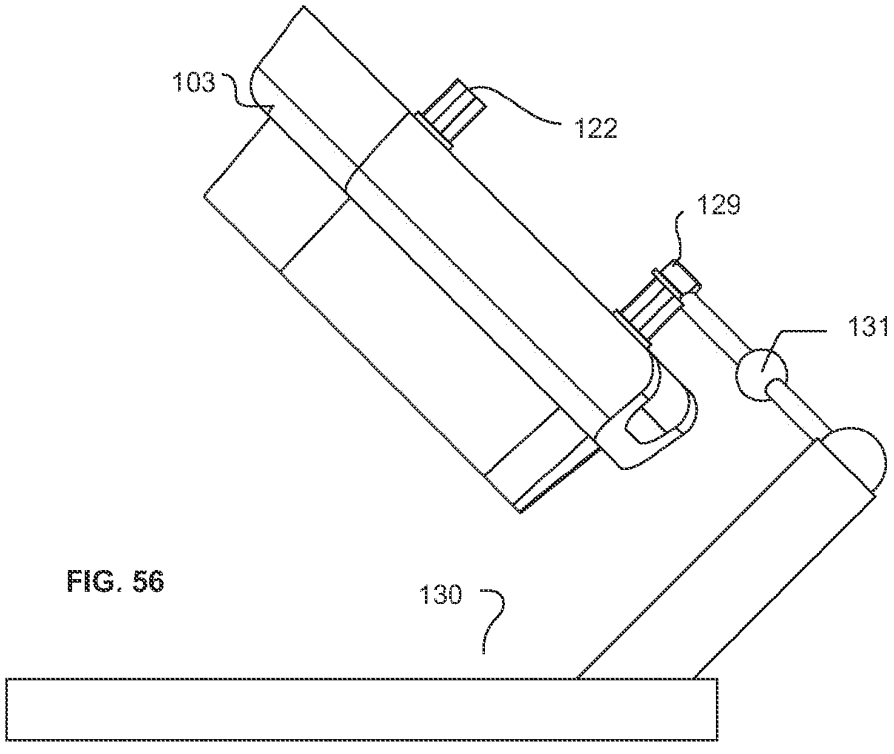


FIG. 56

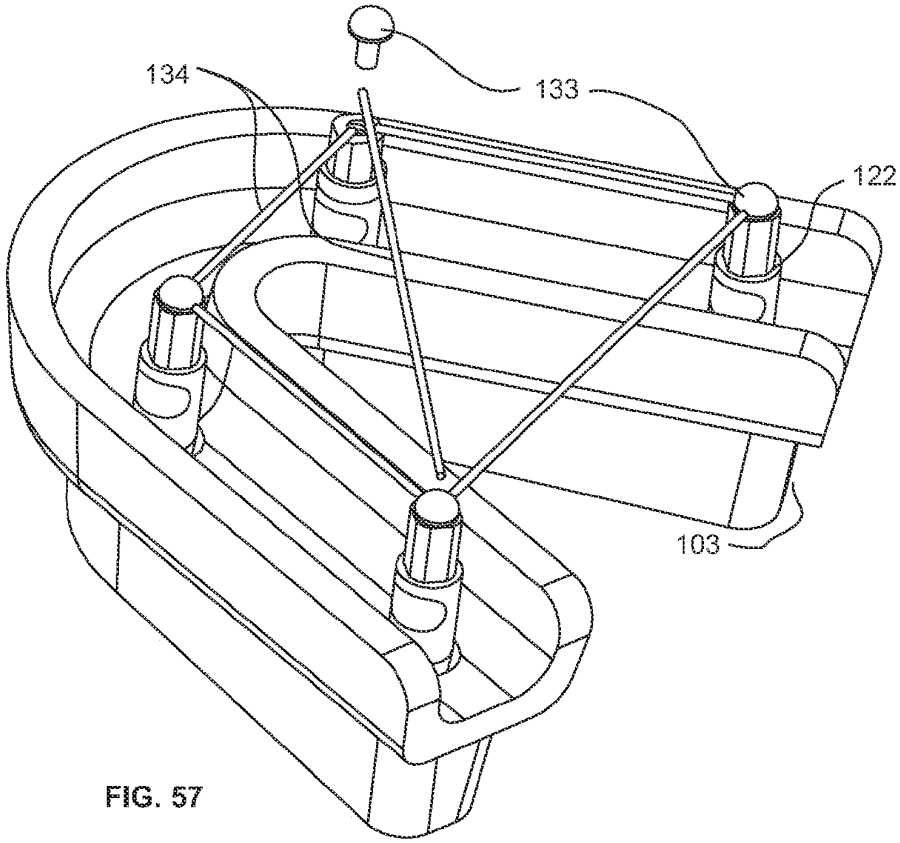


FIG. 57

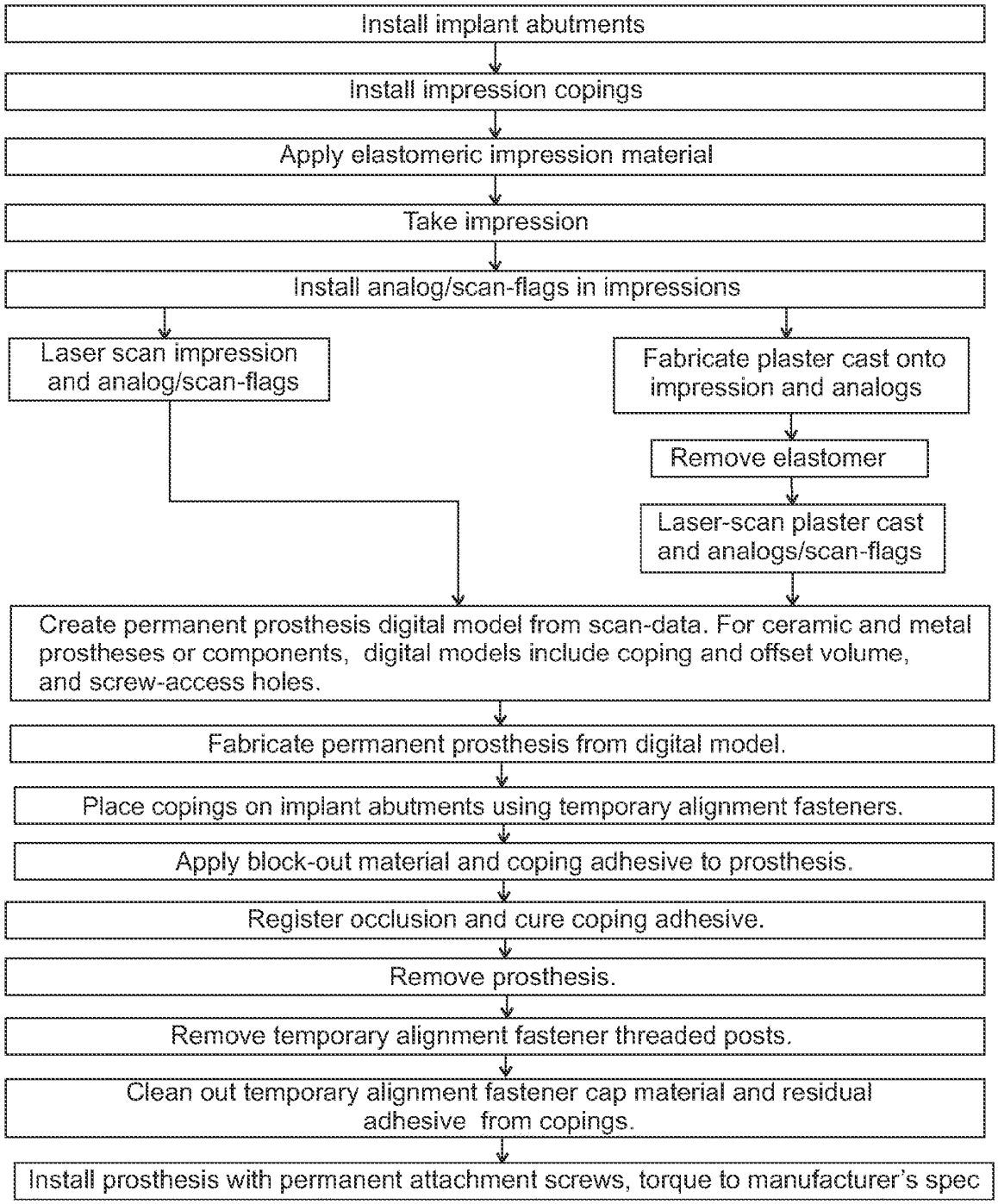

Install implant abutments
Install impression copings
Apply elastomeric impression material
Take impression
Install analog/scan-flags in impressions
Laser scan impression and analog/scan-flags
Fabricate plaster cast onto impression and analogs
Remove elastomer
Laser-scan plaster cast and analogs/scan-flags
Create permanent prosthesis digital model from scan-data. For ceramic and metal prostheses or components, digital models include coping and offset volume, and screw-access holes.
Fabricate permanent prosthesis from digital model.
Place copings on implant abutments using temporary alignment fasteners.
Apply block-out material and coping adhesive to prosthesis.
Register occlusion and cure coping adhesive.
Remove prosthesis.
Remove temporary alignment fastener threaded posts.
Clean out temporary alignment fastener cap material and residual adhesive from copings.
Install prosthesis with permanent attachment screws, torque to manufacturer's spec

FIG. 58

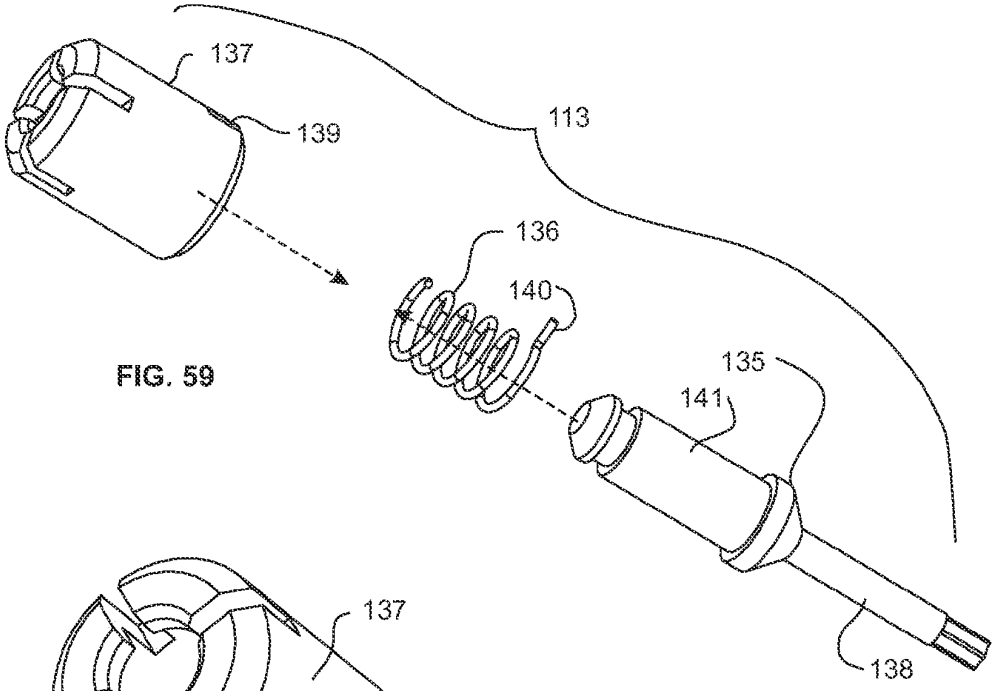


FIG. 59

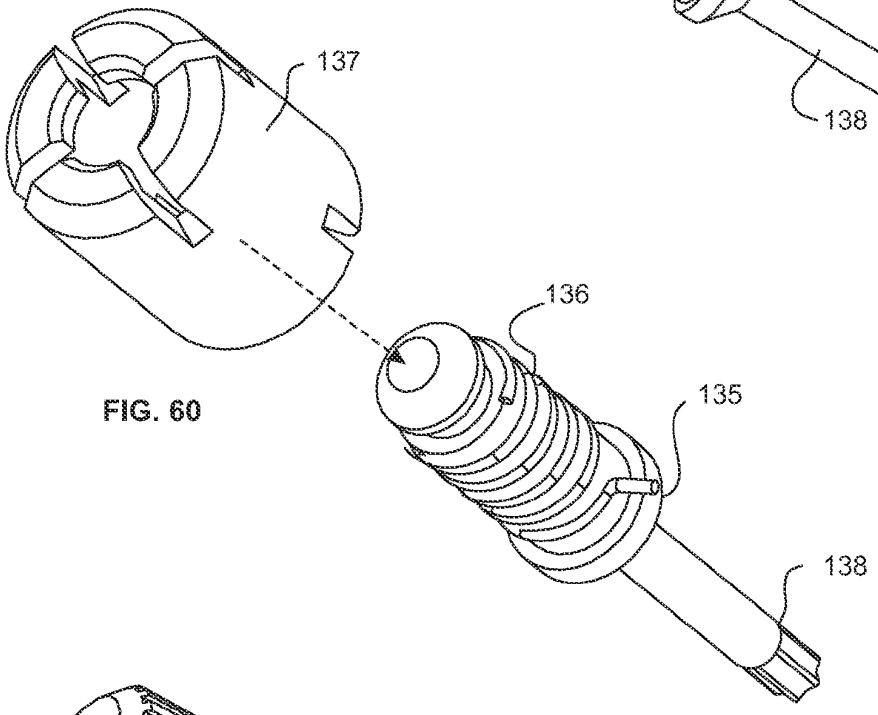


FIG. 60

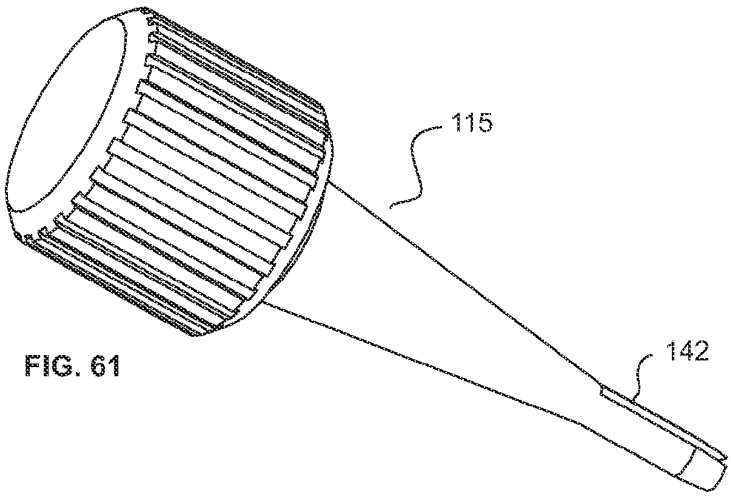


FIG. 61

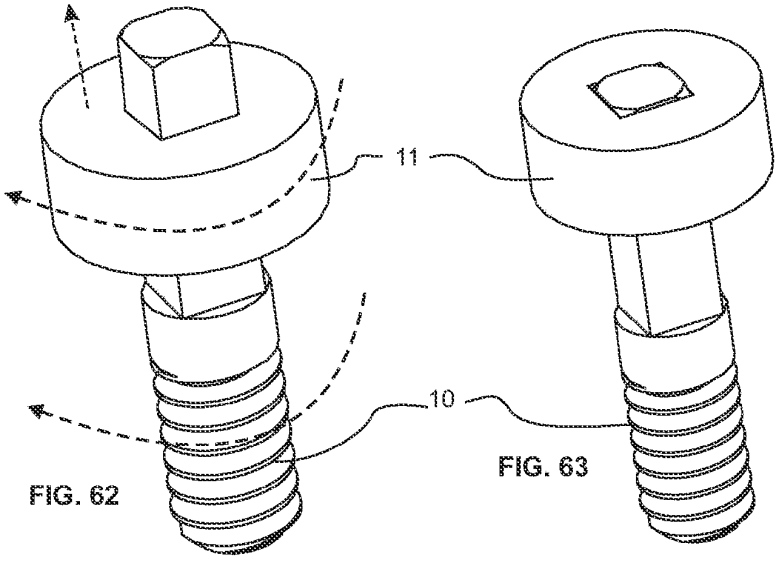


FIG. 62

FIG. 63

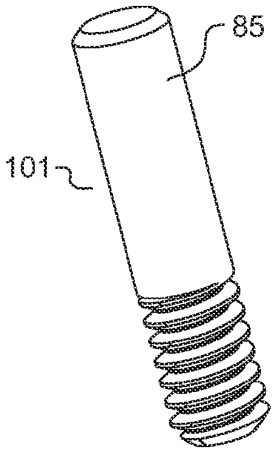


FIG. 64

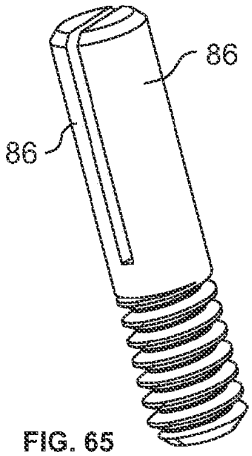


FIG. 65

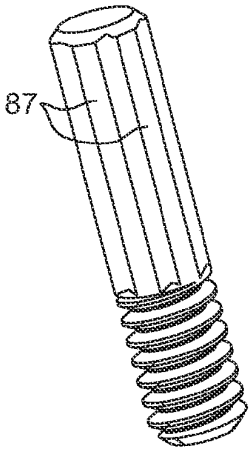


FIG. 66

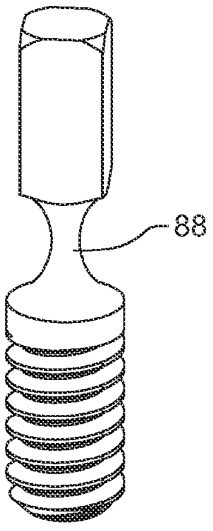


FIG. 67

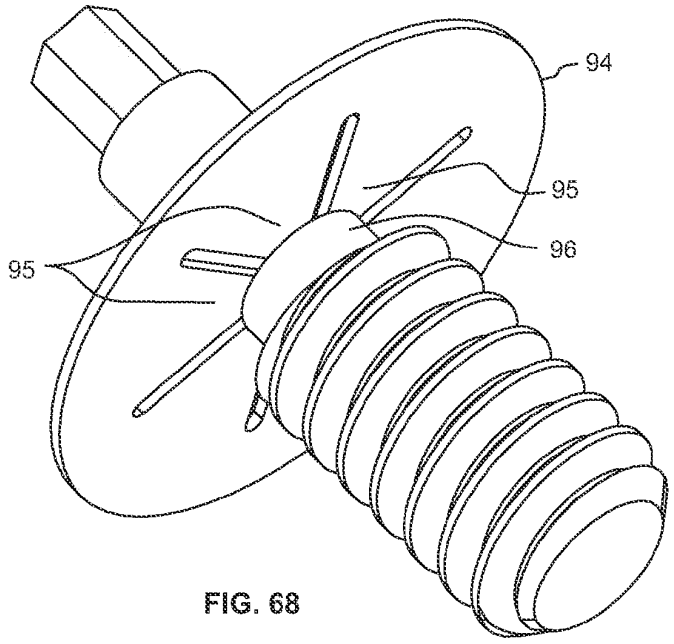


FIG. 68

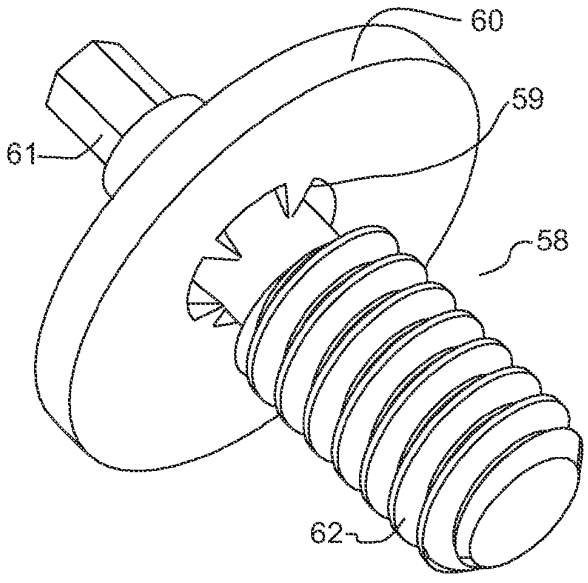


FIG. 69

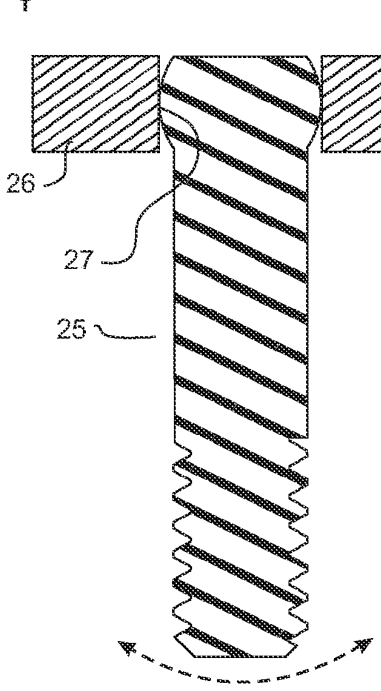


FIG. 70

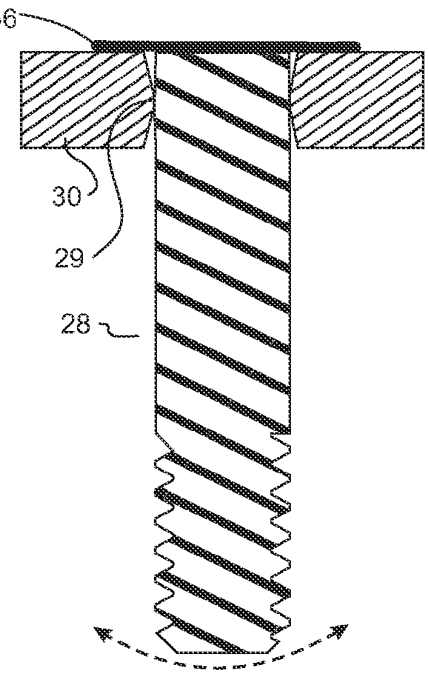


FIG. 71

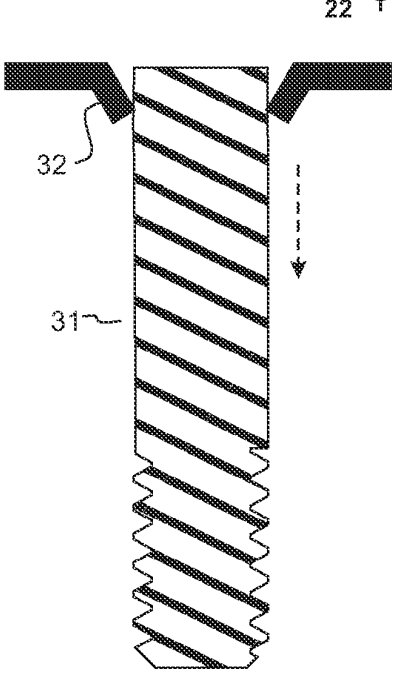


FIG. 72

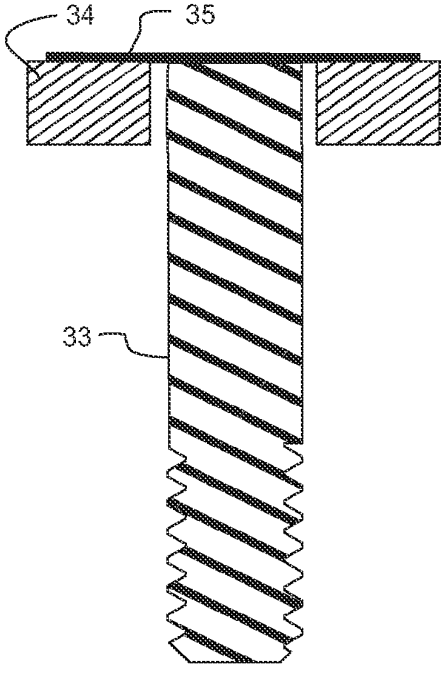


FIG. 73

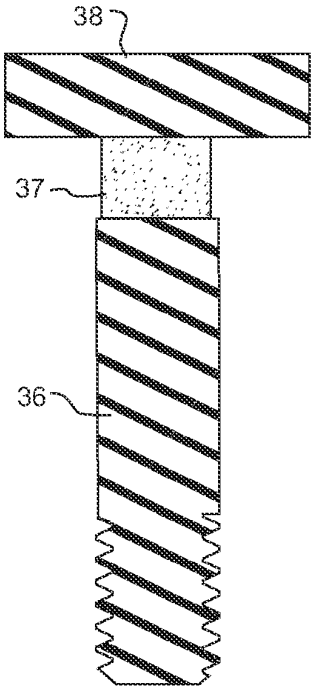


FIG. 74

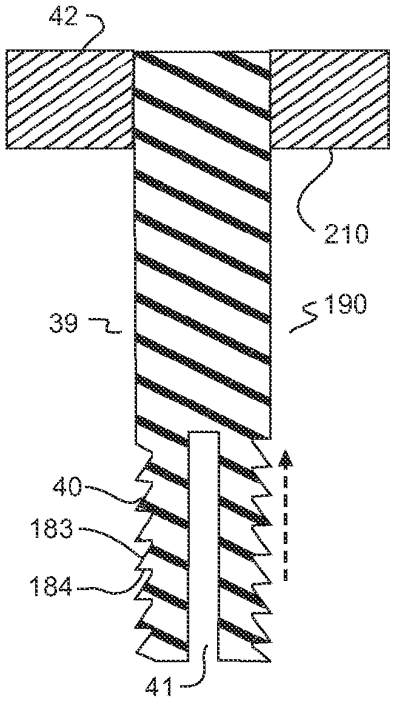


FIG. 75

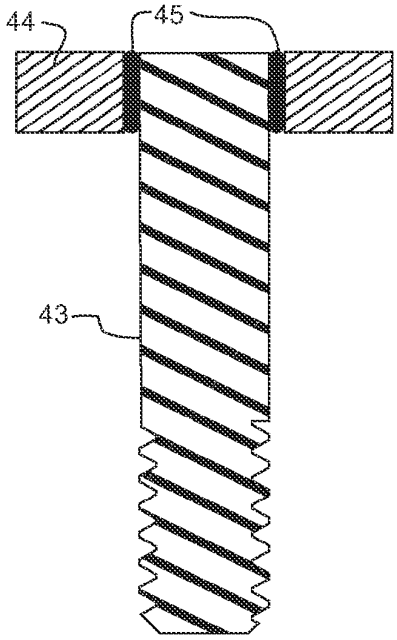


FIG. 76

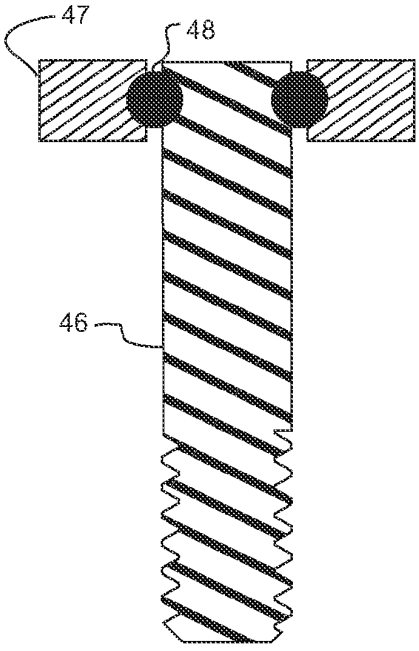


FIG. 77

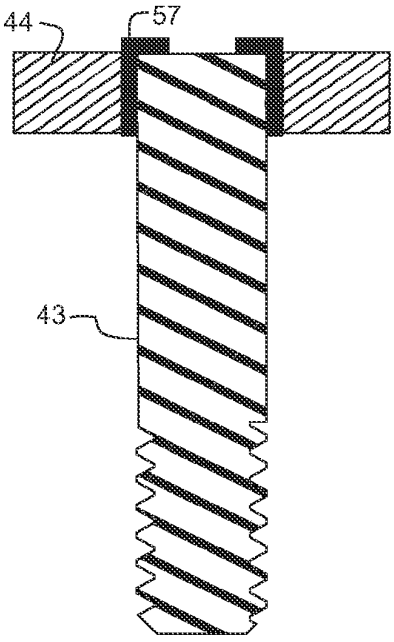


FIG. 78

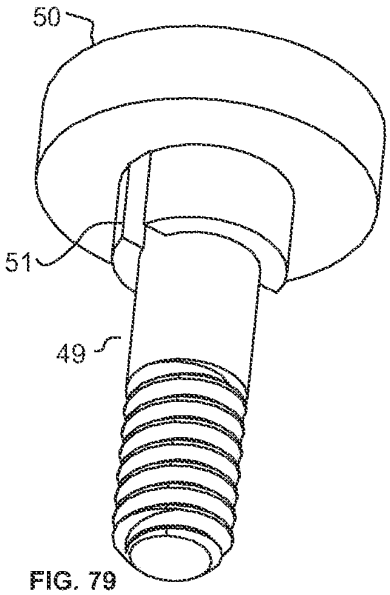


FIG. 79

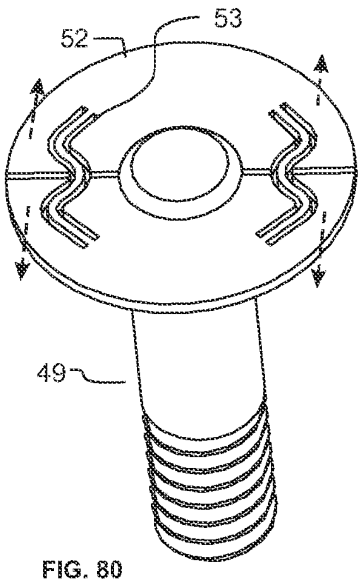


FIG. 80

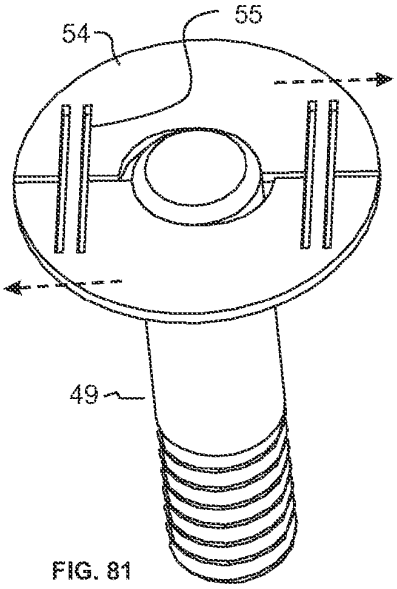


FIG. 81

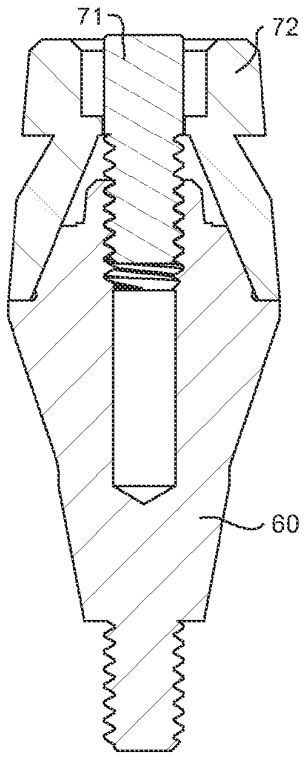


FIG. 82

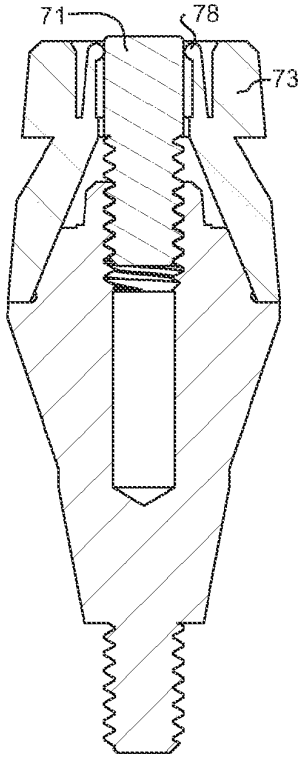


FIG. 83

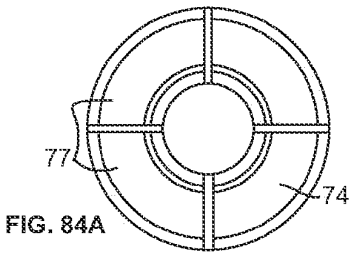


FIG. 84A

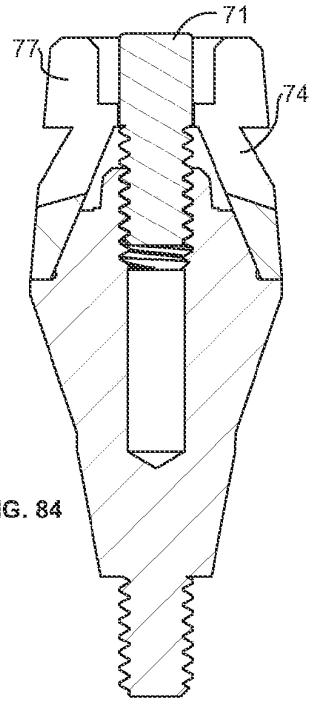


FIG. 84

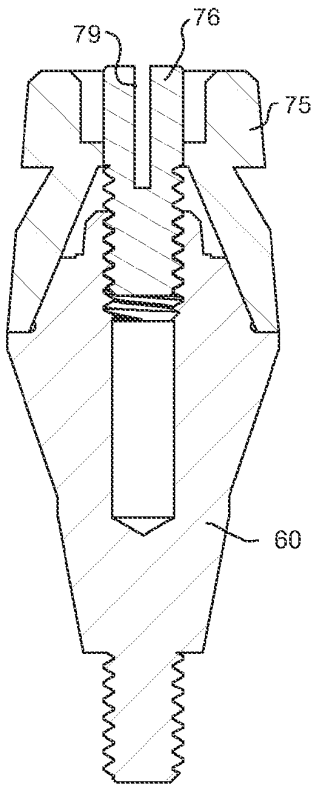


FIG. 85

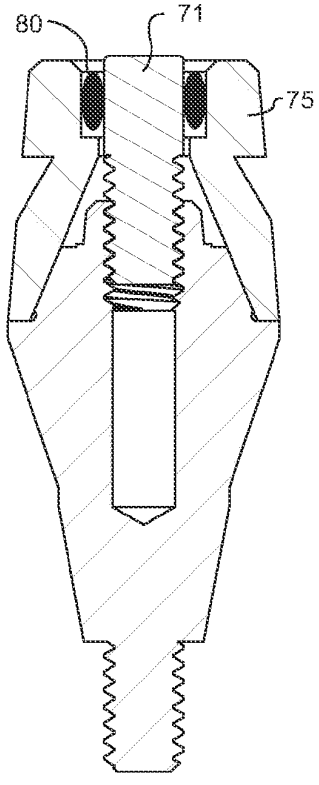


FIG. 86

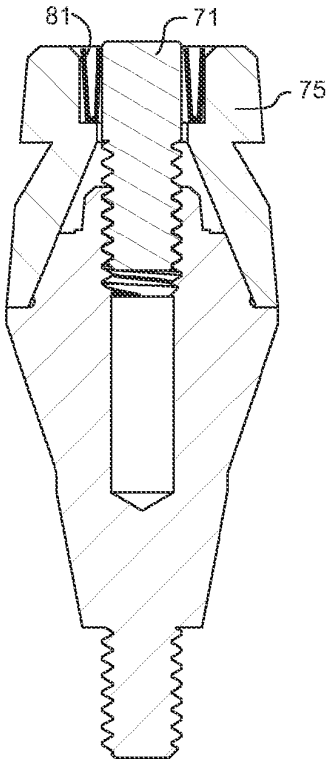


FIG. 87

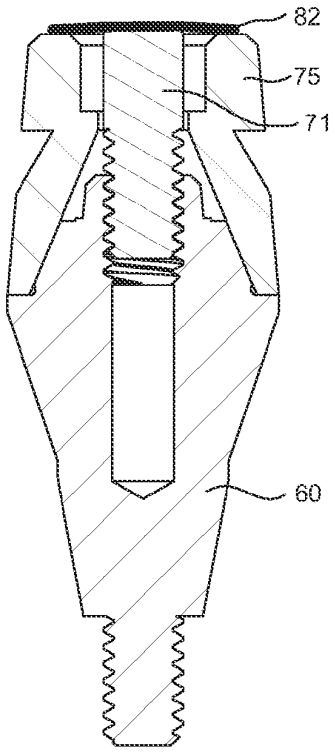


FIG. 88

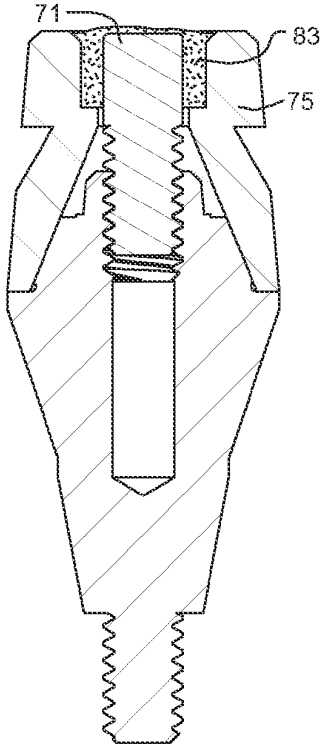


FIG. 89

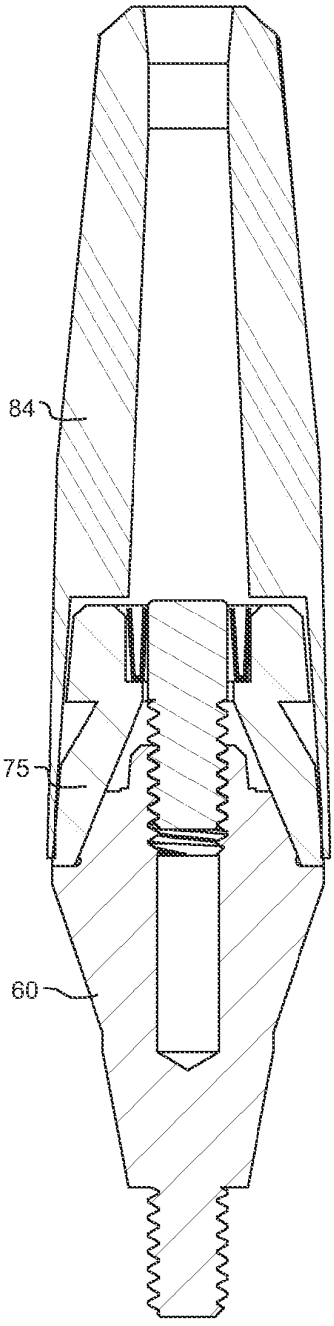


FIG. 90

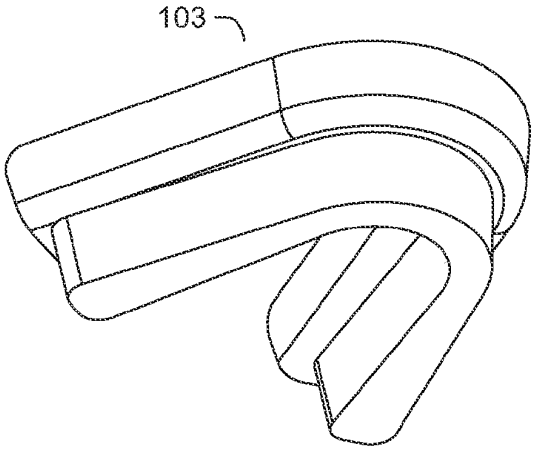


FIG. 91

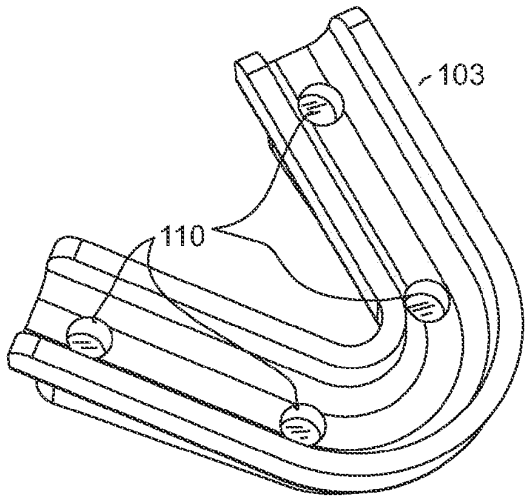


FIG. 92

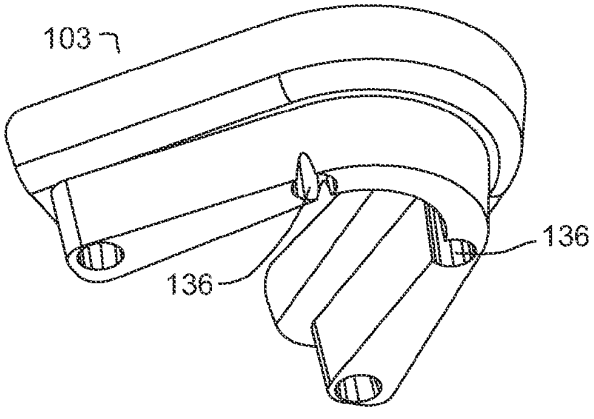


FIG. 93
(PRIOR ART)

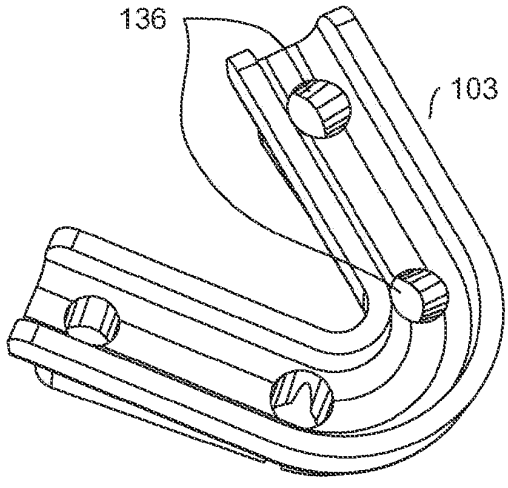


FIG. 94
(PRIOR ART)

UNITED STATES
PATENT AND TRADEMARK OFFICE

P.O. Box 1450
Alexandria, VA 22313 - 1450
www.uspto.gov

ELECTRONIC ACKNOWLEDGEMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/424,696	**01/26/2024 09:36:44 PM Z ET**	**SDC012**

Title of Invention

Screw-attached Pick-up Dental Coping System and Methods

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5633	FILED BY	Daniel Whittle
PATENT CENTER #	63990838	FILING DATE	-
CUSTOMER #	112823	FIRST NAMED INVENTOR	Brandon Dale Kofford
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 10

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
generatedADS63990838.pdf	6	Application Data Sheet	142 KB
npp-IN-figs-26jan2024-26pg.pdf	26	Drawings-only black and white line drawings	699 KB
SDC012spec-APP.TEXT.docx	52	Application body structured text document	67 KB
SDC012spec.pdf	52	Specification	413 KB
aia0424SDC012.pdf	2	Track One Request	117 KB
aia0082SDC012CAR-signed.pdf	4	Power of Attorney	178 KB
aia0082SDC012BDK_signed.pdf	4	Power of Attorney	178 KB

aia0001SDC012CAR-signed.pdf	2	Oath or Declaration filed	147 KB
aia0001SDC012BDK_edited.pdf	2	Oath or Declaration filed	147 KB
aia0015SDC012.pdf	2	Transmittal of New Application	270 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Kofford, Brandon Dale	Nonprovisional Application Number (if known):	
Title of Invention:	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Daniel John Whittle/	Date 01-26-2024
Name (Print/Typed) Daniel John Whittle	Practitioner Registration Number 54,537

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/01 (06-12)
Approved for use through 01/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Charles Albert Rudisill Date (Optional) :_____

Signature: /Charles Albert Rudisill/

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
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6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Application Data Sheet 37 CFR 1.76

The Application Data Sheet is part of the provisional or non-provisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.

Inventor Information

of inventors: 2

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Application Information

Customer number **112823 -**

Correspondence address	---
Title of invention	**Screw-attached Pick-up Dental Coping System and Methods**
Attorney docket number	**SDC012**
Entity status	Small
Application type	Nonprovisional Application under 35 USC 111(a)
Subject matter	Utility
Total number of drawing sheets	26
Suggested figure for publication	75
Filing by reference	No
Publication request	**REQUEST NOT TO PUBLISH** under 35 U.S.C. 122(b) I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information

of representatives: 1

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).

Customer number 112823

Domestic Benefit/National Stage Information

of benefit claims: 6

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c), 386(c), or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior app status	Pending
Application number	---
Continuity type	**Continuation of**
Prior app number	**18328730**
Filing Date	06/03/2023

Prior app status	Pending
Application number	---
Continuity type	**Continuation of**
Prior app number	**17691108**
Filing Date	03/09/2022

Prior app status	Patented
Application number	---
Continuity type	**Continuation of**
Prior app number	**16596361**
Filing Date	03/09/2022
Patent number	11311354

Prior app status	Expired
Application number	---
Continuity type	**Claims benefit of provisional**
Prior app number	**62742942**
Filing Date	03/09/2022

Prior app status	Expired
Application number	---
Continuity type	**Claims benefit of provisional**
Prior app number	**62774402**

Filing Date	03/09/2022

Prior app status	Expired
Application number	---
Continuity type	**Claims benefit of provisional**
Prior app number	**62818082**
Filing Date	03/09/2022

Foreign Priority Information

of foreign priority claims: 0

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the Application Data Sheet constitutes the claim for priority as required by 35 U.S.C. 119 (b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX) the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Data was not provided for this section.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

Checking this box will cause the application to be examined under the first inventor to file provisions of the AIA.

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013. NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 2016, 2013, will be examined under the first inventor to file provisions of the AIA.

Authorization or Opt-Out of Authorization to Permit Access

When this Application Data Sheet is properly signed and filled with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in

subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE:
This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. **Priority Document Exchange (PDX)**
Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h) (1).

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The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

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☑ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

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NOTE:
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Applicant Information

of applicants: 0

The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46.

Data was not provided for this section.

Assignee Information including Non-Applicant Assignee Information

of assignees: 0

An assignee-applicant identified in the "Applicant" section will appear on the patent application as an applicant.

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Data was not provided for this section.

Signature

NOTE:

This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c)**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See CFR 1.4(d) for the manner of making signatures and certifications.

Signature	First name	Last name	Registration #	Date
/Daniel John Whittle/	Daniel	Whittle	54537	01/26/2024

Doc Code: PA..
Document Description: Power of Attorney

PTO/AIA/82A (07-13)
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Application Number	
Filing Date	2024-01-26
First Named Inventor	Brandon Dale Kofford
Title	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS
Art Unit	
Examiner Name	
Attorney Docket Number	SDC012

SIGNATURE of Applicant or Patent Practitioner

Signature	/Daniel John Whittle, #54,537/	Date (Optional)	
Name	Daniel John Whittle	Registration Number	54,537
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ *Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Doc Code: PA..
Document Description: Power of Attorney

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POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

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☑ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above: 000112823

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☐ The address associated with the above-mentioned Customer Number

OR

☑ The address associated with Customer Number: 000112823

OR

Firm or Individual Name					
Address					
City		State		Zip	
Country					
Telephone		Email			

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

☑ Inventor or Joint Inventor (title not required below)

☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)

☐ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)

☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature	/Brandon D. Kofford/	Date (Optional)	
Name	Brandon D Kofford		
Title			

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☑ Total of 2 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number

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The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS

ABSTRACT

A temporary alignment system and method for holding a dental coping to an implant abutment using the same threads in the abutment that are used for definitive attachment are disclosed. The disclosed temporary fasteners initially orient and hold a coping against an abutment with a force along the same axis as the semi-definitive screw. The aligned coping can be picked-up in a closed-tray impression process without unscrewing the temporary fastener. Embodiments include threaded posts that release copings from the abutment through axial forces. Some embodiments include a threaded post with separable cap that is picked-up with the coping. Methods for converting an existing prosthesis for screw attachment to implants in a single visit and digital capture of the converted prosthesis are described.

1 Specification

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of US Patent Application 18/328,730, filed on June 3, 2023, which is a continuation of US Patent Application 17/691,108, filed on March 9, 2022, which is a continuation of US Patent Application 16/596,361, filed on October 8, 2019, and issued as US Patent 11,311,354 on April 26, 2022. This disclosure claims priority of US provisional patent application number 62/742,942, filed on October 9, 2018, and US provisional patent application number 62/774,402, filed on December 3, 2018, and US provisional patent application number 62/818,082, filed on March 13, 2019. All of the above non-provisional and provisional applications are incorporated herein by reference in their entirety.

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BACKGROUND OF THE INVENTION

[0002] Different systems have been introduced for attaching dental prostheses to dental implants to replace one or more natural teeth. In order to simplify future modification or replacement needs, it is desirable to have reversable attachment between the implants and prostheses using mechanical systems as opposed to directly bonding these components together. These systems require features to provide both proper alignment and retention for acceptable use by the patient. Intermediate components such as copings and separable abutments having different lengths or orientations are often employed to provide proper registration between a dental prosthesis, one or more implants embedded in the patient's

jawbone, and the soft-tissue and any remaining natural teeth. These intermediate elements may be mutually attached with screws or with ball-and-socket or other forms of snap-on mounts. In the case of a single-tooth crown attachment, the coping and abutment surfaces preferably include features to remove rotational symmetry in the mating of the abutment and coping surfaces. Rotational locking features may also be included in these single mount systems. When the prosthesis contains multiple copings for attachment to multiple abutments, this rotational fixation is not generally required. For example, 30-degree tapered mating surfaces for multiple interface locations are sufficient to provide complete registration.

[0003] It is common to attach a complete upper or lower denture to four or more implants. The multi-unit abutment system interfaces with mating surfaces of the final prosthetic. In some cases, these dentures may be designed or fabricated from scratch following the pulling of undesirable teeth and mounting of implants. In other cases, no teeth are pulled, but it is desirable to convert an existing removable denture to definitive mounting to new implants. In some cases, it is preferable to convert these existing dentures shortly after the implants are placed. This chair-side processing decreases patient discomfort by providing at least temporary dentures more quickly.

[0004] Dental impressions are often used to provide information on the location of implants, soft tissue and existing teeth for designing new prostheses or mounting copings in existing dentures for implant attachment conversion. Generally, the copings are mounted to implant abutments and an impression is made to provide location information for the prosthesis through the copings. Impression material is introduced and cured around the copings to define their position. In the case of transfer copings, less rigid impression material is used to form a cavity for each coping; the coping remains attached to the abutment and the cured impression is removed. Subsequently, copings are inserted into the impression.

In the case of pick-up copings, the coping is directly retained in the impression material after curing. That is, the copings are picked-up when the impression is removed from the mouth. The resulting alignment of pick-up copings is generally superior to transfer copings as a result of the direct transfer of coping location information. Transfer copings introduce an indirect secondary alignment reference since the insertion of the coping into the impression may not accurately duplicate the original position, particularly in insertion depth.

[0005] Pick-up copings can be used with either an open tray or a closed tray protocol. For snap-on systems, a closed impression tray pick-up technique may be done. The tray can be closed because there is no need to access the copings in order to disconnect them after the impression material sets. However, it is desirable to ensure that the assembly of snap-on copings can be removed without patient discomfort. The amount of force required to remove the tray or converted prosthesis depends upon the total number of implant abutment/coping sets and their position and mutual alignment. Some snap-on systems provide features to provide different retention levels, but this complicates the installation process. Special tools have been introduced to help separate impression trays or prostheses with snap-on systems but may still result in patient discomfort. Since snap-on systems are generally physically larger than dental screws, converting an existing denture may require large clearance cavities to be bored into the existing denture before it can be used as an impression tray in a pick-up coping process. These large holes may significantly reduce the mechanical stability of the existing denture. The mechanical precision required of snap-on system elements generally makes them more expensive than screw-attached systems.

[0006] The simplicity of screw-attached systems provides some benefits over snap-on systems beyond fabrication cost. The mounting pressure between the coping and abutment is readily controlled through the torque applied to the screw

to tighten it. This axial tension control and the self-aligning characteristics of engaged screw threads provides more certainty in the engagement force and relative orientation of the components. Even if a screw breaks, techniques are known for removing the pieces without damage to surrounding components. Screws also have a benefit of independence for removal since each coping can be loosened individually. Tilting the prosthesis after screw removal to disengage one coping cannot cause reengagement of another coping.

[0007] A disadvantage with commercially available screw-attachment systems for pick-up copings is the requirement for using an open-tray impression in order to release the coping from the abutment after the impression material sets. By having an opening in the tray or existing denture, impression screws may be used. These impression screws extend through the tray beyond the impression material and can be unscrewed after the material sets. The impression screws use the same abutment threads as the semi-permanent screws used to attach the prosthesis later. As a result, the introduction of alignment uncertainty through a secondary reference may be avoided or minimized. The copings used with the impression screws are often relatively long and require modification for denture conversion. This customization may result in larger clearance holes in dentures and require additional process time by the dental practitioner. The length of the impression screws sticking through the tray can cause patient discomfort and a gag reflex. In the case of denture conversion, clearance for a set of impression screws at different angles may require additional material removal leading to a weakened denture. A schematic representation of the larger through-holes 136 required using conventional denture conversion processes for screw attachment are illustrated in FIGS. 93-94. The impression screws can also prevent the patient from applying bite pressure during the pick-up process to ensure proper registration of the modified denture and opposing teeth.

[0008] Prosthetic dentistry has rapidly moved into the realm of digital design and manufacturing. Typically, this requires that a digital model is created from a physical model or impression to allow digital design and manufacturing techniques to produce a physical prosthetic that can be delivered to a patient for restoration of dental and oral structures. When making a dental restoration with implants in this manner, an implant impression coping is often used in the mouth to reference the position of the implant geometry relative to surrounding structures such as gingiva, adjacent teeth, opposing teeth, etc. Once removed from the mouth, an implant analog is attached to the impression coping that was picked-up or transferred. With the lab implant analog attached to the impression coping in the elastomeric impression, dental stone is flowed into the impression and allowed to harden before separation from the impression with a resultant dental cast. A scan flag is attached to the lab analog on the dental stone model and is scanned in by laser or optical scanning technology. The scan flag is used for design software to reference and replicate the accurate positioning of the virtual implant relative to the adjacent teeth, gingiva and opposing tooth, as well as the timing of the implant and other pertinent implant geometries. Once the virtual implant is accurately brought into the design software, a prosthetic can be designed by following the workflow in the design software. A completed design is post-processed, and a CAD file is used in CAM software to direct either the 3-D printing or milling of the designed prosthesis. The manufactured prosthesis is verified on the physical model in a remote prosthetic manufacturing lab prior to delivery to the dentist or is verified directly on the dental patient if the prosthesis was manufactured in the local dental clinic. It is currently the standard of care to verify the fit, form, and function on a physical model.

[0009] Recently, an impression scan flag was introduced to the market for a few major implant systems and the most common multi-unit geometry. This scan flag allows for an impression to be digitized without the creation of a stone model. A digital model is created directly from the elastomeric impression, a prosthesis is

designed digitally and processed with CAM software and both a 3-D printed model and 3-D printed or milled prosthesis is finished and tested on the 3-D printed model. The disadvantage of the 3-D printed model for full arch implant prosthetics is the positioning of the implant lab analog within the 3-D printed model introduces a degree of inaccuracy. Additionally, an impression only captures the implant or multi-unit abutment relative to the tissues and requires cumbersome steps to incorporate a provisional prosthesis or wax-up into the design software relative to the scan of the impression.

[0010] A properly converted denture provides a valuable source of information of the relative location of the implant and its abutment surfaces, copings and soft tissue and any remaining teeth of the patient. It can be used as a model for digital scanning to produce a duplicate denture if needed in the future or as a starting digital model for manipulation to improve aesthetics or other characteristics. However, if the mechanical integrity of the converted denture is compromised, the scanned information may not faithfully represent the relative geometry of these elements and result in a poor fit.

[0011] Other alignment systems have been proposed which use silicone or melting screw threads to allow closed tray transfer for definitive screw attachment, but the practicality of providing adequate alignment and seating forces with a screw diameter in the range of existing systems or overcoming the lack of disengagement independence required in melting all threads simultaneously without patient discomfort has not been documented. Details on removing any residual material in the abutment threads or in the prosthesis after the pick-up process have not been disclosed. Other hybrid systems that use a snap-on engagement for the pick-up coping during transfer and subsequent screw-attachment have also been proposed, but detailed information on the tradeoffs in precision and associated complexity or size required for equivalent performance to open-tray impression screw techniques have not been disclosed.

A general need exists for systems that improve clinical efficiency, implant to prosthesis alignment accuracy, application to a wide range of coping designs and sources and patient comfort over existing systems.

[0012] The present disclosure includes systems and methods that address one or more of these issues in the prior art.

BRIEF SUMMARY OF THE INVENTION

[0013] Some embodiments of the invention include a screw-in fastener system used to temporarily retain a coping on an abutment during bonding of the coping into a blind hole located in the tissue-side of a removable dental element such as a removable complete denture. The temporary fastener system disclosed has features to allow easy removal of the dental prosthesis from the fastener post after pick-up of the coping into the dental prosthesis is complete, without the need for special tools or access to the fastener system to unscrew it.

[0014] Some embodiments include a temporary fastener with a male-threaded bottom portion that is installed into the screw threads of an abutment, and an axially separable top portion, or cap, that retains the coping onto the abutment. The separable portion allows removal of the coping picked-up in the dental prosthesis without requiring mechanical access to the fastener. The inventive concepts disclosed facilitate easier installation and removal on multiple abutments that may be oriented at different compound angles when compared to the conventional open-tray processes and long impression screws. The temporary fastener may engage the same screw threads of the abutment that are used to definitively attach the prosthesis. In this manner, the coping is held against the abutment for the pick-up process with a force oriented identically to that of the final screw mounting. The retention of the cap on the screw post can

be designed to provide a desired force holding the coping to the abutment through the applied torque on the temporary fastener. The cap can be attached to the post through a combination of known mechanical attachment means including but not limited to interference fits, adhesives, snap fits or other elastic and inelastically deforming retention elements. The cap may also be formed as an integral part of the screw post that has portions that fracture as a result of an applied axial force. In addition to applied axial forces, the cap may separate from the post as a result of retention changes resulting from chemical or thermal processes and or the application of electromagnetic energy during or subsequent to the pick-up process.

[0015] Other embodiments include a threaded post that has a temporary retention feature that engages the coping without a separable cap. These embodiments engage the abutment threads in mounting the coping but release the coping after bonding to the prosthesis.

[0016] The disclosed systems and methods can be applied to single tooth prostheses with copings and abutments with orientational features or for multiple tooth prostheses using copings and abutments with symmetrical mating surfaces such as 30-degree tapers.

[0017] In some embodiments, the temporary fastener is driven into the abutment threads by a tool that engages the post. In other embodiments, the temporary fastener is driven into the abutment threads by a tool that engages the cap. The drive torque can be designed to be sufficient for holding the coping to the abutment accurately, but less than the torque that would result in movement of the cap relative to the post.

[0018] In some embodiments, the threaded end of the post portion of the temporary fastener has a deflecting feature that allows the post to engage or disengage the abutment threads through axial motion instead of a rotary screw motion.

[0019] One embodiment describes a system for aligning a dental implant abutment, coping and separable dental element for definitive screw-attachment comprising:

a. a temporary alignment fastener comprising:

b. a post having an axis, a first post end and second post end, wherein the first post end is threaded for screw attachment to the implant abutment;

c. a cap, wherein the cap is attached to the second post end;

[0020] and wherein the temporary alignment screw is configured to hold the coping against the implant abutment when the first post end is screwed into the implant abutment and wherein the cap is separable from the post through a release force directed away from the first post end.

[0021] One embodiment describes a system for aligning a separable dental element for installation to a threaded implant abutment with a definitive screw having a head and threaded shaft portion comprising:

[0022] a coping having a distal end shaped to engage with the implant abutment and a proximal end with an aperture sized to allow the shaft portion of the definitive screw to pass through;

[0023] a temporary screw having a distal end portion adapted to engage the threads of the implant abutment and a proximal end portion having temporary engagement means for attachment adjacent to the proximal end of the coping wherein the temporary screw holds the distal end of the coping in alignment

against the implant abutment when the distal end portion of the temporary screw engages the implant abutment threads and wherein the temporary engagement means releases the coping without disengaging the post portion of the temporary screw upon the application of a predetermined axial force in the proximal direction.

[0024] In some embodiments, an existing removable denture is converted to a screw attached denture by milling pockets to allow copings to be bonded in a pick-up process. In this process, the denture acts in an equivalent manner to a closed impression tray. Proper registration can be confirmed by having the patient bite down on the denture during the pick-up process. After coping pick-up, clearance for the definitive screws can be drilled using the coping as a guide. The converted denture can be used with scan flags to provide a 3-dimensional digital capture. Thus a digital model can be used to make a duplicate prosthesis or as the starting point for a new custom prosthesis.

[0025] One embodiment describes an alignment system for converting an existing denture for screw attachment to threaded implant abutments designed to perform the process of:

a. mounting pick-up copings to the implant abutments with temporary fasteners,
b. adhering the copings to cavities formed in the existing denture,
c. pulling the denture with secured pick-up copings away from the implant abutments,
d. unscrewing the threaded portions of the temporary fasteners from the implant abutments,
e. forming definitive screw clearance holes in the denture,
f. mounting the denture to the implant abutments with definitive screws that engage the same implant abutment threads as the temporary fasteners,

wherein the unscrewing the threaded portions of the temporary fasteners and the forming definitive screw clearance holes in the denture may occur in either order.

[0026] For the purposes of this disclosure, a separable dental element is defined to be anything that incorporates one or more dental copings that can be mounted and removed from one or more implant abutments. Different coping designs are known in the dental industry, and the systems and methods disclosed here can be adapted to work with many commercially available types of copings including pick-up copings, temporary cylinders, inserts and impression copings. Implant abutments are known in the dental industry having compatible interfaces to these copings. Since the mechanical interface is the same, for the purposes of this disclosure, implant abutment is considered a generic term that includes abutment analogs. Description of alignment systems and process methods with copings and implant abutments that are installed in a patient's jaw should be considered to also describe equivalent inventive concepts that may be used with copings and implant abutment analogs in a dental lab. The inventive concepts disclosed herein can be used with different types of separable dental elements. The separable dental element can be any form of impression used in a dental lab to assist in creating and testing dental prostheses. A separable dental element can also be a dental prosthesis fabricated in the dental lab using a physical model made from the impression, a dental prosthesis newly fabricated, or an existing prosthesis being converted for screw attachment. A dental prosthesis is defined to include a single-tooth appliance such as a crown, or any multiple-tooth bridge or denture. These prostheses may incorporate copings to provide a separable interface to provide orientation with an appropriate abutment attached to a patient's jaw or gingiva. The abutments for use with the inventive concepts disclosed herein include screw threads to mount the prosthesis with copings onto the abutments. While the concepts describe female threads in the abutment mating with male threads on a mounting screw, this is for convenience in

disclosure. The inventive concepts could be applied with systems having male threads in the abutment engaging a screw with female threads for mounting the prosthesis. These are considered to be straightforward variations of the inventive concepts.

[0027] For the purposes of this disclosure, the abutments may be integral to the implants embedded into the patient's jaw or gingiva, or they may be separate units that are attached to the implants. The inventive concepts disclosed apply to both configurations.

[0028] For the purposes of this disclosure, an existing denture should be interpreted broadly to include any prosthesis that has been created prior to the use of the innovative systems and methods disclosed. An existing denture may be a loose denture that was worn by the patient prior to the installation of implants were installed, or it may be a new denture that is in the process of first fitting in the patient's mouth.

[0029] The systems and methods disclosed herein can be used with prostheses for attachment to both the upper and lower jaw. As a result, portions of the system that are oriented downward for the lower jaw will be oriented upward for the upper jaw and vice versa. For convenience, a disclosure of an embodiment of inventive concepts that is limited to a single jaw orientation, is considered to disclose an embodiment for the opposite jaw orientation. When referring to the perspective of a clinician, proximal portions are nearer to the clinician than distal portions. While a term such as top is the opposite of the term bottom, and proximal is the opposite of distal, their actual relative orientation will be determined by the context of their use. The term tissue-side is used interchangeably with intaglio to indicate the side of a prosthesis that is opposite the occlusal or cameo surface.

[0030] The inventive systems disclosed are beneficially applicable to screw-attached prostheses. Key benefits of screw-attachment are variable tightening torques and reversibility. The terms permanent, semi-permanent, definitive and final when referring to screw-attachment are used interchangeably in this disclosure. A conventional screw that is definitively attached can still be removed by accessing the screw and rotating it in the opposite direction that was used for attachment. For the purposes of screw-attached prostheses for this disclosure, the attachment is semi-permanent, permanent or definitive in the sense that frequent attachment and removal is not anticipated for normal use. In contrast, the temporary screw attachment is applied for a planned process duration or other anticipated interval. Removal of a semi-permanent or definitive screw is generally motivated by a problem or an opportunity for an improvement. Access to the screw to apply a tool for removal may require removal of material covering the screw for aesthetic reasons.

[0031] Other terms in the specification and claims of this application should be interpreted using generally accepted, common meanings qualified by any contextual language where they are used. The terms "a" or "an", as used herein, are defined as one or as more than one. The term "plurality", as used herein, is defined as two or as more than two. The term "another", as used herein, is defined as at least a second or more. The terms "including" and/or "having", as used herein, are defined as comprising (i.e., open language). The term "coupled", as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically. The terms “about” and “essentially” mean ±10 percent. Reference throughout this document to "one embodiment", "certain embodiments", and “an embodiment" or similar terms means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention.

Thus, the appearances of such phrases or in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments without limitation. The term "or" as used herein is to be interpreted as an inclusive or meaning any one or any combination. Therefore, "A, B or C" means any of the following: "A; B; C; A and B; A and C; B and C; A, B and C". An exception to this definition will occur only when a combination of elements, functions, steps or acts are in some way inherently mutually exclusive.

[0032] The drawings featured in the figures are for the purpose of illustrating certain convenient embodiments of the present invention and are not to be considered as limitation thereto. The term “means” preceding a present participle of an operation indicates a desired function for which there is one or more embodiments, i.e., one or more methods, devices, or apparatuses for achieving the desired function and that one skilled in the art could select from these or their equivalent in view of the disclosure herein and use of the term “means” is not intended to be limiting. Other objects, features, embodiments and/or advantages of the invention will be apparent from the following specification taken in conjunction with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0033] FIG. 1 is a top exploded isometric view of a first embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0034] FIG. 2 is a side plan view of a first embodiment of a system for aligning a dental implant abutment, coping and prothesis for definitive screw-attachment.

[0035] FIG. 3 is a top plan view of a first embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0036] FIG. 4 is a side cross-sectional view of the system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment along the line indicated in FIG. 3.

[0037] FIG. 5 is a side cross-sectional view of the embodiment of FIG. 4 attached to the jaw and prosthesis prior to the pick-up process.

[0038] FIG. 6 is a side cross-sectional view of the embodiment of FIG. 5 after the pick-up process.

[0039] FIG. 7 is a side cross-sectional view of the embodiment of FIG. 6 showing a drill bit creating a pilot hole for a definitive screw.

[0040] FIG. 8 is a side cross-sectional view of the embodiment of FIG. 7 showing a stepped drill bit creating a clearance for the head and shaft of a definitive screw.

[0041] FIG. 9 is side cross-sectional view of the embodiment of FIG. 8 showing the definitive screw holding the prosthesis to the implant.

[0042] FIG. 10 is an exploded top isometric view of a second embodiment of a system for aligning a dental implant abutment, coping and prothesis for definitive screw-attachment illustrating a single abutment and a temporary screw with breakaway tool.

[0043] FIG. 11 is an exploded side isometric view of the second embodiment of FIG. 10 prior to installation to the implant abutment.

[0044] FIG. 12 is an exploded side isometric view of the embodiment of FIG. 10 with the breakaway tool pushed onto the post and the coping placed on the implant abutment.

[0045] FIG. 13 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the tool being rotated to screw the post into the implant abutment.

[0046] FIG. 14 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the tool breaking away from the cap after the coping is secured on the abutment.

[0047] FIG. 15 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the prosthesis being marked for positioning a clearance hole.

[0048] FIG. 16 is a side isometric view of the marked prosthesis from FIG. 15.

[0049] FIG. 17 is a side isometric view of the marked prosthesis from FIG. 16 with blind clearance hole and boring tool.

[0050] FIG. 18 is an exploded side isometric view of the prepared embodiment of FIG. 17 as adhesive is schematically applied to the coping fixed to the abutment with the temporary screw.

[0051] FIG. 19 is a side view of the prosthesis in position for curing of the adhesive applied in FIG. 18.

[0052] FIG. 20 is a bottom side isometric exploded view of the coping incorporated in FIG. 19 being picked up as the prosthesis is removed from the implant abutment.

[0053] FIG. 21 is a top side isometric view schematically showing the post of the temporary screw being unscrewed from the implant abutment.

[0054] FIG. 22 is a top side isometric view of the implant abutment prepared for attachment of a prosthesis with a definitive screw.

[0055] FIG. 23 is a bottom isometric view of the prosthesis with picked-up coping from FIG. 20 being drilled from the bottom to provide clearance for the threaded shaft of a definitive screw following coping pick-up.

[0056] FIG. 24 is a top isometric view of the prosthesis with picked-up coping from FIG. 20 with a drill applied from the top to provide clearance for the definitive screw head.

[0057] FIG. 25 is top exploded isometric view of the prepared prosthesis from FIG. 24 with the definitive screw.

[0058] FIG. 26 is a top isometric view of the prepared prosthesis from FIG. 24 after attachment to the implant abutment with the definitive screw.

[0059] FIG. 27 is a schematic description of a process for aligning dental implant abutments, copings and a prosthesis for definitive screw-attachment.

[0060] FIG. 28 is an exploded bottom isometric view of a third embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment with tool oriented for assembly.

[0061] FIG. 29 is an assembled bottom isometric view of the embodiment of FIG. 28 with temporary screw and coping inserted into tool.

[0062] FIG. 30 is a side view of the system of FIG. 29 after assembly with the implant abutment.

[0063] FIG. 31 is a cross-sectional view of the assembly of FIG. 30 along C-C.

[0064] FIG. 32 is a side view of the assembly of FIG. 28 after the pick-up process showing the removal end of the tool engaging the retained temporary screw post.

[0065] FIG. 33 is a cross-sectional of the assembly of FIG. 32 along D-D.

[0066] FIG. 34 is an exploded isometric view of another embodiment of a temporary screw of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0067] FIG. 35 is an isometric view of the temporary screw of FIG. 34 from the screw thread end.

[0068] FIG. 36 is an isometric view of the temporary screw of FIG. 34 from the cap end.

[0069] FIG. 37 is a bottom isometric view of a jaw with multiple abutments in preparation of marking a prosthesis as part of the process for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0070] FIG. 38 is a top isometric view of the prosthesis of FIG. 37 showing abutment location markings.

[0071] FIG. 39 is a top isometric view of the prosthesis with clearances milled to receive copings for pick-up.

[0072] FIG. 40 is a bottom isometric view showing installed copings and the assembly of a coping to an implant abutment with a temporary screw and torque driver.

[0073] FIG. 41 is a top isometric view showing adhesive being dispensed in recesses of the prosthesis.

[0074] FIG. 42 is a bottom isometric view of the abutments with attached copings in the process of being positioned into the recesses of the prothesis after adhesive is dispensed.

[0075] FIG. 43 is a top isometric view of the copings attached to the prosthesis after adhesive curing and pick-up.

[0076] FIG. 44 is a bottom isometric view showing the removal of temporary screw posts from the implant abutments after the pick-up process.

[0077] FIG. 45 is a top view of a drill in position to create a pilot hole in the prosthesis of FIG. 43.

[0078] FIG. 46 is bottom view showing the pilot holes from the process of FIG. 45 extending through the prosthesis to exit on the occlusion side.

[0079] FIG. 47 is a bottom isometric view showing a counterbore positioned on the occlusion side of the prosthesis to provide clearance for the definitive screw.

[0080] FIG. 48 is a bottom isometric view illustrating a reamer positioned to clean residue from the bore.

[0081] FIG. 49 is a bottom isometric view of the prepared prosthesis with definitive mounting screws prior to fastening to the abutments.

[0082] FIG. 50 is a top isometric view corresponding to FIG. 49.

[0083] FIG. 51 is a top isometric view of an embodiment of a component suitable for use as a scan flag for digital capture and a laboratory analog for physical model creation.

[0084] FIG. 52 is a bottom isometric view of the component from FIG. 51.

[0085] FIG. 53 is a bottom isometric view showing the component of FIG. 51 positioned for screw attachment to the converted prosthesis of FIG. 49.

[0086] FIG. 54 is a top isometric view of FIG. 53.

[0087] FIG. 55 is a top isometric view showing the assembly of FIG. 54 mounted on a stand in preparation for scanning.

[0088] FIG. 56 is a side view of FIG. 55.

[0089] FIG. 57 is an isometric view of the assembly of FIG. 54 with reinforcing bars mounted prior to pouring of dental stone.

[0090] FIG. 58 is a schematic flow chart illustrating options for creating and attaching a permanent prosthesis.

[0091] FIG. 59 is an exploded isometric view of the torque driver shown in FIG. 40.

[0092] FIG. 60 is a top isometric view of the torque driver of FIG. 59 partially assembled.

[0093] FIG. 61 is a top isometric view of the post removal tool shown in FIG. 44.

[0094] FIG. 62 is a top isometric view of an embodiment of a temporary screw similar to FIG. 1 schematically illustrating axial motion of the cap away from the post threads from screwing after the coping contacts the abutment.

[0095] FIG. 63 is a top isometric view of the embodiment of FIG. 62 in which the temporary screw post end has become flush with the top of the cap.

[0096] FIG. 64 is a top isometric view of a temporary screw post embodiment having a cylindrical stem.

[0097] FIG. 65 is a top isometric view of a split temporary screw post embodiment having deflecting sections.

[0098] FIG. 66 is an isometric view of a temporary screw post embodiment having symmetric axial splines.

[0099] FIG. 67 is an isometric view of a temporary screw post embodiment having a weakened portion facilitating lateral movement during pick-up.

[0100] FIG. 68 is a bottom isometric view of a temporary screw embodiment having a spring cap.

[0101] FIG. 69 is a bottom isometric view of a one-piece temporary screw embodiment designed to fracture under axial loading.

[0102] FIG. 70 is a cross-sectional view of a temporary screw embodiment incorporating a rounded interface between cap and post facilitating pivotal movement as illustrated.

[0103] FIG. 71 is a cross-sectional view of a temporary screw embodiment incorporating a restricted interface between cap and post facilitating pivotal movement and protective film.

[0104] FIG. 72 is a cross-sectional view of a temporary screw embodiment incorporating a spring cap with preferential axial movement in the pick-up direction.

[0105] FIG. 73 is a cross-sectional view of a temporary screw embodiment incorporating a laminar cap fixed to the end of the post.

[0106] FIG. 74 is a cross-sectional view of a temporary screw embodiment incorporating a compliant interface between the cap and post.

[0107] FIG. 75 is a cross-sectional view of a temporary screw embodiment incorporating a split post that has deflecting sections with screw threads shaped to facilitate axial separation without unscrewing the post threads.

[0108] FIG. 76 is a cross-sectional view of a temporary screw embodiment incorporating an interface material between the cap and post.

[0109] FIG. 77 is a cross-sectional view of a temporary screw embodiment incorporating an O-ring interface between the cap and post.

[0110] FIG. 78 is a cross-sectional view of a temporary screw embodiment incorporating a cup-shaped interface material between the cap and post.

[0111] FIG. 79 is a bottom isometric view of a temporary screw embodiment incorporating a split collar cap.

[0112] FIG. 80 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled perpendicular to the diameter indicated.

[0113] FIG. 81 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled parallel perpendicular to the diameter indicated.

[0114] FIG. 82 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping is held by mechanical interference to the proximal end of the threaded post.

[0115] FIG. 83 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping has spring fingers holding the proximal end of the threaded post.

[0116] FIG. 84 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent

screw-attachment in which the coping has collet-type spring fingers holding the proximal end of the threaded post.

[0117] FIG. 84A is a top view of the embodiment of FIG. 84.

[0118] FIG. 85 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the proximal end of threaded post has a slotted spring section holding the coping.

[0119] FIG. 86 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring holds the coping to the proximal end of the threaded post.

[0120] FIG. 87 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring with a u-shaped cross-section holds the coping to the proximal end of the threaded post.

[0121] FIG. 88 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a thin cap fixes the coping to the proximal end of the threaded post.

[0122] FIG. 89 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a filler material is placed in the bore of the coping at the proximal end of the threaded post.

[0123] FIG. 90 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment showing a tool engaging features of the coping to screw in the threaded portion of the post.

[0124] FIG. 91 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

[0125] FIG. 92 is a top isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

[0126] FIG. 93 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

[0127] FIG. 94 is a top isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

DETAILED DESCRIPTION OF THE INVENTION

[0128] FIG. 1 shows an exploded view of one embodiment of a temporary alignment system 12 for use in a direct coping pick-up process for screw attachment of a prosthesis. Implant abutment 8 has a distal end which may include attachment feature portion 135 illustrated as a screw thread for direct attachment to the patient's jaw and a proximal end with an abutment shaped to accommodate a coping 9. The abutment includes threaded section 18. The coping has a central bore 16 to accommodate screw fastening and may include ridges 17 or other structures or surface treatments to increase retention to the prosthesis with adhesive. The coping and abutment mating surfaces as shown in FIG. 1 are symmetrical. The inventive concepts of this disclosure may also be applied to abutment and coping systems that are keyed to restrict mating orientation. The coping may be mounted onto the abutment through rotation of a temporary adjustment screw comprising a threaded post 10 and cap 11. The cap

11 is mechanically attached to post 10 in a manner that allows relative axial motion with the application of a predetermined force. As illustrated in FIG. 1, cap 11 has a square central bore 13 that is press-fit onto a square portion 14 of post 10. The cap 11 temporarily retains coping 9 onto the implant abutment 8 during the pick-up process of the coping into the prosthesis with a force aligned directly along the same axis as the semi-permanent screw that will be used for definitive prosthesis mounting. The portion of the post engaging the abutment threads also prevents any pick-up material from contacting the abutment screw threads. After the coping is picked-up into the prosthesis, the cap and coping may be released from the abutment by applying an axial force. In the embodiment shown, the post threads 15 remain engaged with abutment threads 18 after the pick-up process. The post can then be removed from the abutment by unscrewing it. The prosthesis with embedded coping can be subsequently processed to accommodate semi-permanent screw attachment as will be described later.

[0129] FIGS. 2 and 3 show a side and top view of the assembled system of FIG. 1; FIG. 4 shows a cross-sectional view along the axis as indicated. As shown in FIG. 4, matching conical surfaces on the exterior of the implant abutment 8 and the interior of the coping 9 are engaged. In the orientation shown, the coping 9 is pulled into alignment by an axial force from the lower surface 11s of the cap 11 pushing against the upper surface 9s of the coping 9 from screwing the threads of post 10 into the implant abutment 8. As shown, there is a gap 219 between the temporary screw attachment post 10 and the coping 9. As also shown in FIG. 4, the width of the temporary screw cap 11 is greater than the width of the largest portion of the central aperture 16 of the coping 9. The temporary screw cap 11 holds the coping 9 in position on the implant abutment 8. As shown in FIG. 4, the cap-coping interface 210 is located at the proximal end 16p of the central aperture 16. As also shown in FIG. 4, due to the gap 219 and open space 211 between the coping 9 and the temporary screw attachment post 10 facing the implant abutment 8, the only contact between the temporary screw

190 and the coping 9 is between the temporary screw cap 11 and the proximal end of the coping 9 which provides an axial force by torquing the temporary screw 190 into the abutment 8 to hold the coping 9 on the implant abutment 8. The distal end of the abutment may be directly attached to the patient's jaw or attached to a separate implant attached to the jaw. The inventive concepts are not dependent upon the nature of the implant, so the distal end attachment feature 135 is represented schematically.

[0130] The capability for relative axial movement between the cap 11 and temporary attachment post 10 allows separation of the temporary attachment post from the cap without tools after retaining the coping onto the abutment during fitting and bonding of the coping into the prosthesis. These parts are accurately aligned during the bonding process since the temporary post engages the abutment threads to provide an axial force holding the coping to the abutment just like the screw used for final attachment.

[0131] The cap may be sized to have an amount of press-fit mechanical interference to the temporary attachment post to provide an axial retention force of approximately 20 to 900 grams, this force being sufficient to retain coping 9 during assembly while allowing relatively easy pick-up removal of the coping and prosthesis from the temporary attachment post after assembly. The temporary attachment post 10 may include indicators (not shown) in the end by the cap 11 to provide intermediate visual and/or tactile feedback on the depth of threaded engagement of the post during screw attachment of the coping to the abutment.

[0132] In this embodiment, screw driving torque is provided by the square cross-section of the cap aperture and temporary attachment post. In the cross-sectional view of FIG. 4, the post 10 has been screwed in so that only a small beveled surface of the post extends above the top of the cap when the post

threads bottom out in the abutment. During installation, this optional configuration provides feedback to the dental practitioner when the torque increases as the threads bottom. The square drive tool engagement can also be designed to disengage at a pre-designed minimum extension of the square post above the top of the cap. Alternatively, a tool with a specified maximum torque may be used to ensure engagement of the coping and abutment surfaces.

[0133] The screw driving torque function may be accomplished by engaging other features on the temporary attachment post such as hex or spline or asymmetric features. Alternately, the cap may be used to engage a screwdriver or other tool for torquing. For example, in the case of a cylindrical temporary attachment post top portion, driving torque can be provided by the friction of the press-fit between the cap and temporary attachment post. For example, a medium press-fit of a 3 mm diameter 1 mm thick nylon cap onto a 1.3 mm diameter stainless steel cylindrical rod may produce approximately 500 grams of axial retention force and 17 gram-cm driving torque. A typical screw thread size for appliances is m1.4 x 0.3. Note that in FIG. 4, the temporary attachment post threads 181 are illustrated making contact with the abutment threads 182 when engaged. The retention/axial force of the cap to the temporary attachment post may be determined by the degree of press-fit and frictional properties between the cap and temporary attachment post, and/or spring features incorporated into the temporary attachment post and/or cap.

[0134] In actual trial installations, polymer caps of approximately 1.2 mm thickness press fit onto posts of approximately 1.4 mm diameter with cylindrical axial bores have been sufficient for installation and pick-up removal of a single prosthesis from multiple implant abutments in which the axes of the screw threads in the implant abutments are not mutually parallel.

[0135] The separable mechanical attachment means may include any combination of techniques, including frictional forces from interference, adhesives, waxes, chemical bonding, solders, elastically or inelastically deformable spring, snap or interlocking structures, thermally or electromagnetically fusible materials, fracturing structures, etc.

[0136] FIG. 5 through FIG. 9 show example cross-sectional views of some of the different stages of installation of the temporary fastener system into a denture. FIG. 5 shows a cross-sectional view of the assembly of the first embodiment during the initial phase of the coping pick-up process. As illustrated, the implant abutment 8 is attached to a schematic implant 70. The implant 70 has an interface 7 (shown schematically) that is attached to the patient's jawbone 22. The coping 9 is held against the implant abutment 8 through the temporary screw comprising the post 10 and cap 11. A blind clearance hole 5 in the prosthesis 3 is sized to accommodate the coping and temporary screw. Pick-up material 171 is positioned in the clearance hole 5 to capture the coping in proper alignment within the prosthesis. The cap-coping interface 210 is positioned at the proximal end 9p of the coping central bore or aperture 16 and, as shown in FIG. 5, blocks pick-up material 171 from entering the coping central aperture 16. After the pick-up material 171 has set up, the prosthesis 3, coping 9 and temporary screw cap 10 are pulled off as an assembly off the patient's jaw as shown by the arrows in FIG. 6. The coping 9 and cap 11 are released from the implant abutment 8 and post 10, while the threads of the post 10 keep it engaged in the implant abutment 8. The post 10 is subsequently removed to make the abutment threads 18 available for holding the prosthesis in proper alignment with a definitive screw.

[0137] The prosthesis/coping assembly must be processed after the pick-up process for screw attachment. A pilot hole is drilled with bit 172 from the bottom side of the assembly. As shown in FIG. 7, the diameter of the bit may be selected to use the interior bores of the coping and cap to act as guides for hand

processing. Alternately, a drill guide may be employed that engages a portion of the interior of the coping to align the pilot hole. The pilot hole provides guidance for a tool to provide clearance for the definitive screw shaft and head. FIG. 8 shows a stepped drill 173 that cuts both clearances in a single process. Alternatively, the shaft and head clearance may be drilled with two drills in two process steps. If desired, the cap 11 of the temporary screw 190 can be fabricated of a material that is easier to drill than the coping material to provide feedback on the drill position. It has been found that it is possible to distinguish where the drill is positioned by feel at the interfaces between the pick-up adhesive and the top of the cap (as shown in FIG. 8) and the bottom of the cap and the top of the coping. Since pick-up material was blocked from entering the coping, drilling resistance decreases rapidly upon breaking through the bottom of the cap and entering the interior channel of the coping. Color differences in the materials can also be detected. Alternatively, a tool can be configured to fit within the bore of the coping to limit the depth of the drill.

[0138] Once clearance hole 174 for the definitive screw has been made from the top of the prosthesis, the prosthesis is ready for mounting to the implant with definitive screw 175 as shown in FIG. 9. The male threads 150 of the definitive screw are shown filling the female threads of the abutment over an engagement depth extending from a first end of the thread engagement 163 to the second end of abutment thread engagement 164 of the implant abutment threading 18. Once the most distal thread of the definitive screw 175 is engaged in an abutment thread, the engagement depth will increase by a distance equal to the thread pitch for each complete revolution of the definitive screw 175. As shown in FIG. 4, a screw clearance hole 174 is large enough to accommodate the definitive screw head 151. A residual portion 161 of the cap 11 is shown in FIG. 9 for aligning the coping 9 to the prosthesis 3 in the closed tray pick-up process. After the definitive screw 175 is torqued into position, the screw clearance hole 174 in the prosthesis 3 may be filled with Teflon tape and color-matching composite

materials for aesthetic purposes. In the illustrated embodiment, the coping bore 16 has a shoulder 152 to engage a flat surface on the underside of the definitive screw head 151 of the definitive screw 175 to pull the coping 9 into proper seating on the implant abutment 8. Alternate configurations are possible without deviating from the temporary screw system for coping pick-up disclosed.

[0139] FIG. 10 is another exploded isometric view of parts of an embodiment of the invention. In this example, cap 11 is integrated into a breakaway installation tool 18. The tool portion 19 may be used to install the temporary attachment post 10, and then section 19 broken away at mechanically weak separation feature 20, for example, when the post bottoms out in the abutment leaving the cap portion 11 in position. Alternatively, the tool can be designed to increase stress on the separation feature as the top of the post moves axially down relative to the weakened section. As illustrated, after the cap portion 11 breaks away from the tool portion 19, drive feature 21 in the tool portion may be used to remove the post 10 after the pick-up process. One or both ends of the tool may be shaped to subsequently engage and remove the temporary attachment post 10 after installation of coping 9 into the denture.

[0140] FIGS. 11-26 provide schematic isometric views of the process steps for using the elements of an exemplary embodiment introduced in FIG. 10 for a single implant system such as a crown. In FIG. 11, a schematic isometric view of a portion of the patient's jaw 22 is shown with an implant 70 (not shown) installed, and implant abutment 8 installed into the implant. The coping 9 is placed onto the implant abutment 8, the top portion of temporary attachment post 10 is assembled onto cap 11. The top portion of temporary attachment post 10 and cap 11 are configured such that there is a means to drive the temporary attachment post into the abutment, while allowing axial movement of the cap 11 relative to the temporary attachment post axis, the cap/temporary attachment post interface having sufficient retention force to keep the coping in place on the

abutment during subsequent installation steps, and the temporary attachment post being removable after picking up the coping into the prosthesis. Cap 11 may be attached to a break-away installation/removal tool 18.

[0141] FIG. 12 shows the coping 9 placed on the implant abutment 8 and the cap/tool 18 installed onto temporary attachment post 10. The coping-abutment surfaces may comprise a conical or spherical concave feature on the coping 9 that mates with a complementary feature on the top of the implant abutment 8, as illustrated. Alternatively, keying features may be employed to restrict relative rotational orientation, particularly in the case of single implants.

[0142] FIG. 13 shows the temporary attachment post being threaded into the implant abutment 8, through a clearance hole in the coping 9. The cap abuts the coping to secure the coping to the abutment. The cap 11 is free to move axially along the temporary attachment post with a frictional retaining force of the cap to the temporary attachment post. A known amount of retention force of the coping to abutment is provided by the design and materials used in the cap and temporary attachment post.

[0143] FIG. 14 shows the tool portion of the cap being removed after the cap has broken away; the tool may be used for removal of the temporary attachment post at a later step.

[0144] FIG. 15 shows marking of the position of the coping onto the appliance for drilling a recess for the coping in the prosthesis.

[0145] FIG. 16 shows the prosthesis with coping drilling location marking 23.

[0146] FIG. 17 shows the prosthesis after boring the cavity for the coping; the cavity for the coping may be accurately drilled slightly larger than the coping, without significant unwanted material removal from the prosthesis.

[0147] FIG. 18 shows pick-up material being applied to the coping and/or prosthesis after confirmation of freedom to provide proper occlusion during dry testing. Although not illustrated, the cavity of the prosthesis or the coping may optionally include features to provide venting of excess pick-up material if desired.

[0148] FIG. 19 shows the bonded coping being picked up into the prosthesis

[0149] FIG. 20 shows the prosthesis removed from the temporary attachment post; the temporary attachment post/cap design allows removal of the prosthesis from the temporary attachment post. The coping is now incorporated into the prosthesis.

[0150] FIG. 21 shows the temporary attachment post being removed with the tool portion of the cap.

[0151] FIG. 22 shows the abutment installed in the implant with the temporary attachment post removed.

[0152] FIG. 23 shows drilling a small guide-hole (for example 1-2 mm diameter), through the clearance hole of the coping, into and through the prosthesis. This

guide hole provides a small reference hole for enlargement of the hole to accommodate the prosthesis retaining screw.

[0153] FIG. 24 shows enlarging the guide hole to a clearance hole for prosthesis retaining screw, approximately the diameter of the head of the retaining screw (e.g., 1.5-2.5 mm). The clearance hole would typically be drilled down to the top surface of the coping.

[0154] FIG. 25 shows the prosthesis being installed onto the implant abutment by placing the prosthesis coping onto the abutment and installing the prosthesis retaining screw.

[0155] FIG. 26 shows the assembled prosthesis on the implant.

[0156] FIG. 27 contains a summary of a generalized process extending the basic process described above for a prosthesis attached to multiple implant abutments.

[0157] Another embodiment of a prosthesis and implant alignment system and tool are shown in FIG. 28. In this case, the cap is in the form of a hex nut 63 that is press fit onto alignment post 62 to act as the temporary alignment screw. The drive tool 64 includes a concave hex socket 68 that fits temporary post nut 63, and coping retaining portion 69 that retains coping 61 with a slight interference fit. Thus, as shown in FIG. 29, the temporary screw comprising nut 63 with post 62 is engaged with the socket portion of the tool, and the coping 61 is retained in the tool. The coping is seated onto the abutment 60 by using the hex portion of the driver to rotate the nut and engage the threads 66 on the temporary screw post 62. FIGS. 30 and 31 show an exterior and cross-sectional view of the mounting

of the coping on the abutment with the tool. The tool may also have an integrated feature for removing the post as shown in FIG. 32. For example, FIG. 33 shows a tapering feature 170 on the narrow end of tool 64 which may be used to unscrew the post. FIG. 28 illustrates optional undercut 67 for stronger adhesive locking. Optional anti-rotation flat 65 is shown. Such an anti-rotation flat may be used on mating surfaces in circumstances in which there is a preferred orientation around the axis of the screw threads.

[0158] Another embodiment of the inventive concepts in which the cap of the temporary screw is shaped to engage the driving tool is shown in FIGS. 34-36. Cap 102 is mechanically attached to alignment post 101 at end portion 101A to form temporary alignment screw 100. This mechanical attachment may result from press-fitting a polymeric cap 102 onto a metal post 101 to provide adequate resistance to rotary slip to temporarily attach the coping to the implant abutment while still allowing relative axial movement during the pick-up process. The cap 102 may include a tapered surface 102B shaped to match the mating surface of an associated coping 112. A hexalobular internal (Torx) drive feature is shown in the end of the cap 102, although other bit socket shapes are possible. As previously discussed, other mechanical engagement means besides an interference fit are possible. The post may be made of different materials than these, or even be of unitary construction with weakened sections that fracture or otherwise breakaway under a desired pick-up axial force.

[0159] In a preferred embodiment the post 101 is made from stainless-steel or titanium, and the cap of polymer such as PEEK or acetal. The short length of the post and threaded fastener in this embodiment allows separation at high degrees of angularity of the assembled parts in use. This tolerance for off-axial removal has been found to be particularly advantageous when the prosthesis is to be definitively screw mounted to multiple implant abutments. Testing has verified cap axial release forces of up to about

5 pounds and the application of torque to the cap of about 1.6 inch-ounces without slipping.

[0160] The general process for converting an existing removable denture for definitive screw attachment onto four implants with this embodiment is illustrated in FIGS. 37-50. This prosthesis may be, for example, a removable denture that was used prior to implant surgery or a duplicate of such an existing denture as described in US Provisional Patent Application 62/774,402 incorporated herein in its entirety.

[0161] FIG. 37 shows a schematic representation of a human jaw portion 106 with implant abutments 107 installed. It does not matter for this discussion if the abutments are separable from the implanted portion of the implant or not. Prosthesis 103 is shown with occlusion side 104 and intaglio side 105. Pick-up marking caps 108 are installed onto abutments 107. The location of implant abutments 107 is marked onto the prosthesis using customary methods by mating the prosthesis with the abutments. FIG. 38 shows the abutment positions 109 marked onto prosthesis 103. FIG. 39 shows the boring of blind holes 110 slightly larger than copings 112 in marked locations with burr tool 111.

[0162] FIG. 40 shows the installation of copings 112 onto abutments 107 using separable fastener assembly 100, and torque driver 113 (described in more detail later). The torque driver 113 prevents over-tightening of temporary screw 100 and possible separation of the cap 102 from the post 101 due to rotary motion. The cap 102 and/or post 101A of each separable fastener 100 may be mechanically captured or adhered to the coping 112, or may be designed to loosely fit into the bore of the coping as illustrated with axial force from tightening the separable fastener holding the copings to the abutments 107. The prosthesis is placed over the mounted copings to ensure proper fit.

[0163] FIG. 41 shows application of acrylic or other adhesive 144 into cavities 110 of prosthesis 103, which is subsequently fitted onto copings 112.

[0164] FIG. 42 shows prosthesis 103 being mated with copings 112. After the adhesive sets, the separable fasteners allow easy removal of the prosthesis from the abutments with the copings incorporated into the prosthesis. The angular tolerance for removing the prosthesis from multiple abutments allows applying pick-up forces sequentially around the edge of the prosthesis to work the caps 102 off the posts 101. The caps 102 remain in the prosthesis with the copings 112, while the posts 101 remain in the abutments.

[0165] FIG. 43 shows the prosthesis with incorporated copings 112 after the pick-up process.

[0166] FIG. 44 shows the removal of the threaded post 101 from the implant abutment with removal tool 115. This allows the implant abutment threads to be accessible for subsequent definitive screw attachment.

[0167] FIG. 45 shows the drilling of the small pilot hole 117 (e.g., using a drill bit 116 of approximately 1.4 mm diameter), from the intaglio side 105 of the prosthesis out through the occlusion side 104. It has been found that the bore of the coping 112 and the bore of the cap provide adequate guidance for this hole, although a tooling guide could readily be designed to mate with the particular coping used. The pilot hole is drilled completely through the prosthesis to the occlusion side 104 as shown in FIG. 46.

[0168] FIG. 47 shows enlarging of the pilot hole 117 to allow clearance for a prosthetic mounting screw 121. The clearance holes 119 are drilled down to the top of the coping using counterbore drill 118. This requires only a small diameter enlargement (for example, approximately 2.4 mm).

[0169] FIG. 48 shows a step of a final hand reaming with reamer 120 of the coping bore to clean out any debris or remaining material from the cap that would interfere with the definitive screw.

[0170] FIGS. 49 and 50 show the final installation of prosthesis 103 onto abutments 107 using definitive prosthetic screws 121. The screw holes may be subsequently filled to use the modified prosthesis depending upon the anticipated use as a short-term or more permanent prosthesis. This sequence of process steps essentially follows the material provided in FIG. 27.

[0171] Note that in the above procedure very little material is removed from the prosthesis during the coping pick-up installation process. The boring process in FIG. 39 need only be sufficient to provide clearance for the coping and temporary screw. Angular variation in the axes of the implant abutments does not appreciably increase the size of the cavity boring required in this closed tray process compared to the additional prosthesis material that must be removed with relatively long impression screws and sleeves in a conventional open tray conversion process for definitive screw attachment. FIGS. 91-92 provide a schematic comparison of the size of the recess borings required using the concepts disclosed compared to the prior art conversion process with larger through holes in FIGS. 93-94.

[0172] The converted prosthesis with copings and screw-access channels may also be used as an accurate digital scan model of abutment positioning for creating a new prosthesis. In this embodiment, dual purpose scan flag and lab analogs 122 shown in FIGS. 51-52 may be fastened to the provisional or duplicate prosthesis 103, for example, after the clearance hole cleaning shown in FIG. 48. Features that may be present on the scan-flag/analog include a scan-flag reference portion 123 near the top of the analog, reference scan-flag features such as flats 124, axial and radial retention feature 128, screw attachment 125 for scanning fixture and/or reinforcement wire attachment. The abutment features 126 are specific to various systems commercially available. The figures show a tapered abutment mating surface 126 and female thread 127.

[0173] FIGS. 53-54 show scan flag/analogs 122 attached to converted prosthesis 103 with copings 112 using definitive screws 121.

[0174] FIGS. 55-56 show converted prosthesis 103 with scan flags/analogs 122 mounted to fixture 130 by attaching one or more scan flags 122 to the base with adjustable means to orient the prosthesis properly for scanning. For illustration an approximate mounting angle of 45 degrees is shown. In this example, the converted prosthesis 103 is mounted to articulated arm 131 with screw 129 that fits into the threaded hole of scan-flag/analog 122. Base 132 is mounted onto the base of the scanning machine.

[0175] The provisional or duplicate prosthesis with attached scan flags/lab analogs is scanned into the design software. This process captures the accurate position of the implant multi-unit abutment relative to the soft tissues and it also captures the tested prosthetic contours to aid in the design of the definitive prosthesis. After the prosthesis has been scanned in, a physical model may optionally be created by creating a soft tissue moulage and pouring dental stone into the provisional or duplicate prosthetic utilizing the scan flags as the laboratory analogs.

[0176] FIG. 57 schematically shows the application of solder or brazing preforms 133 to attach reinforcement bars 134 prior to pouring dental stone. Preforms 133 may be inserted into holes in the scan-flag/analogs and heated to attach bars 134. Low-temperature solders, brazing compounds, and hot-melt or other adhesives may be utilized in a preform or dispensed method to increase the rigidity of the analog assembly prior to casting.

[0177] This method ensures a fast and efficient means of transferring all pertinent and relevant information from a converted denture required for designing a definitive prosthesis from digital scanning and creating the most accurate and precise physical

model that can be mounted in an articulator with the aid of a bite registration in preparation for post-processing of the machined prosthesis, for example to verify passivity of fit, occlusion, etc.

[0178] In addition to the screw attachment of the scan flags to the modified prosthesis, scan flags may be attached to the prosthesis with incorporated copings of FIG. 43 prior to the drilling operations shown in FIGS. 45-47. In this case, another embodiment of the scan flag (not shown) with a post feature equivalent to post feature 101A of separable screw would be inserted into copings 112 of the modified prosthesis and retained by the embedded cap 102. If the separable fastener uses a snap-fit feature to retain the cap to the post, drilling may not be required through the prosthesis to mount the scan flags or lab analogs to the prosthesis or to attach the modified prosthesis to the abutments after lab use. For example, US Provisional Patent Application 62/774,402 describes the use of spring fingers and O-rings for separable fastening of the coping to the abutment for lift-off, and the use of films to prevent adhesive from entering interior portions of the separable fastener. Scan flags and lab analogs may also be engaged with transferred copings using similar mounting features as the post used in the transfer pick-up process. The referenced patent application also includes separable systems in which the post attaches directly to the coping without a cap which may be applied for mounting scan flags or lab analogs as variations of the methods described above. Since the dimensions of the coping and its engagement with the abutment is precisely controlled, having snap-in scan flags engage with a cavity between the top of the coping and the separable cap or an internal groove or other feature of the coping may be desirable.

[0179] Variations of using the modified prosthesis as a digital scan model, or using the inventive concepts disclosed to create a permanent prosthesis will be recognized as possible to dental practitioners. For example, instead of using a dual-purpose scan flag and lab analog, single purpose scan flags can be mounted into the provisional prosthesis for scanning, and subsequently replaced with lab analogs prior to casting. In addition to the attachment of scan flags to a modified prosthesis for digitization, the separable fastener may be used to transfer a coping and cap to a new impression after implant surgery. A scan flag or lab analog may be attached and held to the impression

with transferred coping for digitization or casting by substituting the new impression for the modified prosthesis in any of the processes above. FIG. 58 describes a workflow for using the temporary alignment fasteners with a permanent prosthesis fabricated from a digital model based on an impression.

[0180] FIGS. 59-60 show an embodiment of a simple torque-driver 113 that can be used for the temporary coping attachment process discussed in reference to FIG. 40. Shaft assembly 135 contains a spring friction cylinder portion 141 and drive portion 138 designed to engage the temporary screw 100. Spring 136 has an interference fit with cylinder 141, and thus when spring 136 is rotated in the "unwind" direction of the spring, a designed amount of slip torque is present between the spring and cylinder. In the "wind" direction, the spring binds on the cylinder. This provides unequal drive torque capability in the two rotation directions. Slot 139 in drive cap 137 engages spring end 140, and snaps onto the end of the shaft assembly, thus when the cap is rotated in the clockwise direction, cylinder and drive slip at a known torque. When the cap is rotated in the counterclockwise direction, the spring binds on the shaft to provide a higher screw removal torque before slipping.

[0181] FIG. 61 shows an embodiment of a temporary screw post extractor 115 which may be used to remove post 101 after the pick-up process as shown in FIG. 44. The extractor utilizes a hollow metal tubular split-cylinder end portion 142 that deflects to grip the end of the temporary screw post 101, allowing removal of the separable fastener posts or other types of fasteners. FIG. 61 illustrates a hand-operated knurled end, but other torque tool systems known in the dental industry such as 3/32" friction and latch designs may be used.

[0182] FIGS. 62-63 schematically illustrate how the position of the temporary screw post 10 of the first embodiment relative to the implant abutment can be determined. As the temporary screw is rotated clockwise, the cap 11 will be pushed axially away from the screw threads of the post by the coping. The depth of threaded engagement and the

length of the temporary screw post 10 and cap can be designed to have the top of the post 10 coincide with the top of the cap 11 as shown in FIG. 63 when the temporary screw is properly positioned. At this point, a drive tool with a square socket cavity (not illustrated) would disengage from the temporary screw assembly since the post 10 would no longer extend into the tool socket cavity.

[0183] FIGS. 64-66 illustrate different embodiments of the end of the temporary screw post that engages the cap. FIG. 64 shows a modified version of the cylindrical post 101 designed for frictional engagement on cylindrical portion 85 with a cap having a circular bore similar to that shown in FIG. 34. In FIG. 65, the cylindrical post is slotted, and the resulting beam portions 86 sprung open to provide additional frictional retention of a cap through spring action with the deflecting beams. Various features such as symmetric axial splines 87 (FIG. 66), asymmetric splines or grooves, and textures may also be used to tailor driving torque and axial retention force of the cap to the temporary attachment post. Non-symmetric features may also be utilized to tailor different installation torque and extraction forces. Surface finish and coefficients of friction of the mating materials may also be used to control the driving and retention properties. Temporary attachment posts and caps may be made from metal and polymer materials such as titanium, stainless steels, nylon and PEEK and other non-corrosive biocompatible materials.

[0184] If additional off-axis accommodation is desired when extracting the temporary attachment post from the coping after pick-up, some flexibility may be incorporated into the temporary attachment post, such as the necked down portion 88 of the temporary attachment post shown in FIG. 67, which allows the temporary attachment post to flex slightly off-axis during the pick-up process. Under tension, the alignment of the temporary screw axis with this necked-down portion can be designed to align the axis of the implant abutment threads with the coping threads but allow some bending when the tension is released. Note that this alignment flexibility will generally not be required during the final screw attachment process. The final attachment process is more accommodating of axial misalignment of multiple abutments than the coping pick-up process. During pick-up, the prosthesis with copings incorporated must be removed

from all abutments simultaneously. For final attachment, each definitive screw is attached individually after the copings of the prosthesis are positioned on the implant abutments.

[0185] FIG. 68 shows an embodiment of a temporary screw cap 94 that includes spring features 95 that engage the outer diameter 96 of the temporary post. If desired the portion of the temporary screw cap with the spring features may be made of a different material than the remainder of the cap.

[0186] Although the temporary screw of FIG. 69 has a similar appearance to that shown in FIG. 68, it has distinct functionality. FIG. 69 shows an embodiment of a temporary alignment screw 58 having threaded portion 62, breakaway flange 60 and hex drive portion 61. The flange 60 pushes down on the top of the coping as the temporary alignment screw threads 62 are rotated into the implant abutment. The flange portion may be molded onto a temporary attachment post with threaded portion 62 and drive portion 61 by insert molding if different materials are desired. Preferable, all portions of the alignment screw are molded integrally of a single material. The cap and post do not slide axially relative to one another. Instead, small break-away tabs 59 in the flange portion are designed to yield under axial force during the prosthesis and coping assembly removal after the bonding step. The breakaway portions are designed to fracture at an axial force exceeding the force applied to align the coping to the implant abutment for pick-up.

[0187] FIG. 67 employed a temporary alignment screw post with a waist that can bend during prosthesis removal in the pick-up process. It is also possible to provide additional off-axis accommodation during coping pick-up with temporary screws that do not bend. For example, in FIG. 70, a temporary alignment screw post 25 includes a rounded portion 27 that bears against the central straight bore of cap 26. FIG.71 shows a tapered profile 29 on cap 30 which engages a straight cylindrical portion of post 28. It is preferable to prevent the incursion of adhesive in the gaps between the post and cap

that allow the post to pivot. FIG. 71 includes a thin protective film 56 for this purpose. This film should be chosen to deform easily when the post is pivoted.

[0188] FIG. 72 shows a thin retaining ring 32 that engages temporary attachment post 31. The retaining ring 32 also provides a one-way insertion direction of temporary attachment post 31. This preferential insertion direction also corresponds to the relative motion of the post and retaining ring for release in the pick-up process.

[0189] FIG. 73 shows another embodiment of a temporary alignment screw that does not have relative axial sliding between the post and cap. In this embodiment a thin retainer 35 that may be comprised of a metallic or polymer sheet is attached to the top portion of temporary attachment post 33 and optional cap 34. The sheet 35 may be attached to temporary attachment post 33 using adhesives, plastic or metal welding, etc. After the adhesive has cured holding the coping to the implant abutment, the mechanical connection between the post and cap is overcome by axial force in the pick-up process. The mechanical connection can be designed to fail by adhesive failure or by fracture of the joint or the sheet 35.

[0190] FIG. 74 shows another embodiment of a temporary alignment screw without relative sliding between the cap portion and the post portion. In this embodiment, a compliant or frangible portion of the post 37 is used to attach a cap 38 to the post. Under tension, the cap portion 38 holds the coping in position against the abutment for pick-up into a prosthesis. Compliant portion 37 may be for example an elastomeric material to provide some angular motion during prosthesis removal after the pick-up material sets. The compliant portion 37 itself or one of its interfaces with the cap or post may provide a separable interface with controlled axial breakaway force. Other methods of separating a compliant portion may include exposure of compliant portion 37 made from a material easily affected by heat, any wavelength of electromagnetic energy, or a chemical reaction that may be applied externally or as part of the pick-up process.

[0191] The inventive concepts disclosed are not meant to be restricted to a temporary attachment post with standard screw threads that both engage and disengage the threads in the implant abutment through rotations. For example, alternate separable temporary attachment posts embodiments are possible providing features that allow the post to removably hold the coping to the abutment by other means than a separable cap. For example, as shown in FIG. 75 an alignment fastener post 39 may contain a separable threaded or serrated portion 40 that engages the screw threads in the abutment for pick-up, but that will release with axial force after. FIG. 75 shows a temporary fastener 190 with a head 42 portion and an attachment post portion 39. The attachment post portion 39 is shown as having a slot 41 and asymmetric threads or serrations 40 that have proximal flank 183 and a distal flank 184. This asymmetric threading still allows the temporary attachment post portion 39 to be inserted through rotation like other temporary screw embodiments for alignment for coping pick-up. The post 39 may be subsequently extracted with a separation force in the axial direction. Although the threads could be designed to provide engagement with the implant abutment threads through axial motion in the opposite direction to the arrow shown in FIG. 75, rotation to a design torque on engagement is generally preferred. If the post 39 is designed to be pulled out of the abutment during the coping pick-up process, it will subsequently need to be removed from flange 42 and the prosthesis assembly. Since there is no processing impact on patient comfort, higher mechanical forces or a broader range of energy or chemical processing may be employed to remove the post 39 from the prosthesis 3 after coping 9 pick-up.

[0192] Further permutations of the separable alignment screw features disclosed above are possible. FIG. 76 shows an embodiment where axial flexibility and/or controlled retention between cap 44 and temporary attachment post 43 is provided by an interface material 45 such as adhesives, silicones, and elastomeric materials contained in the space between the bore of the cap 44 and the post 43. FIG. 77 shows cap 47 retained with an O-ring 48 held in grooves in the cap 47 and temporary attachment post 46. FIG. 78 shows a cup-shaped interface material 57 located within the bore of the cap 44 and extending over a portion of the end of the post 43. FIG. 79 shows a split-collar feature 51 on cap 50 which presses onto the temporary attachment post 49. FIGS. 80 and 81 show alternate designs of flexure beam features in caps gripping a post. In FIG.

80, the pressure on the post 49 is reduced by pulling the cap 52 perpendicular to a diagonal of the cap as indicated by the arrows. In FIG. 81, the pressure on the post 49 is reduced by pulling in opposite directions with moment arms as shown to open the spring.

[0193] It is understood that the concept of the temporary attachment of the coping with the abutment with an axially separable temporary post is not dependent upon having a separate cap 11 or nut 63 on the post. If desired the cap or nut can be eliminated and the coping may be directly fixed and axially separable from the temporary attachment post. That is, the coping can be designed to have an equivalent mechanical interface to the post as the caps in the embodiments above. The mechanical interface between the coping and post may be tailored to provide equivalent rotational engagement and relative axial movement above a designed minimum axial force.

[0194] Example embodiments of the coping and post being the separable components include the following:

[0195] FIG. 82 shows temporary attachment post 71, engaging an interference fit of coping 72 at a position above the threaded portion. Metal, metal-reinforced, ceramic, and polymer copings, posts and fasteners may be included in this and other embodiments. Any of the parts may have surface treatments to control friction or adhesion.

[0196] FIG. 83 shows temporary attachment post 71 engaging integral spring-finger features 78 of coping 73.

[0197] FIG. 84 shows a temporary attachment post 71 engaging collet-type spring fingers 77 of coping 74, these collet-type features may be formed using slots in the coping 74 as shown in FIG. 84A.

[0198] FIG. 85 shows a slotted spring feature 79 formed in the temporary attachment post 76. The spring-features engage a smaller bore portion 90 of the coping 75. Such features may be of varied shapes including slots, eyelets, swaged portions, tubular swaged parts, etc. A film 56 (not shown) may be used to prevent the ingress of pick-up material into any voids at the top of the post/coping assembly similar to that shown in FIG. 71.

[0199] FIG. 86 shows temporary attachment post 71 and coping 75 engaged using an O-ring or washer 80. Such washers may be elastomers, polymers, metals, etc. and may be forms in varied shapes, such as the u-shaped retainer 81 of FIG. 87.

[0200] FIG. 88 shows temporary attachment post 71 retained to coping 75 using a sheet cap 82. Sheet cap 82 may be a tape, or other polymers or metals joined using adhesives, thermal and ultrasonic bonding, welding, and brazing, etc. This is similar to the embodiment shown in FIG. 73, except the sheet cap 82 does not have thicker cap element 34.

[0201] FIG. 89 shows temporary attachment post 71 retained using a filler material 83 in the counterbore of coping 75. Fillers may include a variety of polymer adhesives or fillers, such as silicones, acrylics, epoxies, and/or soft metallic materials. Since the coping 75 in this embodiment is fixed to the post 71, the mating surfaces of the coping 75 and implant abutment must allow relative rotational motion until the predetermined torque is achieved.

[0202] Installation of these embodiments may also be accomplished with simple polymer or metal tools 84, for example, as shown in FIG. 90 that engage the flats or other features of the coping 75, and/or of features on top of the threaded post 71.

[0203] Although the descriptions above use rotational engagement of the bottom of the post with internal threads of the abutment as a preferred approach, this is not meant to be limiting. Alternate approaches for engaging a temporary attachment post with abutment threads through axial insertion without rotation are considered to be part of this disclosure. For example, the split post bottom structure shown in FIG. 75 which allows axial extraction can also be used for axial insertion. Similarly, an interference fit between the bottom of the post with the threads may also be designed to provide sufficient engagement to provide adequate alignment and fixing of the coping for the pick-up bonding process described earlier. For non-rotary extraction of the post, it is not necessary to have the extraction force of the post-abutment thread interface greater than the force required for relative movement of the coping or cap with the upper end of the post. That is, if the temporary attachment post remains fixed to the coping during the pick-up step, the post can be removed from the dental appliance after removal from the patient's mouth.

[0204] Although axially symmetric interfaces between coping and abutment have been described for most embodiments, the inventive concepts may also be applied to asymmetric abutments and copings as long as the coping doesn't need to rotate on the implant abutment as noted, for example, with the embodiment of FIG. 89 .

[0205] Various embodiments have been described to illustrate the disclosed inventive concepts, not to limit the invention. Combining inventive elements of one or more of the embodiments with known materials, components and techniques in dental science to create further embodiments using the inventive concepts is considered to be part of this disclosure.

[0206] Any of the embodiments may contain a film or deposited material on top of the cap and temporary attachment post to prevent adhesion to the temporary attachment post of materials used for pick-up, as shown in the film 56 of FIG. 71.

[0207] Temporary attachment posts may be rotationally driven into the abutment threads using either the cap, coping or the temporary attachment post itself. Temporary attachment posts and caps may have varied drive features such as male or female knurls, hex, spines, spanner notches/holes. These design alternatives are driven by functional requirements of a particular implementation.

[0208] Other means of attaching/joining a secondary separable portion include insert-molding, use of adhesives, waxes, solders or other metallic materials, heat-staking, and ultrasonic bonding.

[0209] Break-away portions may also be formed by two-shot molding, dispensing or otherwise placing a secondary mechanically, thermally, or electromagnetically fusible material on a portion of the fastener to provide the break-away function.

Thin-film or thick-film metallic and polymer coatings may be applied to portions of the fastener to tailor friction and insertion and extraction forces, enhance adhesion of pick-up materials, and other properties such as corrosion-resistance.

Claims

We claim:

1. A dental system for attachment of a coping to a threaded implant abutment comprising:

a coping having a proximal end with an aperture sized to allow a shaft portion of a definitive screw to pass through ; and

an implant abutment having helical threading for securing the coping with a definitive screw; and

a definitive screw having a proximal head end having a tool interface and a distal post portion having threads for securing the coping to the implant abutment after processing; and

a temporary screw having an axis with a length measured along the axis and a width measured perpendicular to the axis, the temporary screw comprising:

a proximal head portion with a width larger than the coping aperture; and

a distal shaft portion shaped for rotary engagement with the implant abutment threads;

wherein rotating the temporary screw to engage the shaft portion of the temporary screw with the implant abutment threads through an engagement depth and to a predetermined torque causes the head portion of the screw to hold the coping into alignment with the implant abutment for processing, and wherein an axial force in the proximal direction releases the coping from the implant abutment, and wherein the shaft portion does not contact the implant abutment threads continuously above the most distal engagement position.

2. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft includes a narrower region having a width that is less than the width of the temporary screw shaft threaded region, and wherein the narrower region is located between the distal end of the temporary screw head and the proximal end of the temporary screw shaft threading.

3. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft comprises asymmetric threading.

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4. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the axial release force is applied through a pick-up process in which the coping is adhered to a separable dental element.

5. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the axial release force is less than about 5 pounds.

6. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading is not a continuous helical structure over the engagement depth.

7. The dental system for attachment of a coping to a threaded implant abutment of Claim 6 wherein the definitive screw post threading comprises a continuous symmetrical helical form.

8. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading deforms under the axial force to release the coping.

9. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein only mechanical energy is applied to release the coping.

10. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft comprises an open space located toward the axis from the threading.

11. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading makes contact with the implant abutment threading over a temporary screw threading contact area when holding the coping against the implant abutment and the definitive screw post makes contact with the implant abutment threading over a definitive screw threading contact area when holding the coping against the implant abutment, and wherein the temporary screw threading contact area is less than the definitive screw threading contact area.

12. The dental system for attachment of a coping to a threaded implant abutment of Claim 11 wherein the volume of the definitive screw post material located distally of the proximal end of the implant abutment threading when holding the coping against the implant abutment is greater than the volume of the temporary screw shaft material

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holding the coping against the implant abutment when holding the coping against the implant abutment.

13. A dental system for attachment of a coping to a threaded implant abutment for pick-up processing comprising:

a threaded implant abutment having an implant abutment longitudinal axis, and

a coping having a proximal end with a central aperture, and

a temporary screw having a temporary screw longitudinal axis with a length measured along the axis and a width measured perpendicular to the axis comprising:

a head with a proximal end having a drive tool interface for rotating the temporary screw to a predetermined torque and wherein the head portion does not fit through the central aperture of the coping, and

a shaft having an axis with a length measured along the axis and a width measured perpendicular to the axis that fits within the central aperture; the shaft comprising:

a distal portion having a shaft thread, and

a proximal portion without a shaft thread, and

wherein inserting the shaft of the temporary screw into the coping central aperture and rotating the temporary screw to a predetermined torque engages the shaft thread with the implant abutment threading to provide an axial overlap of the temporary screw shaft axis and the implant abutment axis to pull the coping into position with the implant abutment for pick-up processing, wherein the axial overlap comprises threaded and unthreaded shaft portions, and wherein applying an axial force above a predetermined value in the proximal direction releases the coping and temporary screw from the implant abutment.

14. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 13 wherein the shaft threading is asymmetrical.

15. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 14 wherein the asymmetrical threading allows axial movement of

the shaft in the proximal and distal directions relative to the implant abutment threading when an axial force is applied above a threshold force for movement in each direction and wherein the axial force threshold for movement is smaller in the proximal direction than in the distal direction.

16. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 13 wherein the distal portion of the shaft deforms during the axial release.

17. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 16 wherein the distal portion of the shaft includes an open space for shaft deformation towards the axis.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS

As the below named inventor, I hereby declare that:

This declaration is directed to:

- [x] The attached application, or
- [ ] United States application or PCT international application number _____

filed on _____.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

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LEGAL NAME OF INVENTOR

Inventor: Brandon Dale Kofford Date (Optional) :_____

Signature: /Brandon Dale Kofford/

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ELECTRONIC PAYMENT RECEIPT

APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/424,696	**01/26/2024 09:36:44 PM Z ET**	**SDC012**

Title of Invention

Screw-attached Pick-up Dental Coping System and Methods

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5633	FILED BY	Daniel Whittle
PATENT CENTER #	63990838	AUTHORIZED BY	-
CUSTOMER #	112823	FILING DATE	-
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Brandon Dale Kofford

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
CARD / 5436	**E20241PL41266308**	**Daniel Whittle**

FEE CODE	DESCRIPTION	ITEM PRICE($)	QUANTITY	ITEM TOTAL($)
2830	PROCESSING FEE, EXCEPT IN PROVISIONAL APPLICATIONS	56.00	1	56.00
2817	REQUEST FOR PRIORITIZED EXAMINATION	1680.00	1	1680.00
2111	UTILITY PATENT APPL. SEARCH FEE	280.00	1	280.00
4011	BASIC FILING FEE- UTILITY	64.00	1	64.00
2311	EXAMINATION OF ORIGINAL PATENT APPLICATION	320.00	1	320.00
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SCREW-ATTACHED PICK-UP DENTAL COPING SYSTEMS AND METHODS

ABSTRACT

A temporary alignment system and method for holding a dental coping to an implant abutment using the same threads in the abutment that are used for definitive attachment are disclosed. The disclosed temporary fasteners initially orient and hold a coping against an abutment with a force along the same axis as the semi-definitive screw. The aligned coping can be picked-up in a closed-tray impression process without unscrewing the temporary fastener. Embodiments include threaded posts that release copings from the abutment through axial forces. Some embodiments include a threaded post with separable cap that is picked-up with the coping. Methods for converting an existing prosthesis for screw attachment to implants in a single visit and digital capture of the converted prosthesis are described.

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation of US Patent Application 18/328,730, filed on June 3, 2023, which is a continuation of US Patent Application 17/691,108, filed on March 9, 2022, which is a continuation of US Patent Application 16/596,361, filed on October 8, 2019, and issued as US Patent 11,311,354 on April 26, 2022. This disclosure claims priority of US provisional patent application number 62/742,942, filed on October 9, 2018, and US provisional patent application number 62/774,402, filed on December 3, 2018, and US provisional patent application number 62/818,082, filed on March 13, 2019. All of the above non-provisional and provisional applications are incorporated herein by reference in their entirety.

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BACKGROUND OF THE INVENTION

[0003] Different systems have been introduced for attaching dental prostheses to dental implants to replace one or more natural teeth. In order to simplify future modification or replacement needs, it is desirable to have reversable attachment between the implants and prostheses using mechanical systems as opposed to directly bonding these components together. These systems require features to provide both proper alignment and retention for acceptable use by the patient. Intermediate components such as copings and separable abutments having different lengths or orientations are often employed to provide proper registration between a dental prosthesis, one or more implants embedded in the patient's

jawbone, and the soft-tissue and any remaining natural teeth. These intermediate elements may be mutually attached with screws or with ball-and-socket or other forms of snap-on mounts. In the case of a single-tooth crown attachment, the coping and abutment surfaces preferably include features to remove rotational symmetry in the mating of the abutment and coping surfaces. Rotational locking features may also be included in these single mount systems. When the prosthesis contains multiple copings for attachment to multiple abutments, this rotational fixation is not generally required. For example, 30-degree tapered mating surfaces for multiple interface locations are sufficient to provide complete registration.

[0004] It is common to attach a complete upper or lower denture to four or more implants. The multi-unit abutment system interfaces with mating surfaces of the final prosthetic. In some cases, these dentures may be designed or fabricated from scratch following the pulling of undesirable teeth and mounting of implants. In other cases, no teeth are pulled, but it is desirable to convert an existing removable denture to definitive mounting to new implants. In some cases, it is preferable to convert these existing dentures shortly after the implants are placed. This chair-side processing decreases patient discomfort by providing at least temporary dentures more quickly.

[0005] Dental impressions are often used to provide information on the location of implants, soft tissue and existing teeth for designing new prostheses or mounting copings in existing dentures for implant attachment conversion. Generally, the copings are mounted to implant abutments and an impression is made to provide location information for the prosthesis through the copings. Impression material is introduced and cured around the copings to define their position. In the case of transfer copings, less rigid impression material is used to form a cavity for each coping; the coping remains attached to the abutment and the cured impression is removed. Subsequently, copings are inserted into the impression.

In the case of pick-up copings, the coping is directly retained in the impression material after curing. That is, the copings are picked-up when the impression is removed from the mouth. The resulting alignment of pick-up copings is generally superior to transfer copings as a result of the direct transfer of coping location information. Transfer copings introduce an indirect secondary alignment reference since the insertion of the coping into the impression may not accurately duplicate the original position, particularly in insertion depth.

[0006] Pick-up copings can be used with either an open tray or a closed tray protocol. For snap-on systems, a closed impression tray pick-up technique may be done. The tray can be closed because there is no need to access the copings in order to disconnect them after the impression material sets. However, it is desirable to ensure that the assembly of snap-on copings can be removed without patient discomfort. The amount of force required to remove the tray or converted prosthesis depends upon the total number of implant abutment/coping sets and their position and mutual alignment. Some snap-on systems provide features to provide different retention levels, but this complicates the installation process. Special tools have been introduced to help separate impression trays or prostheses with snap-on systems but may still result in patient discomfort. Since snap-on systems are generally physically larger than dental screws, converting an existing denture may require large clearance cavities to be bored into the existing denture before it can be used as an impression tray in a pick-up coping process. These large holes may significantly reduce the mechanical stability of the existing denture. The mechanical precision required of snap-on system elements generally makes them more expensive than screw-attached systems.

[0007] The simplicity of screw-attached systems provides some benefits over snap-on systems beyond fabrication cost. The mounting pressure between the coping and abutment is readily controlled through the torque applied to the screw

to tighten it. This axial tension control and the self-aligning characteristics of engaged screw threads provides more certainty in the engagement force and relative orientation of the components. Even if a screw breaks, techniques are known for removing the pieces without damage to surrounding components. Screws also have a benefit of independence for removal since each coping can be loosened individually. Tilting the prosthesis after screw removal to disengage one coping cannot cause reengagement of another coping.

[0008] A disadvantage with commercially available screw-attachment systems for pick-up copings is the requirement for using an open-tray impression in order to release the coping from the abutment after the impression material sets. By having an opening in the tray or existing denture, impression screws may be used. These impression screws extend through the tray beyond the impression material and can be unscrewed after the material sets. The impression screws use the same abutment threads as the semi-permanent screws used to attach the prosthesis later. As a result, the introduction of alignment uncertainty through a secondary reference may be avoided or minimized. The copings used with the impression screws are often relatively long and require modification for denture conversion. This customization may result in larger clearance holes in dentures and require additional process time by the dental practitioner. The length of the impression screws sticking through the tray can cause patient discomfort and a gag reflex. In the case of denture conversion, clearance for a set of impression screws at different angles may require additional material removal leading to a weakened denture. A schematic representation of the larger through-holes 136 required using conventional denture conversion processes for screw attachment are illustrated in FIGS. 93-94. The impression screws can also prevent the patient from applying bite pressure during the pick-up process to ensure proper registration of the modified denture and opposing teeth.

[0009] Prosthetic dentistry has rapidly moved into the realm of digital design and manufacturing. Typically, this requires that a digital model is created from a physical model or impression to allow digital design and manufacturing techniques to produce a physical prosthetic that can be delivered to a patient for restoration of dental and oral structures. When making a dental restoration with implants in this manner, an implant impression coping is often used in the mouth to reference the position of the implant geometry relative to surrounding structures such as gingiva, adjacent teeth, opposing teeth, etc. Once removed from the mouth, an implant analog is attached to the impression coping that was picked-up or transferred. With the lab implant analog attached to the impression coping in the elastomeric impression, dental stone is flowed into the impression and allowed to harden before separation from the impression with a resultant dental cast. A scan flag is attached to the lab analog on the dental stone model and is scanned in by laser or optical scanning technology. The scan flag is used for design software to reference and replicate the accurate positioning of the virtual implant relative to the adjacent teeth, gingiva and opposing tooth, as well as the timing of the implant and other pertinent implant geometries. Once the virtual implant is accurately brought into the design software, a prosthetic can be designed by following the workflow in the design software. A completed design is post-processed, and a CAD file is used in CAM software to direct either the 3-D printing or milling of the designed prosthesis. The manufactured prosthesis is verified on the physical model in a remote prosthetic manufacturing lab prior to delivery to the dentist or is verified directly on the dental patient if the prosthesis was manufactured in the local dental clinic. It is currently the standard of care to verify the fit, form, and function on a physical model.

[0010] Recently, an impression scan flag was introduced to the market for a few major implant systems and the most common multi-unit geometry. This scan flag allows for an impression to be digitized without the creation of a stone model. A digital model is created directly from the elastomeric impression, a prosthesis is

designed digitally and processed with CAM software and both a 3-D printed model and 3-D printed or milled prosthesis is finished and tested on the 3-D printed model. The disadvantage of the 3-D printed model for full arch implant prosthetics is the positioning of the implant lab analog within the 3-D printed model introduces a degree of inaccuracy. Additionally, an impression only captures the implant or multi-unit abutment relative to the tissues and requires cumbersome steps to incorporate a provisional prosthesis or wax-up into the design software relative to the scan of the impression.

[0011] A properly converted denture provides a valuable source of information of the relative location of the implant and its abutment surfaces, copings and soft tissue and any remaining teeth of the patient. It can be used as a model for digital scanning to produce a duplicate denture if needed in the future or as a starting digital model for manipulation to improve aesthetics or other characteristics. However, if the mechanical integrity of the converted denture is compromised, the scanned information may not faithfully represent the relative geometry of these elements and result in a poor fit.

[0012] Other alignment systems have been proposed which use silicone or melting screw threads to allow closed tray transfer for definitive screw attachment, but the practicality of providing adequate alignment and seating forces with a screw diameter in the range of existing systems or overcoming the lack of disengagement independence required in melting all threads simultaneously without patient discomfort has not been documented. Details on removing any residual material in the abutment threads or in the prosthesis after the pick-up process have not been disclosed. Other hybrid systems that use a snap-on engagement for the pick-up coping during transfer and subsequent screw-attachment have also been proposed, but detailed information on the tradeoffs in precision and associated complexity or size required for equivalent performance to open-tray impression screw techniques have not been disclosed.

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A general need exists for systems that improve clinical efficiency, implant to prosthesis alignment accuracy, application to a wide range of coping designs and sources and patient comfort over existing systems.

[0013] The present disclosure includes systems and methods that address one or more of these issues in the prior art.

BRIEF SUMMARY OF THE INVENTION

[0014] Some embodiments of the invention include a screw-in fastener system used to temporarily retain a coping on an abutment during bonding of the coping into a blind hole located in the tissue-side of a removable dental element such as a removable complete denture. The temporary fastener system disclosed has features to allow easy removal of the dental prosthesis from the fastener post after pick-up of the coping into the dental prosthesis is complete, without the need for special tools or access to the fastener system to unscrew it.

[0015] Some embodiments include a temporary fastener with a male-threaded bottom portion that is installed into the screw threads of an abutment, and an axially separable top portion, or cap, that retains the coping onto the abutment. The separable portion allows removal of the coping picked-up in the dental prosthesis without requiring mechanical access to the fastener. The inventive concepts disclosed facilitate easier installation and removal on multiple abutments that may be oriented at different compound angles when compared to the conventional open-tray processes and long impression screws. The temporary fastener may engage the same screw threads of the abutment that are used to definitively attach the prosthesis. In this manner, the coping is held against the abutment for the pick-up process with a force oriented identically to that of the final screw mounting. The retention of the cap on the screw post can

be designed to provide a desired force holding the coping to the abutment through the applied torque on the temporary fastener. The cap can be attached to the post through a combination of known mechanical attachment means including but not limited to interference fits, adhesives, snap fits or other elastic and inelastically deforming retention elements. The cap may also be formed as an integral part of the screw post that has portions that fracture as a result of an applied axial force. In addition to applied axial forces, the cap may separate from the post as a result of retention changes resulting from chemical or thermal processes and or the application of electromagnetic energy during or subsequent to the pick-up process.

[0016] Other embodiments include a threaded post that has a temporary retention feature that engages the coping without a separable cap. These embodiments engage the abutment threads in mounting the coping but release the coping after bonding to the prosthesis.

[0017] The disclosed systems and methods can be applied to single tooth prostheses with copings and abutments with orientational features or for multiple tooth prostheses using copings and abutments with symmetrical mating surfaces such as 30-degree tapers.

[0018] In some embodiments, the temporary fastener is driven into the abutment threads by a tool that engages the post. In other embodiments, the temporary fastener is driven into the abutment threads by a tool that engages the cap. The drive torque can be designed to be sufficient for holding the coping to the abutment accurately, but less than the torque that would result in movement of the cap relative to the post.

[0019] In some embodiments, the threaded end of the post portion of the temporary fastener has a deflecting feature that allows the post to engage or disengage the abutment threads through axial motion instead of a rotary screw motion.

[0020] One embodiment describes a system for aligning a dental implant abutment, coping and separable dental element for definitive screw-attachment comprising:

a. a temporary alignment fastener comprising:

b. a post having an axis, a first post end and second post end, wherein the first post end is threaded for screw attachment to the implant abutment;

c. a cap, wherein the cap is attached to the second post end;

[0021] and wherein the temporary alignment screw is configured to hold the coping against the implant abutment when the first post end is screwed into the implant abutment and wherein the cap is separable from the post through a release force directed away from the first post end.

[0022] One embodiment describes a system for aligning a separable dental element for installation to a threaded implant abutment with a definitive screw having a head and threaded shaft portion comprising:

[0023] a coping having a distal end shaped to engage with the implant abutment and a proximal end with an aperture sized to allow the shaft portion of the definitive screw to pass through;

[0024] a temporary screw having a distal end portion adapted to engage the threads of the implant abutment and a proximal end portion having temporary engagement means for attachment adjacent to the proximal end of the coping wherein the temporary screw holds the distal end of the coping in alignment

against the implant abutment when the distal end portion of the temporary screw engages the implant abutment threads and wherein the temporary engagement means releases the coping without disengaging the post portion of the temporary screw upon the application of a predetermined axial force in the proximal direction.

[0025] In some embodiments, an existing removable denture is converted to a screw attached denture by milling pockets to allow copings to be bonded in a pick-up process. In this process, the denture acts in an equivalent manner to a closed impression tray. Proper registration can be confirmed by having the patient bite down on the denture during the pick-up process. After coping pick-up, clearance for the definitive screws can be drilled using the coping as a guide. The converted denture can be used with scan flags to provide a 3-dimensional digital capture. Thus a digital model can be used to make a duplicate prosthesis or as the starting point for a new custom prosthesis.

[0026] One embodiment describes an alignment system for converting an existing denture for screw attachment to threaded implant abutments designed to perform the process of:

a. mounting pick-up copings to the implant abutments with temporary fasteners,
b. adhering the copings to cavities formed in the existing denture,
c. pulling the denture with secured pick-up copings away from the implant abutments,
d. unscrewing the threaded portions of the temporary fasteners from the implant abutments,
e. forming definitive screw clearance holes in the denture,
f. mounting the denture to the implant abutments with definitive screws that engage the same implant abutment threads as the temporary fasteners,

wherein the unscrewing the threaded portions of the temporary fasteners and the forming definitive screw clearance holes in the denture may occur in either order.

[0027] For the purposes of this disclosure, a separable dental element is defined to be anything that incorporates one or more dental copings that can be mounted and removed from one or more implant abutments. Different coping designs are known in the dental industry, and the systems and methods disclosed here can be adapted to work with many commercially available types of copings including pick-up copings, temporary cylinders, inserts and impression copings. Implant abutments are known in the dental industry having compatible interfaces to these copings. Since the mechanical interface is the same, for the purposes of this disclosure, implant abutment is considered a generic term that includes abutment analogs. Description of alignment systems and process methods with copings and implant abutments that are installed in a patient's jaw should be considered to also describe equivalent inventive concepts that may be used with copings and implant abutment analogs in a dental lab. The inventive concepts disclosed herein can be used with different types of separable dental elements. The separable dental element can be any form of impression used in a dental lab to assist in creating and testing dental prostheses. A separable dental element can also be a dental prosthesis fabricated in the dental lab using a physical model made from the impression, a dental prosthesis newly fabricated, or an existing prosthesis being converted for screw attachment. A dental prosthesis is defined to include a single-tooth appliance such as a crown, or any multiple-tooth bridge or denture. These prostheses may incorporate copings to provide a separable interface to provide orientation with an appropriate abutment attached to a patient's jaw or gingiva. The abutments for use with the inventive concepts disclosed herein include screw threads to mount the prosthesis with copings onto the abutments. While the concepts describe female threads in the abutment mating with male threads on a mounting screw, this is for convenience in

disclosure. The inventive concepts could be applied with systems having male threads in the abutment engaging a screw with female threads for mounting the prosthesis. These are considered to be straightforward variations of the inventive concepts.

[0028] For the purposes of this disclosure, the abutments may be integral to the implants embedded into the patient's jaw or gingiva, or they may be separate units that are attached to the implants. The inventive concepts disclosed apply to both configurations.

[0029] For the purposes of this disclosure, an existing denture should be interpreted broadly to include any prosthesis that has been created prior to the use of the innovative systems and methods disclosed. An existing denture may be a loose denture that was worn by the patient prior to the installation of implants were installed, or it may be a new denture that is in the process of first fitting in the patient's mouth.

[0030] The systems and methods disclosed herein can be used with prostheses for attachment to both the upper and lower jaw. As a result, portions of the system that are oriented downward for the lower jaw will be oriented upward for the upper jaw and vice versa. For convenience, a disclosure of an embodiment of inventive concepts that is limited to a single jaw orientation, is considered to disclose an embodiment for the opposite jaw orientation. When referring to the perspective of a clinician, proximal portions are nearer to the clinician than distal portions. While a term such as top is the opposite of the term bottom, and proximal is the opposite of distal, their actual relative orientation will be determined by the context of their use. The term tissue-side is used interchangeably with intaglio to indicate the side of a prosthesis that is opposite the occlusal or cameo surface.

[0031] The inventive systems disclosed are beneficially applicable to screw-attached prostheses. Key benefits of screw-attachment are variable tightening torques and reversibility. The terms permanent, semi-permanent, definitive and final when referring to screw-attachment are used interchangeably in this disclosure. A conventional screw that is definitively attached can still be removed by accessing the screw and rotating it in the opposite direction that was used for attachment. For the purposes of screw-attached prostheses for this disclosure, the attachment is semi-permanent, permanent or definitive in the sense that frequent attachment and removal is not anticipated for normal use. In contrast, the temporary screw attachment is applied for a planned process duration or other anticipated interval. Removal of a semi-permanent or definitive screw is generally motivated by a problem or an opportunity for an improvement. Access to the screw to apply a tool for removal may require removal of material covering the screw for aesthetic reasons.

[0032] Other terms in the specification and claims of this application should be interpreted using generally accepted, common meanings qualified by any contextual language where they are used. The terms "a" or "an", as used herein, are defined as one or as more than one. The term "plurality", as used herein, is defined as two or as more than two. The term "another", as used herein, is defined as at least a second or more. The terms "including" and/or "having", as used herein, are defined as comprising (i.e., open language). The term "coupled", as used herein, is defined as connected, although not necessarily directly, and not necessarily mechanically. The terms “about” and “essentially” mean ±10 percent. Reference throughout this document to "one embodiment", "certain embodiments", and “an embodiment" or similar terms means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention.

Thus, the appearances of such phrases or in various places throughout this specification are not necessarily all referring to the same embodiment. Furthermore, the particular features, structures, or characteristics may be combined in any suitable manner in one or more embodiments without limitation. The term "or" as used herein is to be interpreted as an inclusive or meaning any one or any combination. Therefore, "A, B or C" means any of the following: "A; B; C; A and B; A and C; B and C; A, B and C". An exception to this definition will occur only when a combination of elements, functions, steps or acts are in some way inherently mutually exclusive.

[0033] The drawings featured in the figures are for the purpose of illustrating certain convenient embodiments of the present invention and are not to be considered as limitation thereto. The term “means” preceding a present participle of an operation indicates a desired function for which there is one or more embodiments, i.e., one or more methods, devices, or apparatuses for achieving the desired function and that one skilled in the art could select from these or their equivalent in view of the disclosure herein and use of the term “means” is not intended to be limiting. Other objects, features, embodiments and/or advantages of the invention will be apparent from the following specification taken in conjunction with the following drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0034] FIG. 1 is a top exploded isometric view of a first embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0035] FIG. 2 is a side plan view of a first embodiment of a system for aligning a dental implant abutment, coping and prothesis for definitive screw-attachment.

[0036] FIG. 3 is a top plan view of a first embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0037] FIG. 4 is a side cross-sectional view of the system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment along the line indicated in FIG. 3.

[0038] FIG. 5 is a side cross-sectional view of the embodiment of FIG. 4 attached to the jaw and prosthesis prior to the pick-up process.

[0039] FIG. 6 is a side cross-sectional view of the embodiment of FIG. 5 after the pick-up process.

[0040] FIG. 7 is a side cross-sectional view of the embodiment of FIG. 6 showing a drill bit creating a pilot hole for a definitive screw.

[0041] FIG. 8 is a side cross-sectional view of the embodiment of FIG. 7 showing a stepped drill bit creating a clearance for the head and shaft of a definitive screw.

[0042] FIG. 9 is side cross-sectional view of the embodiment of FIG. 8 showing the definitive screw holding the prosthesis to the implant.

[0043] FIG. 10 is an exploded top isometric view of a second embodiment of a system for aligning a dental implant abutment, coping and prothesis for definitive screw-attachment illustrating a single abutment and a temporary screw with breakaway tool.

[0044] FIG. 11 is an exploded side isometric view of the second embodiment of FIG. 10 prior to installation to the implant abutment.

[0045] FIG. 12 is an exploded side isometric view of the embodiment of FIG. 10 with the breakaway tool pushed onto the post and the coping placed on the implant abutment.

[0046] FIG. 13 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the tool being rotated to screw the post into the implant abutment.

[0047] FIG. 14 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the tool breaking away from the cap after the coping is secured on the abutment.

[0048] FIG. 15 is an exploded side isometric view of the embodiment of FIG. 10 schematically showing the prosthesis being marked for positioning a clearance hole.

[0049] FIG. 16 is a side isometric view of the marked prosthesis from FIG. 15.

[0050] FIG. 17 is a side isometric view of the marked prosthesis from FIG. 16 with blind clearance hole and boring tool.

[0051] FIG. 18 is an exploded side isometric view of the prepared embodiment of FIG. 17 as adhesive is schematically applied to the coping fixed to the abutment with the temporary screw.

[0052] FIG. 19 is a side view of the prosthesis in position for curing of the adhesive applied in FIG. 18.

[0053] FIG. 20 is a bottom side isometric exploded view of the coping incorporated in FIG. 19 being picked up as the prosthesis is removed from the implant abutment.

[0054] FIG. 21 is a top side isometric view schematically showing the post of the temporary screw being unscrewed from the implant abutment.

[0055] FIG. 22 is a top side isometric view of the implant abutment prepared for attachment of a prosthesis with a definitive screw.

[0056] FIG. 23 is a bottom isometric view of the prosthesis with picked-up coping from FIG. 20 being drilled from the bottom to provide clearance for the threaded shaft of a definitive screw following coping pick-up.

[0057] FIG. 24 is a top isometric view of the prosthesis with picked-up coping from FIG. 20 with a drill applied from the top to provide clearance for the definitive screw head.

[0058] FIG. 25 is top exploded isometric view of the prepared prosthesis from FIG. 24 with the definitive screw.

[0059] FIG. 26 is a top isometric view of the prepared prosthesis from FIG. 24 after attachment to the implant abutment with the definitive screw.

[0060] FIG. 27 is a schematic description of a process for aligning dental implant abutments, copings and a prosthesis for definitive screw-attachment.

[0061] FIG. 28 is an exploded bottom isometric view of a third embodiment of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment with tool oriented for assembly.

[0062] FIG. 29 is an assembled bottom isometric view of the embodiment of FIG. 28 with temporary screw and coping inserted into tool.

[0063] FIG. 30 is a side view of the system of FIG. 29 after assembly with the implant abutment.

[0064] FIG. 31 is a cross-sectional view of the assembly of FIG. 30 along C-C.

[0065] FIG. 32 is a side view of the assembly of FIG. 28 after the pick-up process showing the removal end of the tool engaging the retained temporary screw post.

[0066] FIG. 33 is a cross-sectional of the assembly of FIG. 32 along D-D.

[0067] FIG. 34 is an exploded isometric view of another embodiment of a temporary screw of a system for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0068] FIG. 35 is an isometric view of the temporary screw of FIG. 34 from the screw thread end.

[0069] FIG. 36 is an isometric view of the temporary screw of FIG. 34 from the cap end.

[0070] FIG. 37 is a bottom isometric view of a jaw with multiple abutments in preparation of marking a prosthesis as part of the process for aligning a dental implant abutment, coping and prosthesis for definitive screw-attachment.

[0071] FIG. 38 is a top isometric view of the prosthesis of FIG. 37 showing abutment location markings.

[0072] FIG. 39 is a top isometric view of the prosthesis with clearances milled to receive copings for pick-up.

[0073] FIG. 40 is a bottom isometric view showing installed copings and the assembly of a coping to an implant abutment with a temporary screw and torque driver.

[0074] FIG. 41 is a top isometric view showing adhesive being dispensed in recesses of the prosthesis.

[0075] FIG. 42 is a bottom isometric view of the abutments with attached copings in the process of being positioned into the recesses of the prothesis after adhesive is dispensed.

[0076] FIG. 43 is a top isometric view of the copings attached to the prosthesis after adhesive curing and pick-up.

[0077] FIG. 44 is a bottom isometric view showing the removal of temporary screw posts from the implant abutments after the pick-up process.

[0078] FIG. 45 is a top view of a drill in position to create a pilot hole in the prosthesis of FIG. 43.

[0079] FIG. 46 is bottom view showing the pilot holes from the process of FIG. 45 extending through the prosthesis to exit on the occlusion side.

[0080] FIG. 47 is a bottom isometric view showing a counterbore positioned on the occlusion side of the prosthesis to provide clearance for the definitive screw.

[0081] FIG. 48 is a bottom isometric view illustrating a reamer positioned to clean residue from the bore.

[0082] FIG. 49 is a bottom isometric view of the prepared prosthesis with definitive mounting screws prior to fastening to the abutments.

[0083] FIG. 50 is a top isometric view corresponding to FIG. 49.

[0084] FIG. 51 is a top isometric view of an embodiment of a component suitable for use as a scan flag for digital capture and a laboratory analog for physical model creation.

[0085] FIG. 52 is a bottom isometric view of the component from FIG. 51.

[0086] FIG. 53 is a bottom isometric view showing the component of FIG. 51 positioned for screw attachment to the converted prosthesis of FIG. 49.

[0087] FIG. 54 is a top isometric view of FIG. 53.

[0088] FIG. 55 is a top isometric view showing the assembly of FIG. 54 mounted on a stand in preparation for scanning.

[0089] FIG. 56 is a side view of FIG. 55.

[0090] FIG. 57 is an isometric view of the assembly of FIG. 54 with reinforcing bars mounted prior to pouring of dental stone.

[0091] FIG. 58 is a schematic flow chart illustrating options for creating and attaching a permanent prosthesis.

[0092] FIG. 59 is an exploded isometric view of the torque driver shown in FIG. 40.

[0093] FIG. 60 is a top isometric view of the torque driver of FIG. 59 partially assembled.

[0094] FIG. 61 is a top isometric view of the post removal tool shown in FIG. 44.

[0095] FIG. 62 is a top isometric view of an embodiment of a temporary screw similar to FIG. 1 schematically illustrating axial motion of the cap away from the post threads from screwing after the coping contacts the abutment.

[0096] FIG. 63 is a top isometric view of the embodiment of FIG. 62 in which the temporary screw post end has become flush with the top of the cap.

[0097] FIG. 64 is a top isometric view of a temporary screw post embodiment having a cylindrical stem.

[0098] FIG. 65 is a top isometric view of a split temporary screw post embodiment having deflecting sections.

[0099] FIG. 66 is an isometric view of a temporary screw post embodiment having symmetric axial splines.

[0100] FIG. 67 is an isometric view of a temporary screw post embodiment having a weakened portion facilitating lateral movement during pick-up.

[0101] FIG. 68 is a bottom isometric view of a temporary screw embodiment having a spring cap.

[0102] FIG. 69 is a bottom isometric view of a one-piece temporary screw embodiment designed to fracture under axial loading.

[0103] FIG. 70 is a cross-sectional view of a temporary screw embodiment incorporating a rounded interface between cap and post facilitating pivotal movement as illustrated.

[0104] FIG. 71 is a cross-sectional view of a temporary screw embodiment incorporating a restricted interface between cap and post facilitating pivotal movement and protective film.

[0105] FIG. 72 is a cross-sectional view of a temporary screw embodiment incorporating a spring cap with preferential axial movement in the pick-up direction.

[0106] FIG. 73 is a cross-sectional view of a temporary screw embodiment incorporating a laminar cap fixed to the end of the post.

[0107] FIG. 74 is a cross-sectional view of a temporary screw embodiment incorporating a compliant interface between the cap and post.

[0108] FIG. 75 is a cross-sectional view of a temporary screw embodiment incorporating a split post that has deflecting sections with screw threads shaped to facilitate axial separation without unscrewing the post threads.

[0109] FIG. 76 is a cross-sectional view of a temporary screw embodiment incorporating an interface material between the cap and post.

[0110] FIG. 77 is a cross-sectional view of a temporary screw embodiment incorporating an O-ring interface between the cap and post.

[0111] FIG. 78 is a cross-sectional view of a temporary screw embodiment incorporating a cup-shaped interface material between the cap and post.

[0112] FIG. 79 is a bottom isometric view of a temporary screw embodiment incorporating a split collar cap.

[0113] FIG. 80 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled perpendicular to the diameter indicated.

[0114] FIG. 81 is a top isometric view of a temporary screw embodiment incorporating a planar spring that flexes when pulled parallel perpendicular to the diameter indicated.

[0115] FIG. 82 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping is held by mechanical interference to the proximal end of the threaded post.

[0116] FIG. 83 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the coping has spring fingers holding the proximal end of the threaded post.

[0117] FIG. 84 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent

screw-attachment in which the coping has collet-type spring fingers holding the proximal end of the threaded post.

[0118] FIG. 84A is a top view of the embodiment of FIG. 84.

[0119] FIG. 85 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which the proximal end of threaded post has a slotted spring section holding the coping.

[0120] FIG. 86 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring holds the coping to the proximal end of the threaded post.

[0121] FIG. 87 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a compressed ring with a u-shaped cross-section holds the coping to the proximal end of the threaded post.

[0122] FIG. 88 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a thin cap fixes the coping to the proximal end of the threaded post.

[0123] FIG. 89 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment in which a filler material is placed in the bore of the coping at the proximal end of the threaded post.

[0124] FIG. 90 is a cross-sectional view of an embodiment of a system for aligning a dental implant abutment, coping and prosthesis for semi-permanent screw-attachment showing a tool engaging features of the coping to screw in the threaded portion of the post.

[0125] FIG. 91 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

[0126] FIG. 92 is a top isometric view schematically illustrating the material removed from an existing denture necessary with inventive concepts disclosed in preparation for pick-up.

[0127] FIG. 93 is a bottom isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

[0128] FIG. 94 is a top isometric view schematically illustrating the material removed from an existing denture necessary using prior art impression screw systems.

DETAILED DESCRIPTION OF THE INVENTION

[0129] FIG. 1 shows an exploded view of one embodiment of a temporary alignment system 12 for use in a direct coping pick-up process for screw attachment of a prosthesis. Implant abutment 8 has a distal end which may include attachment feature portion 135 illustrated as a screw thread for direct attachment to the patient's jaw and a proximal end with an abutment shaped to accommodate a coping 9. The abutment includes threaded section 18. The coping has a central bore 16 to accommodate screw fastening and may include ridges 17 or other structures or surface treatments to increase retention to the prosthesis with adhesive. The coping and abutment mating surfaces as shown in FIG. 1 are symmetrical. The inventive concepts of this disclosure may also be applied to abutment and coping systems that are keyed to restrict mating orientation. The coping may be mounted onto the abutment through rotation of a temporary adjustment screw comprising a threaded post 10 and cap 11. The cap

11 is mechanically attached to post 10 in a manner that allows relative axial motion with the application of a predetermined force. As illustrated in FIG. 1, cap 11 has a square central bore 13 that is press-fit onto a square portion 14 of post 10. The cap 11 temporarily retains coping 9 onto the implant abutment 8 during the pick-up process of the coping into the prosthesis with a force aligned directly along the same axis as the semi-permanent screw that will be used for definitive prosthesis mounting. The portion of the post engaging the abutment threads also prevents any pick-up material from contacting the abutment screw threads. After the coping is picked-up into the prosthesis, the cap and coping may be released from the abutment by applying an axial force. In the embodiment shown, the post threads 15 remain engaged with abutment threads 18 after the pick-up process. The post can then be removed from the abutment by unscrewing it. The prosthesis with embedded coping can be subsequently processed to accommodate semi-permanent screw attachment as will be described later.

[0130] FIGS. 2 and 3 show a side and top view of the assembled system of FIG. 1; FIG. 4 shows a cross-sectional view along the axis as indicated. As shown in FIG. 4, matching conical surfaces on the exterior of the implant abutment 8 and the interior of the coping 9 are engaged. In the orientation shown, the coping 9 is pulled into alignment by an axial force from the lower surface 11s of the cap 11 pushing against the upper surface 9s of the coping 9 from screwing the threads of post 10 into the implant abutment 8. As shown, there is a gap 219 between the temporary screw attachment post 10 and the coping 9. As also shown in FIG. 4, the width of the temporary screw cap 11 is greater than the width of the largest portion of the central aperture 16 of the coping 9. The temporary screw cap 11 holds the coping 9 in position on the implant abutment 8. As shown in FIG. 4, the cap-coping interface 210 is located at the proximal end 16p of the central aperture 16. As also shown in FIG. 4, due to the gap 219 and open space 211 between the coping 9 and the temporary screw attachment post 10 facing the implant abutment 8, the only contact between the temporary screw

190 and the coping 9 is between the temporary screw cap 11 and the proximal end of the coping 9 which provides an axial force by torquing the temporary screw 190 into the abutment 8 to hold the coping 9 on the implant abutment 8. The distal end of the abutment may be directly attached to the patient's jaw or attached to a separate implant attached to the jaw. The inventive concepts are not dependent upon the nature of the implant, so the distal end attachment feature 135 is represented schematically.

[0131] The capability for relative axial movement between the cap 11 and temporary attachment post 10 allows separation of the temporary attachment post from the cap without tools after retaining the coping onto the abutment during fitting and bonding of the coping into the prosthesis. These parts are accurately aligned during the bonding process since the temporary post engages the abutment threads to provide an axial force holding the coping to the abutment just like the screw used for final attachment.

[0132] The cap may be sized to have an amount of press-fit mechanical interference to the temporary attachment post to provide an axial retention force of approximately 20 to 900 grams, this force being sufficient to retain coping 9 during assembly while allowing relatively easy pick-up removal of the coping and prosthesis from the temporary attachment post after assembly. The temporary attachment post 10 may include indicators (not shown) in the end by the cap 11 to provide intermediate visual and/or tactile feedback on the depth of threaded engagement of the post during screw attachment of the coping to the abutment.

[0133] In this embodiment, screw driving torque is provided by the square cross-section of the cap aperture and temporary attachment post. In the cross-sectional view of FIG. 4, the post 10 has been screwed in so that only a small beveled surface of the post extends above the top of the cap when the post

threads bottom out in the abutment. During installation, this optional configuration provides feedback to the dental practitioner when the torque increases as the threads bottom. The square drive tool engagement can also be designed to disengage at a pre-designed minimum extension of the square post above the top of the cap. Alternatively, a tool with a specified maximum torque may be used to ensure engagement of the coping and abutment surfaces.

[0134] The screw driving torque function may be accomplished by engaging other features on the temporary attachment post such as hex or spline or asymmetric features. Alternately, the cap may be used to engage a screwdriver or other tool for torquing. For example, in the case of a cylindrical temporary attachment post top portion, driving torque can be provided by the friction of the press-fit between the cap and temporary attachment post. For example, a medium press-fit of a 3 mm diameter 1 mm thick nylon cap onto a 1.3 mm diameter stainless steel cylindrical rod may produce approximately 500 grams of axial retention force and 17 gram-cm driving torque. A typical screw thread size for appliances is m1.4 x 0.3. Note that in FIG. 4, the temporary attachment post threads 181 are illustrated making contact with the abutment threads 182 when engaged. The retention/axial force of the cap to the temporary attachment post may be determined by the degree of press-fit and frictional properties between the cap and temporary attachment post, and/or spring features incorporated into the temporary attachment post and/or cap.

[0135] In actual trial installations, polymer caps of approximately 1.2 mm thickness press fit onto posts of approximately 1.4 mm diameter with cylindrical axial bores have been sufficient for installation and pick-up removal of a single prosthesis from multiple implant abutments in which the axes of the screw threads in the implant abutments are not mutually parallel.

[0136] The separable mechanical attachment means may include any combination of techniques, including frictional forces from interference, adhesives, waxes, chemical bonding, solders, elastically or inelastically deformable spring, snap or interlocking structures, thermally or electromagnetically fusible materials, fracturing structures, etc.

[0137] FIG. 5 through FIG. 9 show example cross-sectional views of some of the different stages of installation of the temporary fastener system into a denture. FIG. 5 shows a cross-sectional view of the assembly of the first embodiment during the initial phase of the coping pick-up process. As illustrated, the implant abutment 8 is attached to a schematic implant 70. The implant 70 has an interface 7 (shown schematically) that is attached to the patient's jawbone 22. The coping 9 is held against the implant abutment 8 through the temporary screw comprising the post 10 and cap 11. A blind clearance hole 5 in the prosthesis 3 is sized to accommodate the coping and temporary screw. Pick-up material 171 is positioned in the clearance hole 5 to capture the coping in proper alignment within the prosthesis. The cap-coping interface 210 is positioned at the proximal end 9p of the coping central bore or aperture 16 and, as shown in FIG. 5, blocks pick-up material 171 from entering the coping central aperture 16. After the pick-up material 171 has set up, the prosthesis 3, coping 9 and temporary screw cap 10 are pulled off as an assembly off the patient's jaw as shown by the arrows in FIG. 6. The coping 9 and cap 11 are released from the implant abutment 8 and post 10, while the threads of the post 10 keep it engaged in the implant abutment 8. The post 10 is subsequently removed to make the abutment threads 18 available for holding the prosthesis in proper alignment with a definitive screw.

[0138] The prosthesis/coping assembly must be processed after the pick-up process for screw attachment. A pilot hole is drilled with bit 172 from the bottom side of the assembly. As shown in FIG. 7, the diameter of the bit may be selected to use the interior bores of the coping and cap to act as guides for hand

processing. Alternately, a drill guide may be employed that engages a portion of the interior of the coping to align the pilot hole. The pilot hole provides guidance for a tool to provide clearance for the definitive screw shaft and head. FIG. 8 shows a stepped drill 173 that cuts both clearances in a single process. Alternatively, the shaft and head clearance may be drilled with two drills in two process steps. If desired, the cap 11 of the temporary screw 190 can be fabricated of a material that is easier to drill than the coping material to provide feedback on the drill position. It has been found that it is possible to distinguish where the drill is positioned by feel at the interfaces between the pick-up adhesive and the top of the cap (as shown in FIG. 8) and the bottom of the cap and the top of the coping. Since pick-up material was blocked from entering the coping, drilling resistance decreases rapidly upon breaking through the bottom of the cap and entering the interior channel of the coping. Color differences in the materials can also be detected. Alternatively, a tool can be configured to fit within the bore of the coping to limit the depth of the drill.

[0139] Once clearance hole 174 for the definitive screw has been made from the top of the prosthesis, the prosthesis is ready for mounting to the implant with definitive screw 175 as shown in FIG. 9. The male threads 150 of the definitive screw are shown filling the female threads of the abutment over an engagement depth extending from a first end of the thread engagement 163 to the second end of abutment thread engagement 164 of the implant abutment threading 18. Once the most distal thread of the definitive screw 175 is engaged in an abutment thread, the engagement depth will increase by a distance equal to the thread pitch for each complete revolution of the definitive screw 175. As shown in FIG. 4, a screw clearance hole 174 is large enough to accommodate the definitive screw head 151. A residual portion 161 of the cap 11 is shown in FIG. 9 for aligning the coping 9 to the prosthesis 3 in the closed tray pick-up process. After the definitive screw 175 is torqued into position, the screw clearance hole 174 in the prosthesis 3 may be filled with Teflon tape and color-matching composite

materials for aesthetic purposes. In the illustrated embodiment, the coping bore 16 has a shoulder 152 to engage a flat surface on the underside of the definitive screw head 151 of the definitive screw 175 to pull the coping 9 into proper seating on the implant abutment 8. Alternate configurations are possible without deviating from the temporary screw system for coping pick-up disclosed.

[0140] FIG. 10 is another exploded isometric view of parts of an embodiment of the invention. In this example, cap 11 is integrated into a breakaway installation tool 18. The tool portion 19 may be used to install the temporary attachment post 10, and then section 19 broken away at mechanically weak separation feature 20, for example, when the post bottoms out in the abutment leaving the cap portion 11 in position. Alternatively, the tool can be designed to increase stress on the separation feature as the top of the post moves axially down relative to the weakened section. As illustrated, after the cap portion 11 breaks away from the tool portion 19, drive feature 21 in the tool portion may be used to remove the post 10 after the pick-up process. One or both ends of the tool may be shaped to subsequently engage and remove the temporary attachment post 10 after installation of coping 9 into the denture.

[0141] FIGS. 11-26 provide schematic isometric views of the process steps for using the elements of an exemplary embodiment introduced in FIG. 10 for a single implant system such as a crown. In FIG. 11, a schematic isometric view of a portion of the patient's jaw 22 is shown with an implant 70 (not shown) installed, and implant abutment 8 installed into the implant. The coping 9 is placed onto the implant abutment 8, the top portion of temporary attachment post 10 is assembled onto cap 11. The top portion of temporary attachment post 10 and cap 11 are configured such that there is a means to drive the temporary attachment post into the abutment, while allowing axial movement of the cap 11 relative to the temporary attachment post axis, the cap/temporary attachment post interface having sufficient retention force to keep the coping in place on the

abutment during subsequent installation steps, and the temporary attachment post being removable after picking up the coping into the prosthesis. Cap 11 may be attached to a break-away installation/removal tool 18.

[0142] FIG. 12 shows the coping 9 placed on the implant abutment 8 and the cap/tool 18 installed onto temporary attachment post 10. The coping-abutment surfaces may comprise a conical or spherical concave feature on the coping 9 that mates with a complementary feature on the top of the implant abutment 8, as illustrated. Alternatively, keying features may be employed to restrict relative rotational orientation, particularly in the case of single implants.

[0143] FIG. 13 shows the temporary attachment post being threaded into the implant abutment 8, through a clearance hole in the coping 9. The cap abuts the coping to secure the coping to the abutment. The cap 11 is free to move axially along the temporary attachment post with a frictional retaining force of the cap to the temporary attachment post. A known amount of retention force of the coping to abutment is provided by the design and materials used in the cap and temporary attachment post.

[0144] FIG. 14 shows the tool portion of the cap being removed after the cap has broken away; the tool may be used for removal of the temporary attachment post at a later step.

[0145] FIG. 15 shows marking of the position of the coping onto the appliance for drilling a recess for the coping in the prosthesis.

[0146] FIG. 16 shows the prosthesis with coping drilling location marking 23.

[0147] FIG. 17 shows the prosthesis after boring the cavity for the coping; the cavity for the coping may be accurately drilled slightly larger than the coping, without significant unwanted material removal from the prosthesis.

[0148] FIG. 18 shows pick-up material being applied to the coping and/or prosthesis after confirmation of freedom to provide proper occlusion during dry testing. Although not illustrated, the cavity of the prosthesis or the coping may optionally include features to provide venting of excess pick-up material if desired.

[0149] FIG. 19 shows the bonded coping being picked up into the prosthesis

[0150] FIG. 20 shows the prosthesis removed from the temporary attachment post; the temporary attachment post/cap design allows removal of the prosthesis from the temporary attachment post. The coping is now incorporated into the prosthesis.

[0151] FIG. 21 shows the temporary attachment post being removed with the tool portion of the cap.

[0152] FIG. 22 shows the abutment installed in the implant with the temporary attachment post removed.

[0153] FIG. 23 shows drilling a small guide-hole (for example 1-2 mm diameter), through the clearance hole of the coping, into and through the prosthesis. This

guide hole provides a small reference hole for enlargement of the hole to accommodate the prosthesis retaining screw.

[0154] FIG. 24 shows enlarging the guide hole to a clearance hole for prosthesis retaining screw, approximately the diameter of the head of the retaining screw (e.g., 1.5-2.5 mm). The clearance hole would typically be drilled down to the top surface of the coping.

[0155] FIG. 25 shows the prosthesis being installed onto the implant abutment by placing the prosthesis coping onto the abutment and installing the prosthesis retaining screw.

[0156] FIG. 26 shows the assembled prosthesis on the implant.

[0157] FIG. 27 contains a summary of a generalized process extending the basic process described above for a prosthesis attached to multiple implant abutments.

[0158] Another embodiment of a prosthesis and implant alignment system and tool are shown in FIG. 28. In this case, the cap is in the form of a hex nut 63 that is press fit onto alignment post 62 to act as the temporary alignment screw. The drive tool 64 includes a concave hex socket 68 that fits temporary post nut 63, and coping retaining portion 69 that retains coping 61 with a slight interference fit. Thus, as shown in FIG. 29, the temporary screw comprising nut 63 with post 62 is engaged with the socket portion of the tool, and the coping 61 is retained in the tool. The coping is seated onto the abutment 60 by using the hex portion of the driver to rotate the nut and engage the threads 66 on the temporary screw post 62. FIGS. 30 and 31 show an exterior and cross-sectional view of the mounting

of the coping on the abutment with the tool. The tool may also have an integrated feature for removing the post as shown in FIG. 32. For example, FIG. 33 shows a tapering feature 170 on the narrow end of tool 64 which may be used to unscrew the post. FIG. 28 illustrates optional undercut 67 for stronger adhesive locking. Optional anti-rotation flat 65 is shown. Such an anti-rotation flat may be used on mating surfaces in circumstances in which there is a preferred orientation around the axis of the screw threads.

[0159] Another embodiment of the inventive concepts in which the cap of the temporary screw is shaped to engage the driving tool is shown in FIGS. 34-36. Cap 102 is mechanically attached to alignment post 101 at end portion 101A to form temporary alignment screw 100. This mechanical attachment may result from press-fitting a polymeric cap 102 onto a metal post 101 to provide adequate resistance to rotary slip to temporarily attach the coping to the implant abutment while still allowing relative axial movement during the pick-up process. The cap 102 may include a tapered surface 102B shaped to match the mating surface of an associated coping 112. A hexalobular internal (Torx) drive feature is shown in the end of the cap 102, although other bit socket shapes are possible. As previously discussed, other mechanical engagement means besides an interference fit are possible. The post may be made of different materials than these, or even be of unitary construction with weakened sections that fracture or otherwise breakaway under a desired pick-up axial force.

[0160] In a preferred embodiment the post 101 is made from stainless-steel or titanium, and the cap of polymer such as PEEK or acetal. The short length of the post and threaded fastener in this embodiment allows separation at high degrees of angularity of the assembled parts in use. This tolerance for off-axial removal has been found to be particularly advantageous when the prosthesis is to be definitively screw mounted to multiple implant abutments. Testing has verified cap axial release forces of up to about

5 pounds and the application of torque to the cap of about 1.6 inch-ounces without slipping.

[0161] The general process for converting an existing removable denture for definitive screw attachment onto four implants with this embodiment is illustrated in FIGS. 37-50. This prosthesis may be, for example, a removable denture that was used prior to implant surgery or a duplicate of such an existing denture as described in US Provisional Patent Application 62/774,402 incorporated herein in its entirety.

[0162] FIG. 37 shows a schematic representation of a human jaw portion 106 with implant abutments 107 installed. It does not matter for this discussion if the abutments are separable from the implanted portion of the implant or not. Prosthesis 103 is shown with occlusion side 104 and intaglio side 105. Pick-up marking caps 108 are installed onto abutments 107. The location of implant abutments 107 is marked onto the prosthesis using customary methods by mating the prosthesis with the abutments. FIG. 38 shows the abutment positions 109 marked onto prosthesis 103. FIG. 39 shows the boring of blind holes 110 slightly larger than copings 112 in marked locations with burr tool 111.

[0163] FIG. 40 shows the installation of copings 112 onto abutments 107 using separable fastener assembly 100, and torque driver 113 (described in more detail later). The torque driver 113 prevents over-tightening of temporary screw 100 and possible separation of the cap 102 from the post 101 due to rotary motion. The cap 102 and/or post 101A of each separable fastener 100 may be mechanically captured or adhered to the coping 112, or may be designed to loosely fit into the bore of the coping as illustrated with axial force from tightening the separable fastener holding the copings to the abutments 107. The prosthesis is placed over the mounted copings to ensure proper fit.

[0164] FIG. 41 shows application of acrylic or other adhesive 144 into cavities 110 of prosthesis 103, which is subsequently fitted onto copings 112.

[0165] FIG. 42 shows prosthesis 103 being mated with copings 112. After the adhesive sets, the separable fasteners allow easy removal of the prosthesis from the abutments with the copings incorporated into the prosthesis. The angular tolerance for removing the prosthesis from multiple abutments allows applying pick-up forces sequentially around the edge of the prosthesis to work the caps 102 off the posts 101. The caps 102 remain in the prosthesis with the copings 112, while the posts 101 remain in the abutments.

[0166] FIG. 43 shows the prosthesis with incorporated copings 112 after the pick-up process.

[0167] FIG. 44 shows the removal of the threaded post 101 from the implant abutment with removal tool 115. This allows the implant abutment threads to be accessible for subsequent definitive screw attachment.

[0168] FIG. 45 shows the drilling of the small pilot hole 117 (e.g., using a drill bit 116 of approximately 1.4 mm diameter), from the intaglio side 105 of the prosthesis out through the occlusion side 104. It has been found that the bore of the coping 112 and the bore of the cap provide adequate guidance for this hole, although a tooling guide could readily be designed to mate with the particular coping used. The pilot hole is drilled completely through the prosthesis to the occlusion side 104 as shown in FIG. 46.

[0169] FIG. 47 shows enlarging of the pilot hole 117 to allow clearance for a prosthetic mounting screw 121. The clearance holes 119 are drilled down to the top of the coping using counterbore drill 118. This requires only a small diameter enlargement (for example, approximately 2.4 mm).

[0170] FIG. 48 shows a step of a final hand reaming with reamer 120 of the coping bore to clean out any debris or remaining material from the cap that would interfere with the definitive screw.

[0171] FIGS. 49 and 50 show the final installation of prosthesis 103 onto abutments 107 using definitive prosthetic screws 121. The screw holes may be subsequently filled to use the modified prosthesis depending upon the anticipated use as a short-term or more permanent prosthesis. This sequence of process steps essentially follows the material provided in FIG. 27.

[0172] Note that in the above procedure very little material is removed from the prosthesis during the coping pick-up installation process. The boring process in FIG. 39 need only be sufficient to provide clearance for the coping and temporary screw. Angular variation in the axes of the implant abutments does not appreciably increase the size of the cavity boring required in this closed tray process compared to the additional prosthesis material that must be removed with relatively long impression screws and sleeves in a conventional open tray conversion process for definitive screw attachment. FIGS. 91-92 provide a schematic comparison of the size of the recess borings required using the concepts disclosed compared to the prior art conversion process with larger through holes in FIGS. 93-94.

[0173] The converted prosthesis with copings and screw-access channels may also be used as an accurate digital scan model of abutment positioning for creating a new prosthesis. In this embodiment, dual purpose scan flag and lab analogs 122 shown in FIGS. 51-52 may be fastened to the provisional or duplicate prosthesis 103, for example, after the clearance hole cleaning shown in FIG. 48. Features that may be present on the scan-flag/analog include a scan-flag reference portion 123 near the top of the analog, reference scan-flag features such as flats 124, axial and radial retention feature 128, screw attachment 125 for scanning fixture and/or reinforcement wire attachment. The abutment features 126 are specific to various systems commercially available. The figures show a tapered abutment mating surface 126 and female thread 127.

[0174] FIGS. 53-54 show scan flag/analogs 122 attached to converted prosthesis 103 with copings 112 using definitive screws 121.

[0175] FIGS. 55-56 show converted prosthesis 103 with scan flags/analogs 122 mounted to fixture 130 by attaching one or more scan flags 122 to the base with adjustable means to orient the prosthesis properly for scanning. For illustration an approximate mounting angle of 45 degrees is shown. In this example, the converted prosthesis 103 is mounted to articulated arm 131 with screw 129 that fits into the threaded hole of scan-flag/analog 122. Base 132 is mounted onto the base of the scanning machine.

[0176] The provisional or duplicate prosthesis with attached scan flags/lab analogs is scanned into the design software. This process captures the accurate position of the implant multi-unit abutment relative to the soft tissues and it also captures the tested prosthetic contours to aid in the design of the definitive prosthesis. After the prosthesis has been scanned in, a physical model may optionally be created by creating a soft tissue moulage and pouring dental stone into the provisional or duplicate prosthetic utilizing the scan flags as the laboratory analogs.

[0177] FIG. 57 schematically shows the application of solder or brazing preforms 133 to attach reinforcement bars 134 prior to pouring dental stone. Preforms 133 may be inserted into holes in the scan-flag/analogs and heated to attach bars 134. Low-temperature solders, brazing compounds, and hot-melt or other adhesives may be utilized in a preform or dispensed method to increase the rigidity of the analog assembly prior to casting.

[0178] This method ensures a fast and efficient means of transferring all pertinent and relevant information from a converted denture required for designing a definitive prosthesis from digital scanning and creating the most accurate and precise physical

model that can be mounted in an articulator with the aid of a bite registration in preparation for post-processing of the machined prosthesis, for example to verify passivity of fit, occlusion, etc.

[0179] In addition to the screw attachment of the scan flags to the modified prosthesis, scan flags may be attached to the prosthesis with incorporated copings of FIG. 43 prior to the drilling operations shown in FIGS. 45-47. In this case, another embodiment of the scan flag (not shown) with a post feature equivalent to post feature 101A of separable screw would be inserted into copings 112 of the modified prosthesis and retained by the embedded cap 102. If the separable fastener uses a snap-fit feature to retain the cap to the post, drilling may not be required through the prosthesis to mount the scan flags or lab analogs to the prosthesis or to attach the modified prosthesis to the abutments after lab use. For example, US Provisional Patent Application 62/774,402 describes the use of spring fingers and O-rings for separable fastening of the coping to the abutment for lift-off, and the use of films to prevent adhesive from entering interior portions of the separable fastener. Scan flags and lab analogs may also be engaged with transferred copings using similar mounting features as the post used in the transfer pick-up process. The referenced patent application also includes separable systems in which the post attaches directly to the coping without a cap which may be applied for mounting scan flags or lab analogs as variations of the methods described above. Since the dimensions of the coping and its engagement with the abutment is precisely controlled, having snap-in scan flags engage with a cavity between the top of the coping and the separable cap or an internal groove or other feature of the coping may be desirable.

[0180] Variations of using the modified prosthesis as a digital scan model, or using the inventive concepts disclosed to create a permanent prosthesis will be recognized as possible to dental practitioners. For example, instead of using a dual-purpose scan flag and lab analog, single purpose scan flags can be mounted into the provisional prosthesis for scanning, and subsequently replaced with lab analogs prior to casting. In addition to the attachment of scan flags to a modified prosthesis for digitization, the separable fastener may be used to transfer a coping and cap to a new impression after implant surgery. A scan flag or lab analog may be attached and held to the impression

with transferred coping for digitization or casting by substituting the new impression for the modified prosthesis in any of the processes above. FIG. 58 describes a workflow for using the temporary alignment fasteners with a permanent prosthesis fabricated from a digital model based on an impression.

[0181] FIGS. 59-60 show an embodiment of a simple torque-driver 113 that can be used for the temporary coping attachment process discussed in reference to FIG. 40. Shaft assembly 135 contains a spring friction cylinder portion 141 and drive portion 138 designed to engage the temporary screw 100. Spring 136 has an interference fit with cylinder 141, and thus when spring 136 is rotated in the "unwind" direction of the spring, a designed amount of slip torque is present between the spring and cylinder. In the "wind" direction, the spring binds on the cylinder. This provides unequal drive torque capability in the two rotation directions. Slot 139 in drive cap 137 engages spring end 140, and snaps onto the end of the shaft assembly, thus when the cap is rotated in the clockwise direction, cylinder and drive slip at a known torque. When the cap is rotated in the counterclockwise direction, the spring binds on the shaft to provide a higher screw removal torque before slipping.

[0182] FIG. 61 shows an embodiment of a temporary screw post extractor 115 which may be used to remove post 101 after the pick-up process as shown in FIG. 44. The extractor utilizes a hollow metal tubular split-cylinder end portion 142 that deflects to grip the end of the temporary screw post 101, allowing removal of the separable fastener posts or other types of fasteners. FIG. 61 illustrates a hand-operated knurled end, but other torque tool systems known in the dental industry such as 3/32" friction and latch designs may be used.

[0183] FIGS. 62-63 schematically illustrate how the position of the temporary screw post 10 of the first embodiment relative to the implant abutment can be determined. As the temporary screw is rotated clockwise, the cap 11 will be pushed axially away from the screw threads of the post by the coping. The depth of threaded engagement and the

length of the temporary screw post 10 and cap can be designed to have the top of the post 10 coincide with the top of the cap 11 as shown in FIG. 63 when the temporary screw is properly positioned. At this point, a drive tool with a square socket cavity (not illustrated) would disengage from the temporary screw assembly since the post 10 would no longer extend into the tool socket cavity.

[0184] FIGS. 64-66 illustrate different embodiments of the end of the temporary screw post that engages the cap. FIG. 64 shows a modified version of the cylindrical post 101 designed for frictional engagement on cylindrical portion 85 with a cap having a circular bore similar to that shown in FIG. 34. In FIG. 65, the cylindrical post is slotted, and the resulting beam portions 86 sprung open to provide additional frictional retention of a cap through spring action with the deflecting beams. Various features such as symmetric axial splines 87 (FIG. 66), asymmetric splines or grooves, and textures may also be used to tailor driving torque and axial retention force of the cap to the temporary attachment post. Non-symmetric features may also be utilized to tailor different installation torque and extraction forces. Surface finish and coefficients of friction of the mating materials may also be used to control the driving and retention properties. Temporary attachment posts and caps may be made from metal and polymer materials such as titanium, stainless steels, nylon and PEEK and other non-corrosive biocompatible materials.

[0185] If additional off-axis accommodation is desired when extracting the temporary attachment post from the coping after pick-up, some flexibility may be incorporated into the temporary attachment post, such as the necked down portion 88 of the temporary attachment post shown in FIG. 67, which allows the temporary attachment post to flex slightly off-axis during the pick-up process. Under tension, the alignment of the temporary screw axis with this necked-down portion can be designed to align the axis of the implant abutment threads with the coping threads but allow some bending when the tension is released. Note that this alignment flexibility will generally not be required during the final screw attachment process. The final attachment process is more accommodating of axial misalignment of multiple abutments than the coping pick-up process. During pick-up, the prosthesis with copings incorporated must be removed

from all abutments simultaneously. For final attachment, each definitive screw is attached individually after the copings of the prosthesis are positioned on the implant abutments.

[0186] FIG. 68 shows an embodiment of a temporary screw cap 94 that includes spring features 95 that engage the outer diameter 96 of the temporary post. If desired the portion of the temporary screw cap with the spring features may be made of a different material than the remainder of the cap.

[0187] Although the temporary screw of FIG. 69 has a similar appearance to that shown in FIG. 68, it has distinct functionality. FIG. 69 shows an embodiment of a temporary alignment screw 58 having threaded portion 62, breakaway flange 60 and hex drive portion 61. The flange 60 pushes down on the top of the coping as the temporary alignment screw threads 62 are rotated into the implant abutment. The flange portion may be molded onto a temporary attachment post with threaded portion 62 and drive portion 61 by insert molding if different materials are desired. Preferable, all portions of the alignment screw are molded integrally of a single material. The cap and post do not slide axially relative to one another. Instead, small break-away tabs 59 in the flange portion are designed to yield under axial force during the prosthesis and coping assembly removal after the bonding step. The breakaway portions are designed to fracture at an axial force exceeding the force applied to align the coping to the implant abutment for pick-up.

[0188] FIG. 67 employed a temporary alignment screw post with a waist that can bend during prosthesis removal in the pick-up process. It is also possible to provide additional off-axis accommodation during coping pick-up with temporary screws that do not bend. For example, in FIG. 70, a temporary alignment screw post 25 includes a rounded portion 27 that bears against the central straight bore of cap 26. FIG.71 shows a tapered profile 29 on cap 30 which engages a straight cylindrical portion of post 28. It is preferable to prevent the incursion of adhesive in the gaps between the post and cap

that allow the post to pivot. FIG. 71 includes a thin protective film 56 for this purpose. This film should be chosen to deform easily when the post is pivoted.

[0189] FIG. 72 shows a thin retaining ring 32 that engages temporary attachment post 31. The retaining ring 32 also provides a one-way insertion direction of temporary attachment post 31. This preferential insertion direction also corresponds to the relative motion of the post and retaining ring for release in the pick-up process.

[0190] FIG. 73 shows another embodiment of a temporary alignment screw that does not have relative axial sliding between the post and cap. In this embodiment a thin retainer 35 that may be comprised of a metallic or polymer sheet is attached to the top portion of temporary attachment post 33 and optional cap 34. The sheet 35 may be attached to temporary attachment post 33 using adhesives, plastic or metal welding, etc. After the adhesive has cured holding the coping to the implant abutment, the mechanical connection between the post and cap is overcome by axial force in the pick-up process. The mechanical connection can be designed to fail by adhesive failure or by fracture of the joint or the sheet 35.

[0191] FIG. 74 shows another embodiment of a temporary alignment screw without relative sliding between the cap portion and the post portion. In this embodiment, a compliant or frangible portion of the post 37 is used to attach a cap 38 to the post. Under tension, the cap portion 38 holds the coping in position against the abutment for pick-up into a prosthesis. Compliant portion 37 may be for example an elastomeric material to provide some angular motion during prosthesis removal after the pick-up material sets. The compliant portion 37 itself or one of its interfaces with the cap or post may provide a separable interface with controlled axial breakaway force. Other methods of separating a compliant portion may include exposure of compliant portion 37 made from a material easily affected by heat, any wavelength of electromagnetic energy, or a chemical reaction that may be applied externally or as part of the pick-up process.

[0192] The inventive concepts disclosed are not meant to be restricted to a temporary attachment post with standard screw threads that both engage and disengage the threads in the implant abutment through rotations. For example, alternate separable temporary attachment posts embodiments are possible providing features that allow the post to removably hold the coping to the abutment by other means than a separable cap. For example, as shown in FIG. 75 an alignment fastener post 39 may contain a separable threaded or serrated portion 40 that engages the screw threads in the abutment for pick-up, but that will release with axial force after. FIG. 75 shows a temporary fastener 190 with a head 42 portion and an attachment post portion 39. The attachment post portion 39 is shown as having a slot 41 and asymmetric threads or serrations 40 that have proximal flank 183 and a distal flank 184. This asymmetric threading still allows the temporary attachment post portion 39 to be inserted through rotation like other temporary screw embodiments for alignment for coping pick-up. The post 39 may be subsequently extracted with a separation force in the axial direction. Although the threads could be designed to provide engagement with the implant abutment threads through axial motion in the opposite direction to the arrow shown in FIG. 75, rotation to a design torque on engagement is generally preferred. If the post 39 is designed to be pulled out of the abutment during the coping pick-up process, it will subsequently need to be removed from flange 42 and the prosthesis assembly. Since there is no processing impact on patient comfort, higher mechanical forces or a broader range of energy or chemical processing may be employed to remove the post 39 from the prosthesis 3 after coping 9 pick-up.

[0193] Further permutations of the separable alignment screw features disclosed above are possible. FIG. 76 shows an embodiment where axial flexibility and/or controlled retention between cap 44 and temporary attachment post 43 is provided by an interface material 45 such as adhesives, silicones, and elastomeric materials contained in the space between the bore of the cap 44 and the post 43. FIG. 77 shows cap 47 retained with an O-ring 48 held in grooves in the cap 47 and temporary attachment post 46. FIG. 78 shows a cup-shaped interface material 57 located within the bore of the cap 44 and extending over a portion of the end of the post 43. FIG. 79 shows a split-collar feature 51 on cap 50 which presses onto the temporary attachment post 49. FIGS. 80 and 81 show alternate designs of flexure beam features in caps gripping a post. In FIG.

80, the pressure on the post 49 is reduced by pulling the cap 52 perpendicular to a diagonal of the cap as indicated by the arrows. In FIG. 81, the pressure on the post 49 is reduced by pulling in opposite directions with moment arms as shown to open the spring.

[0194] It is understood that the concept of the temporary attachment of the coping with the abutment with an axially separable temporary post is not dependent upon having a separate cap 11 or nut 63 on the post. If desired the cap or nut can be eliminated and the coping may be directly fixed and axially separable from the temporary attachment post. That is, the coping can be designed to have an equivalent mechanical interface to the post as the caps in the embodiments above. The mechanical interface between the coping and post may be tailored to provide equivalent rotational engagement and relative axial movement above a designed minimum axial force.

[0195] Example embodiments of the coping and post being the separable components include the following:

[0196] FIG. 82 shows temporary attachment post 71, engaging an interference fit of coping 72 at a position above the threaded portion. Metal, metal-reinforced, ceramic, and polymer copings, posts and fasteners may be included in this and other embodiments. Any of the parts may have surface treatments to control friction or adhesion.

[0197] FIG. 83 shows temporary attachment post 71 engaging integral spring-finger features 78 of coping 73.

[0198] FIG. 84 shows a temporary attachment post 71 engaging collet-type spring fingers 77 of coping 74, these collet-type features may be formed using slots in the coping 74 as shown in FIG. 84A.

[0199] FIG. 85 shows a slotted spring feature 79 formed in the temporary attachment post 76. The spring-features engage a smaller bore portion 90 of the coping 75. Such features may be of varied shapes including slots, eyelets, swaged portions, tubular swaged parts, etc. A film 56 (not shown) may be used to prevent the ingress of pick-up material into any voids at the top of the post/coping assembly similar to that shown in FIG. 71.

[0200] FIG. 86 shows temporary attachment post 71 and coping 75 engaged using an O-ring or washer 80. Such washers may be elastomers, polymers, metals, etc. and may be forms in varied shapes, such as the u-shaped retainer 81 of FIG. 87.

[0201] FIG. 88 shows temporary attachment post 71 retained to coping 75 using a sheet cap 82. Sheet cap 82 may be a tape, or other polymers or metals joined using adhesives, thermal and ultrasonic bonding, welding, and brazing, etc. This is similar to the embodiment shown in FIG. 73, except the sheet cap 82 does not have thicker cap element 34.

[0202] FIG. 89 shows temporary attachment post 71 retained using a filler material 83 in the counterbore of coping 75. Fillers may include a variety of polymer adhesives or fillers, such as silicones, acrylics, epoxies, and/or soft metallic materials. Since the coping 75 in this embodiment is fixed to the post 71, the mating surfaces of the coping 75 and implant abutment must allow relative rotational motion until the predetermined torque is achieved.

[0203] Installation of these embodiments may also be accomplished with simple polymer or metal tools 84, for example, as shown in FIG. 90 that engage the flats or other features of the coping 75, and/or of features on top of the threaded post 71.

[0204] Although the descriptions above use rotational engagement of the bottom of the post with internal threads of the abutment as a preferred approach, this is not meant to be limiting. Alternate approaches for engaging a temporary attachment post with abutment threads through axial insertion without rotation are considered to be part of this disclosure. For example, the split post bottom structure shown in FIG. 75 which allows axial extraction can also be used for axial insertion. Similarly, an interference fit between the bottom of the post with the threads may also be designed to provide sufficient engagement to provide adequate alignment and fixing of the coping for the pick-up bonding process described earlier. For non-rotary extraction of the post, it is not necessary to have the extraction force of the post-abutment thread interface greater than the force required for relative movement of the coping or cap with the upper end of the post. That is, if the temporary attachment post remains fixed to the coping during the pick-up step, the post can be removed from the dental appliance after removal from the patient's mouth.

[0205] Although axially symmetric interfaces between coping and abutment have been described for most embodiments, the inventive concepts may also be applied to asymmetric abutments and copings as long as the coping doesn't need to rotate on the implant abutment as noted, for example, with the embodiment of FIG. 89 .

[0206] Various embodiments have been described to illustrate the disclosed inventive concepts, not to limit the invention. Combining inventive elements of one or more of the embodiments with known materials, components and techniques in dental science to create further embodiments using the inventive concepts is considered to be part of this disclosure.

[0207] Any of the embodiments may contain a film or deposited material on top of the cap and temporary attachment post to prevent adhesion to the temporary attachment post of materials used for pick-up, as shown in the film 56 of FIG. 71.

[0208] Temporary attachment posts may be rotationally driven into the abutment threads using either the cap, coping or the temporary attachment post itself. Temporary attachment posts and caps may have varied drive features such as male or female knurls, hex, spines, spanner notches/holes. These design alternatives are driven by functional requirements of a particular implementation.

[0209] Other means of attaching/joining a secondary separable portion include insert-molding, use of adhesives, waxes, solders or other metallic materials, heat-staking, and ultrasonic bonding.

[0210] Break-away portions may also be formed by two-shot molding, dispensing or otherwise placing a secondary mechanically, thermally, or electromagnetically fusible material on a portion of the fastener to provide the break-away function.

Thin-film or thick-film metallic and polymer coatings may be applied to portions of the fastener to tailor friction and insertion and extraction forces, enhance adhesion of pick-up materials, and other properties such as corrosion-resistance.

Claims

We claim:

1. A dental system for attachment of a coping to a threaded implant abutment comprising:

a coping having a proximal end with an aperture sized to allow a shaft portion of a definitive screw to pass through ; and

an implant abutment having helical threading for securing the coping with a definitive screw; and

a definitive screw having a proximal head end having a tool interface and a distal post portion having threads for securing the coping to the implant abutment after processing; and

a temporary screw having an axis with a length measured along the axis and a width measured perpendicular to the axis, the temporary screw comprising:

a proximal head portion with a width larger than the coping aperture; and

a distal shaft portion shaped for rotary engagement with the implant abutment threads;

wherein rotating the temporary screw to engage the shaft portion of the temporary screw with the implant abutment threads through an engagement depth and to a predetermined torque causes the head portion of the screw to hold the coping into alignment with the implant abutment for processing, and wherein an axial force in the proximal direction releases the coping from the implant abutment, and wherein the shaft portion does not contact the implant abutment threads continuously above the most distal engagement position.

2. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft includes a narrower region having a width that is less than the width of the temporary screw shaft threaded region, and wherein the narrower region is located between the distal end of the temporary screw head and the proximal end of the temporary screw shaft threading.

3. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft comprises asymmetric threading.

4. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the axial release force is applied through a pick-up process in which the coping is adhered to a separable dental element.

5. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the axial release force is less than about 5 pounds.

6. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading is not a continuous helical structure over the engagement depth.

7. The dental system for attachment of a coping to a threaded implant abutment of Claim 6 wherein the definitive screw post threading comprises a continuous symmetrical helical form.

8. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading deforms under the axial force to release the coping.

9. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein only mechanical energy is applied to release the coping.

10. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft comprises an open space located toward the axis from the threading.

11. The dental system for attachment of a coping to a threaded implant abutment of Claim 1 wherein the temporary screw shaft threading makes contact with the implant abutment threading over a temporary screw threading contact area when holding the coping against the implant abutment and the definitive screw post makes contact with the implant abutment threading over a definitive screw threading contact area when holding the coping against the implant abutment, and wherein the temporary screw threading contact area is less than the definitive screw threading contact area.

12. The dental system for attachment of a coping to a threaded implant abutment of Claim 11 wherein the volume of the definitive screw post material located distally of the

proximal end of the implant abutment threading when holding the coping against the implant abutment is greater than the volume of the temporary screw shaft material holding the coping against the implant abutment when holding the coping against the implant abutment.

13. A dental system for attachment of a coping to a threaded implant abutment for pick-up processing comprising:

a threaded implant abutment having an implant abutment longitudinal axis, and

a coping having a proximal end with a central aperture, and

a temporary screw having a temporary screw longitudinal axis with a length measured along the axis and a width measured perpendicular to the axis comprising:

a head with a proximal end having a drive tool interface for rotating the temporary screw to a predetermined torque and wherein the head portion does not fit through the central aperture of the coping, and

a shaft having an axis with a length measured along the axis and a width measured perpendicular to the axis that fits within the central aperture; the shaft comprising:

a distal portion having a shaft thread, and

a proximal portion without a shaft thread, and

wherein inserting the shaft of the temporary screw into the coping central aperture and rotating the temporary screw to a predetermined torque engages the shaft thread with the implant abutment threading to provide an axial overlap of the temporary screw shaft axis and the implant abutment axis to pull the coping into position with the implant abutment for pick-up processing, wherein the axial overlap comprises threaded and unthreaded shaft portions, and wherein applying an axial force above a predetermined value in the proximal direction releases the coping and temporary screw from the implant abutment.

14. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 13 wherein the shaft threading is asymmetrical.

15. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 14 wherein the asymmetrical threading allows axial movement of the shaft in the proximal and distal directions relative to the implant abutment threading when an axial force is applied above a threshold force for movement in each direction and wherein the axial force threshold for movement is smaller in the proximal direction than in the distal direction.

16. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 13 wherein the distal portion of the shaft deforms during the axial release.

17. The dental system for attachment of a coping to a threaded implant abutment for pick-up processing of Claim 16 wherein the distal portion of the shaft includes an open space for shaft deformation towards the axis.

Appl. No.	:	18/424,696	Confirmation No. 5633
Applicant	:	Kofford, Brandon Dale and Rudisill, Charles Albert	
Filed	:	01/26/2024	
TC/A.U.	:		
Examiner	:		
Docket No.	:	SDC012	
Customer No.	:	112823	

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PRELIMINARY AMENDMENT

Proposed Amendments to the Listing of Claims begin on page 2 of this paper.

Remarks begin on page 10 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

What is claimed is:

1-17. (Cancelled)

18. (New) A dental system comprising:

a coping having a proximal end with an aperture; and

an implant abutment having threads;

a definitive screw having a proximal head end having a tool interface and a distal post portion having threads for securing the coping to the threads of the implant abutment after processing, wherein the distal post portion having threads is sized to extend through the aperture of the coping; and

a temporary fastener having an axis with a length measured along the axis and a lateral dimension providing different widths along the axis measured perpendicular to the axis, the temporary fastener comprising:

a proximal portion with a width larger than the coping aperture; and

a shaft comprising a distal shaft portion sized and configured for rotary engagement with the implant abutment threads,

wherein the shaft of the temporary fastener extends through the aperture of the coping and the distal shaft portion engages the implant abutment threads with an engagement depth at a predetermined torque and is configured to cause the proximal portion of the temporary fastener to hold the coping into alignment with the implant abutment for processing,

wherein an axial release force in a proximal direction releases at least a portion of the temporary fastener and the coping from the implant abutment as a unit, and

wherein the distal shaft portion is sized and configured so that it does not engage the implant abutment threads continuously between a most distal position of the distal shaft portion and a proximal end of the implant abutment threads.

19. (Withdrawn – New) The dental system of Claim 18, wherein the shaft of the temporary fastener includes a region located in a proximal direction from the distal shaft portion sized and configured for rotary engagement with the implant abutment threads having a width that is less than a width of the distal shaft portion sized and configured for rotary engagement with the implant abutment threads.

20. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises asymmetric threading.

21. (New) The dental system of Claim 18, wherein the axial release force in the proximal direction is applied through a pick-up process in which the coping is bonded and/or adhered to a dental element.

22. (Withdrawn – New) The dental system of Claim 18, wherein the axial release force is less than about 5 pounds.

23. (New) The dental system of Claim 18, wherein the threads of the distal post portion of the definitive screw comprise a continuous form.

24. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises an outer surface which deforms in response to the axial release force in the proximal direction whereby the at least a portion of the temporary fastener and the coping are released together as the unit.

25. (New) The dental system of Claim 18, wherein the at least a portion of the temporary fastener and the coping are released from the implant abutment as a unit in response to only the axial release force in the proximal direction whereby the axial release force is applied without rotation of the temporary fastener.

26. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises an open space, and wherein a portion of the axis is located within the open space.

27. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises threading which is sized and configured to make contact with the implant

abutment threads over a first threading contact area when holding the coping against the implant abutment, wherein the distal post portion of the definitive screw is sized and configured to make contact with the implant abutment threads over a second threading contact area when holding the coping against the implant abutment, and wherein the first threading contact area is less than the second threading contact area.

28. (New) The dental system of Claim 18, wherein a volume of definitive screw post material of the distal post portion of the definitive screw that is located distally of a proximal end of the implant abutment threads when holding the coping against the implant abutment is greater than a volume of temporary fastener shaft material of the distal shaft portion of the temporary fastener that is located distally of a proximal end of the implant abutment threads when holding the coping against the implant abutment.

29. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises threading, wherein a pattern provided by the threading of the distal shaft portion of the temporary fastener changes circumferentially, and wherein the threads of the definitive screw is in a continuous form with a maximal lateral extent greater than a maximal lateral extent of the threading of the distal shaft portion of the temporary fastener.

30. (New) The dental system of Claim 18, wherein the temporary fastener is polymeric, wherein the distal shaft portion is hollow.

31. (New) A dental system comprising:

an implant abutment having threads having an implant abutment threads contour and an implant abutment longitudinal axis;

a coping having a proximal end with a central aperture, and

a temporary fastener having a longitudinal axis with a length measured along the longitudinal axis and a width dimension measured perpendicular to the longitudinal axis, the temporary fastener comprising:

a head with a proximal end having a drive tool interface for rotating the temporary fastener to a predetermined torque, wherein the head resides external to the central aperture of the coping, and

a shaft coupled to or integral with the head that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising shaft threading having a shaft threading contour, wherein the shaft threading contour does not essentially match the implant threads contour, and

a proximal portion with an outer surface devoid of shaft threading,

wherein, the temporary fastener is configured so that when the distal portion of the shaft is inserted through the central aperture of the coping and rotated to a predetermined torque, the shaft threading engages the threads of the implant abutment whereby the shaft threading cooperates with the threads of the implant abutment to pull the coping into position with the implant abutment for pick-up processing, and wherein the temporary fastener is configured so that in response to application of an axial release force above a predetermined value in a proximal direction during or after pick-up processing, the coping and the temporary fastener are released as a unit from the implant abutment.

32. (New) The dental system of Claim 31, wherein the shaft threading does not have a continuous threading contour along its path around the longitudinal axis.

33. (New) The dental system of Claim 31, wherein the temporary fastener comprises a polymer.

34. (New) The dental system of Claim 33, wherein the temporary fastener comprises a PEEK material.

35. (New) The dental system of Claim 31, wherein the distal shaft portion of the shaft of the temporary fastener is configured to deform during the application of the axial force in the proximal direction to thereby release the coping and the temporary fastener as a unit from the implant abutment.

36. (Withdrawn – New) The dental system of Claim 31, wherein a minimum width of the proximal portion with an outer surface devoid of shaft threading is less than a maximum width of the distal portion having an outer surface comprising the shaft threading.

37. (New) The dental system of Claim 31, further comprising a definitive screw comprising threads configured to engage the implant abutment, wherein a maximal width of the distal

portion of the shaft of the temporary fastener is smaller than a maximal width of the threads of the definitive screw.

38. (New) The dental system of Claim 31, further comprising a definitive screw comprising threads configured to engage the implant abutment, wherein a profile pattern of the threading of the temporary fastener is configured to define a first abutment contact area with the threads of the implant abutment, wherein a profile pattern of the threads of the definitive screw is configured to define a second abutment contact area with the threads of the implant abutment, and wherein the first abutment contact area is less than the second abutment contact area.

39. (New) The dental system of Claim 31, wherein the axial force above the pre-determined value in the proximal direction is applied in a pick-up process after adhesive bonding of the coping to a prosthesis or in a closed tray impression process.

40. (New) A dental system comprising:

a coping having a proximal end with an aperture and a distal end with a coping seating surface; and

an implant abutment having a longitudinal axis comprising:

female threading, wherein the female threading begins proximate the proximal end of the implant abutment and extends along a path having a tightening rotation direction, and

an implant abutment seating surface;

a temporary fastener having an axis with a length measured along the axis and a lateral dimension providing different widths along the axis measured perpendicular to the axis, the temporary fastener comprising:

a proximal portion with a width larger than the coping aperture; and

a shaft comprising a distal shaft portion for rotary engagement with the implant abutment female threading,

wherein the shaft of the temporary fastener extends through the aperture of the coping, wherein the distal shaft portion of the temporary fastener, when in axial alignment with the female threading of the implant abutment, is rotatable in the tightening rotation direction to initiate threaded engagement, and wherein further rotation through a

temporary fastener seating angle in the tightening rotation direction moves the distal shaft portion of the temporary fastener axially in a distal direction to hold the coping seating surface in aligned contact with the implant abutment seating surface for processing, wherein the temporary fastener seating angle is provided by

a temporary fastener engagement angle portion wherein the distal shaft portion continuously engages the female threading of the implant abutment proximate the proximal end of the implant abutment threading, and

a temporary fastener non-engagement angle portion configured so that the distal shaft portion is disengaged from the female threading of the implant abutment proximate the proximal end of the implant abutment threading, and

wherein the temporary fastener engagement angle portion is smaller than the temporary fastener seating angle, and

wherein an axial release force in a proximal direction releases at least a portion of the temporary fastener and the coping from the implant abutment as a unit.

41. (New) The dental system of Claim 40, wherein the axial release force is applied in a pick-up process after adhesive bonding of the coping to a prosthesis or in a closed tray impression process.

42. (New) The dental system of Claim 40, wherein the axial release force in the proximal direction releases the entire temporary fastener and coping from the implant abutment as a unit.

43. (New) The dental system of Claim 40, wherein the temporary fastener comprises a polymeric material.

44. (New) The dental system of Claim 40, further comprising a definitive screw with a longitudinal axis and a width measured perpendicular to the longitudinal axis, the definitive screw comprising:

a head with a proximal end having a drive tool interface for rotating the temporary screw to a predetermined fixing torque, wherein the head is in contact with a proximal surface of the coping proximate the central aperture of the coping, and

a shaft that has a width that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising male shaft threading configured to engage the female threading of the implant abutment, wherein the definitive screw is rotatable in the tightening direction through a definitive screw fixing angle to the predetermined fixing torque which moves the definitive screw axially in a distal direction to fix the coping seating surface into aligned contact with the implant abutment seating surface.

45. (New) The dental system of Claim 44, wherein the definitive screw fixing angle is greater than the temporary fastener engagement angle portion.

46. (New) The dental system of Claim 44, wherein a maximum width of the male shaft threading of the definitive screw is greater than a maximum width of the distal shaft portion of the temporary fastener for rotary engagement with the implant abutment female threading.

47. (New) A dental system comprising:

an implant abutment having threads and an implant abutment longitudinal axis;

a coping having a proximal end with a central aperture, and

a temporary fastener having a longitudinal axis with a length measured along the longitudinal axis and a width dimension measured perpendicular to the longitudinal axis, the temporary fastener comprising:

a head with a proximal end having a drive tool interface for rotating the temporary fastener to a predetermined torque, wherein the head resides external to the central aperture of the coping, and

a shaft coupled to or integral with the head that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising shaft threading, wherein the distal portion includes an open space located toward the longitudinal axis from the shaft threading,

wherein the temporary fastener is configured so that when the distal portion of the shaft is inserted through the central aperture of the coping and rotated to a predetermined torque, the shaft threading engages the threads of the implant abutment whereby the shaft threading cooperates with the threads of the implant abutment to pull the coping into position with the

implant abutment for pick-up processing, and wherein the temporary fastener is configured so that in response to application of an axial release force above a predetermined value in a proximal direction during or after pick-up processing, the coping and the temporary fastener are released as a unit from the implant abutment.

REMARKS

Claim Status

Claims 1-17 were pending in the application. With this amendment, Claims 1-17 are cancelled and Claims 18-47 are new and pending. The Claims of the present application are related to Claims 1-17 of immediate parent application 18/328,730 that were cancelled during prosecution of the parent application. An election of species of Species Q (Fig. 75) was made without recourse in the parent application. Claims 19, 22, and 36 have been designated (Withdrawn – New) in this amendment in anticipation of an equivalent species election requirement and Applicant's election without recourse of the same Species. Applicant is doing this in the interest of compact prosecution.

As a result of this amendment, there are 4 independent claims and a total of 30 claims pending.

Specification and Drawings

The Specification and Drawings of the current application as-filed reflect the final amended version of the referenced parent application 18,328,730. Applicant submits that the pending claims are supported by the application as-filed.

Conclusion

Accordingly, Applicant submits that the present application is in condition for examination and the same is earnestly solicited. The Examiner is encouraged to telephone the undersigned at 360-714-0777 for expeditious handling of any matters outstanding of resolution.

Respectfully submitted,

By /Daniel John Whittle/

Daniel John Whittle

Reg. No. 54,537

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APPLICATION #	RECEIPT DATE / TIME	ATTORNEY DOCKET #
18/424,696	**02/13/2024 02:59:56 PM Z ET**	**SDC012**

Title of Invention

Screw-attached Pick-up Dental Coping System and Methods

Application Information

APPLICATION TYPE	Utility - Nonprovisional Application under 35 USC 111(a)	PATENT #	-
CONFIRMATION #	5633	FILED BY	Daniel Whittle
PATENT CENTER #	64306204	AUTHORIZED BY	-
CUSTOMER #	112823	FILING DATE	01/26/2024
CORRESPONDENCE ADDRESS	-	FIRST NAMED INVENTOR	Brandon Dale Kofford

Payment Information

PAYMENT METHOD	PAYMENT TRANSACTION ID	PAYMENT AUTHORIZED BY
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2830	PROCESSING FEE, EXCEPT IN PROVISIONAL APPLICATIONS	56.00	1	56.00
2202	EACH CLAIM IN EXCESS OF 20	40.00	10	400.00
2201	EACH INDEPENDENT CLAIM IN EXCESS OF THREE	192.00	1	192.00
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New International Application Filed with the USPTO as a Receiving Office

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First Named Inventor	Kofford, Brandon Dale
Art Unit	
Examiner Name	
Attorney Docket Number	SDC012

ENCLOSURES *(Check all that apply)*

- ☐ Fee Transmittal Form
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- ☑ Amendment/Reply
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  - ☐ Affidavits/declaration(s)
- ☐ Extension of Time Request
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- ☐ Information Disclosure Statement
- ☐ Certified Copy of Priority Document(s)
- ☐ Reply to Missing Parts/ Incomplete Application
  - ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53
- ☐ Drawing(s)
- ☐ Licensing-related Papers
- ☐ Petition
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- ☐ Appeal Communication to TC **(Appeal Notice, Brief, Reply Brief)**
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- ☐ Status Letter
- ☐ Other Enclosure(s) (please Identify below):

Remarks

Preliminary amendment with new claims

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT

Firm Name			
Signature	/Daniel John Whittle, #54,537/		
Printed name	Daniel John Whittle		
Date	February 13, 2024	Reg. No.	54,537

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ELECTRONIC ACKNOWLEDGEMENT RECEIPT

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CUSTOMER #	112823	FIRST NAMED INVENTOR	Brandon Dale Kofford
CORRESPONDENCE ADDRESS	-	AUTHORIZED BY	-

Documents

TOTAL DOCUMENTS: 3

DOCUMENT	PAGES	DESCRIPTION	SIZE (KB)
PrelimAmend_FEB2024_SDC012-APP.TEXT.docx	10	Application body structured text document	28 KB
Warning: Bookmarks were found and have been removed.			
sb0021_FEB2024_SDC012.pdf	2	Transmittal Letter	264 KB
PrelimAmend_FEB2024_SDC012.pdf	10	Auxiliary PDF of Application	204 KB

Digest

DOCUMENT	MESSAGE DIGEST(SHA-512)
PrelimAmend_FEB2024_SDC0	DDF1722F10524BBBB5A8307FD973B8127B49FB9077CE51C81

12-APP.TEXT.docx	466BB31EAC435502198CC8B3B59775A0FEDADCB78BE932C8FD71DEB18E4C2D99AE8763C8948D9AA
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PrelimAmend_FEB2024_SDC012.pdf	3B85BED4472E59D835D58310FE92C95097B768585C48F1A920B69CD6F5CAADAFC024B5AB7413C14B426FC358E14E68D93319DC167CD884F6F5F16E5DD7C4A0F2

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Appl. No.	:	18/424,696	Confirmation No. 5633
Applicant	:	Kofford, Brandon Dale and Rudisill, Charles Albert	
Filed	:	01/26/2024	
TC/A.U.	:		
Examiner	:		
Docket No.	:	SDC012	
Customer No.	:	112823	

Commissioner for Patents
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Alexandria VA 22313-1450

PRELIMINARY AMENDMENT

Proposed Amendments to the Listing of Claims begin on page 2 of this paper.

Remarks begin on page 10 of this paper.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

What is claimed is:

1-17. (Cancelled)

18. (New) A dental system comprising:

a coping having a proximal end with an aperture; and

an implant abutment having threads;

a definitive screw having a proximal head end having a tool interface and a distal post portion having threads for securing the coping to the threads of the implant abutment after processing, wherein the distal post portion having threads is sized to extend through the aperture of the coping; and

a temporary fastener having an axis with a length measured along the axis and a lateral dimension providing different widths along the axis measured perpendicular to the axis, the temporary fastener comprising:

a proximal portion with a width larger than the coping aperture; and

a shaft comprising a distal shaft portion sized and configured for rotary engagement with the implant abutment threads,

wherein the shaft of the temporary fastener extends through the aperture of the coping and the distal shaft portion engages the implant abutment threads with an engagement depth at a predetermined torque and is configured to cause the proximal portion of the temporary fastener to hold the coping into alignment with the implant abutment for processing,

wherein an axial release force in a proximal direction releases at least a portion of the temporary fastener and the coping from the implant abutment as a unit, and

wherein the distal shaft portion is sized and configured so that it does not engage the implant abutment threads continuously between a most distal position of the distal shaft portion and a proximal end of the implant abutment threads.

19. (Withdrawn – New) The dental system of Claim 18, wherein the shaft of the temporary fastener includes a region located in a proximal direction from the distal shaft portion sized and configured for rotary engagement with the implant abutment threads having a width that is less than a width of the distal shaft portion sized and configured for rotary engagement with the implant abutment threads.

20. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises asymmetric threading.

21. (New) The dental system of Claim 18, wherein the axial release force in the proximal direction is applied through a pick-up process in which the coping is bonded and/or adhered to a dental element.

22. (Withdrawn – New) The dental system of Claim 18, wherein the axial release force is less than about 5 pounds.

23. (New) The dental system of Claim 18, wherein the threads of the distal post portion of the definitive screw comprise a continuous form.

24. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises an outer surface which deforms in response to the axial release force in the proximal direction whereby the at least a portion of the temporary fastener and the coping are released together as the unit.

25. (New) The dental system of Claim 18, wherein the at least a portion of the temporary fastener and the coping are released from the implant abutment as a unit in response to only the axial release force in the proximal direction whereby the axial release force is applied without rotation of the temporary fastener.

26. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises an open space, and wherein a portion of the axis is located within the open space.

27. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises threading which is sized and configured to make contact with the implant

abutment threads over a first threading contact area when holding the coping against the implant abutment, wherein the distal post portion of the definitive screw is sized and configured to make contact with the implant abutment threads over a second threading contact area when holding the coping against the implant abutment, and wherein the first threading contact area is less than the second threading contact area.

28. (New) The dental system of Claim 18, wherein a volume of definitive screw post material of the distal post portion of the definitive screw that is located distally of a proximal end of the implant abutment threads when holding the coping against the implant abutment is greater than a volume of temporary fastener shaft material of the distal shaft portion of the temporary fastener that is located distally of a proximal end of the implant abutment threads when holding the coping against the implant abutment.

29. (New) The dental system of Claim 18, wherein the distal shaft portion of the temporary fastener comprises threading, wherein a pattern provided by the threading of the distal shaft portion of the temporary fastener changes circumferentially, and wherein the threads of the definitive screw is in a continuous form with a maximal lateral extent greater than a maximal lateral extent of the threading of the distal shaft portion of the temporary fastener.

30. (New) The dental system of Claim 18, wherein the temporary fastener is polymeric, wherein the distal shaft portion is hollow.

31. (New) A dental system comprising:

an implant abutment having threads having an implant abutment threads contour and an implant abutment longitudinal axis;

a coping having a proximal end with a central aperture, and

a temporary fastener having a longitudinal axis with a length measured along the longitudinal axis and a width dimension measured perpendicular to the longitudinal axis, the temporary fastener comprising:

a head with a proximal end having a drive tool interface for rotating the temporary fastener to a predetermined torque, wherein the head resides external to the central aperture of the coping, and

a shaft coupled to or integral with the head that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising shaft threading having a shaft threading contour, wherein the shaft threading contour does not essentially match the implant threads contour, and

a proximal portion with an outer surface devoid of shaft threading,

wherein, the temporary fastener is configured so that when the distal portion of the shaft is inserted through the central aperture of the coping and rotated to a predetermined torque, the shaft threading engages the threads of the implant abutment whereby the shaft threading cooperates with the threads of the implant abutment to pull the coping into position with the implant abutment for pick-up processing, and wherein the temporary fastener is configured so that in response to application of an axial release force above a predetermined value in a proximal direction during or after pick-up processing, the coping and the temporary fastener are released as a unit from the implant abutment.

32. (New) The dental system of Claim 31, wherein the shaft threading does not have a continuous threading contour along its path around the longitudinal axis.

33. (New) The dental system of Claim 31, wherein the temporary fastener comprises a polymer.

34. (New) The dental system of Claim 33, wherein the temporary fastener comprises a PEEK material.

35. (New) The dental system of Claim 31, wherein the distal shaft portion of the shaft of the temporary fastener is configured to deform during the application of the axial force in the proximal direction to thereby release the coping and the temporary fastener as a unit from the implant abutment.

36. (Withdrawn – New) The dental system of Claim 31, wherein a minimum width of the proximal portion with an outer surface devoid of shaft threading is less than a maximum width of the distal portion having an outer surface comprising the shaft threading.

37. (New) The dental system of Claim 31, further comprising a definitive screw comprising threads configured to engage the implant abutment, wherein a maximal width of the distal

portion of the shaft of the temporary fastener is smaller than a maximal width of the threads of the definitive screw.

38. (New) The dental system of Claim 31, further comprising a definitive screw comprising threads configured to engage the implant abutment, wherein a profile pattern of the threading of the temporary fastener is configured to define a first abutment contact area with the threads of the implant abutment, wherein a profile pattern of the threads of the definitive screw is configured to define a second abutment contact area with the threads of the implant abutment, and wherein the first abutment contact area is less than the second abutment contact area.

39. (New) The dental system of Claim 31, wherein the axial force above the pre-determined value in the proximal direction is applied in a pick-up process after adhesive bonding of the coping to a prosthesis or in a closed tray impression process.

40. (New) A dental system comprising:

a coping having a proximal end with an aperture and a distal end with a coping seating surface; and

an implant abutment having a longitudinal axis comprising:

female threading, wherein the female threading begins proximate the proximal end of the implant abutment and extends along a path having a tightening rotation direction, and

an implant abutment seating surface;

a temporary fastener having an axis with a length measured along the axis and a lateral dimension providing different widths along the axis measured perpendicular to the axis, the temporary fastener comprising:

a proximal portion with a width larger than the coping aperture; and

a shaft comprising a distal shaft portion for rotary engagement with the implant abutment female threading,

wherein the shaft of the temporary fastener extends through the aperture of the coping, wherein the distal shaft portion of the temporary fastener, when in axial alignment with the female threading of the implant abutment, is rotatable in the tightening rotation direction to initiate threaded engagement, and wherein further rotation through a

temporary fastener seating angle in the tightening rotation direction moves the distal shaft portion of the temporary fastener axially in a distal direction to hold the coping seating surface in aligned contact with the implant abutment seating surface for processing, wherein the temporary fastener seating angle is provided by

a temporary fastener engagement angle portion wherein the distal shaft portion continuously engages the female threading of the implant abutment proximate the proximal end of the implant abutment threading, and

a temporary fastener non-engagement angle portion configured so that the distal shaft portion is disengaged from the female threading of the implant abutment proximate the proximal end of the implant abutment threading, and

wherein the temporary fastener engagement angle portion is smaller than the temporary fastener seating angle, and

wherein an axial release force in a proximal direction releases at least a portion of the temporary fastener and the coping from the implant abutment as a unit.

41. (New) The dental system of Claim 40, wherein the axial release force is applied in a pick-up process after adhesive bonding of the coping to a prosthesis or in a closed tray impression process.

42. (New) The dental system of Claim 40, wherein the axial release force in the proximal direction releases the entire temporary fastener and coping from the implant abutment as a unit.

43. (New) The dental system of Claim 40, wherein the temporary fastener comprises a polymeric material.

44. (New) The dental system of Claim 40, further comprising a definitive screw with a longitudinal axis and a width measured perpendicular to the longitudinal axis, the definitive screw comprising:

a head with a proximal end having a drive tool interface for rotating the temporary screw to a predetermined fixing torque, wherein the head is in contact with a proximal surface of the coping proximate the central aperture of the coping, and

a shaft that has a width that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising male shaft threading configured to engage the female threading of the implant abutment, wherein the definitive screw is rotatable in the tightening direction through a definitive screw fixing angle to the predetermined fixing torque which moves the definitive screw axially in a distal direction to fix the coping seating surface into aligned contact with the implant abutment seating surface.

45. (New) The dental system of Claim 44, wherein the definitive screw fixing angle is greater than the temporary fastener engagement angle portion.

46. (New) The dental system of Claim 44, wherein a maximum width of the male shaft threading of the definitive screw is greater than a maximum width of the distal shaft portion of the temporary fastener for rotary engagement with the implant abutment female threading.

47. (New) A dental system comprising:

an implant abutment having threads and an implant abutment longitudinal axis;

a coping having a proximal end with a central aperture, and

a temporary fastener having a longitudinal axis with a length measured along the longitudinal axis and a width dimension measured perpendicular to the longitudinal axis, the temporary fastener comprising:

a head with a proximal end having a drive tool interface for rotating the temporary fastener to a predetermined torque, wherein the head resides external to the central aperture of the coping, and

a shaft coupled to or integral with the head that extends through the central aperture of the coping, the shaft comprising:

a distal portion having an outer surface comprising shaft threading, wherein the distal portion includes an open space located toward the longitudinal axis from the shaft threading,

wherein the temporary fastener is configured so that when the distal portion of the shaft is inserted through the central aperture of the coping and rotated to a predetermined torque, the shaft threading engages the threads of the implant abutment whereby the shaft threading cooperates with the threads of the implant abutment to pull the coping into position with the

implant abutment for pick-up processing, and wherein the temporary fastener is configured so that in response to application of an axial release force above a predetermined value in a proximal direction during or after pick-up processing, the coping and the temporary fastener are released as a unit from the implant abutment.

REMARKS

Claim Status

Claims 1-17 were pending in the application. With this amendment, Claims 1-17 are cancelled and Claims 18-47 are new and pending. The Claims of the present application are related to Claims 1-17 of immediate parent application 18/328,730 that were cancelled during prosecution of the parent application. An election of species of Species Q (Fig. 75) was made without recourse in the parent application. Claims 19, 22, and 36 have been designated (Withdrawn – New) in this amendment in anticipation of an equivalent species election requirement and Applicant's election without recourse of the same Species. Applicant is doing this in the interest of compact prosecution.

As a result of this amendment, there are 4 independent claims and a total of 30 claims pending.

Specification and Drawings

The Specification and Drawings of the current application as-filed reflect the final amended version of the referenced parent application 18,328,730. Applicant submits that the pending claims are supported by the application as-filed.

Conclusion

Accordingly, Applicant submits that the present application is in condition for examination and the same is earnestly solicited. The Examiner is encouraged to telephone the undersigned at 360-714-0777 for expeditious handling of any matters outstanding of resolution.

Respectfully submitted,

By /Daniel John Whittle/

Daniel John Whittle

Reg. No. 54,537

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 18/424,696

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	64		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	280		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	320		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	17 minus 20 =	* 0	x =	0	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x =	0			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	664		TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY ADDITIONAL FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE($)	ADDITIONAL FEE($)	OR	RATE($)	ADDITIONAL FEE($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
18/424,696	01/26/2024		664	SDC012	17	2

CONFIRMATION NO. 5633

112823
Daniel J Whittle
1229 Modoc Dr
Bellingham, WA 98229

FILING RECEIPT

OC000000068259634

Date Mailed: 02/14/2024

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

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Inventor(s)

Brandon Dale Kofford, Apex, NC;
Charles Albert Rudisill, Apex, NC;

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Power of Attorney: The patent practitioners associated with Customer Number 112823

Domestic Priority data as claimed by applicant

This application is a CON of 18/328,730 06/03/2023
and is a CON of 17/691,108 03/09/2022
and is a CON of 16/596,361 10/08/2019 PAT 11,311,354
and claims benefit of 62/742,942 10/09/2018
and claims benefit of 62/774,402 12/03/2018
and claims benefit of 62/818,082 03/13/2019

Foreign Applications for which priority is claimed (You may be eligible to benefit from the Patent Prosecution Highway program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

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The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 18/424,696**
Projected Publication Date: Request for Non-Publication Acknowledged
Non-Publication Request: Yes
Early Publication Request: No
**** SMALL ENTITY ****
Title

Screw-attached Pick-up Dental Coping System and Methods

Preliminary Class

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

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Derrick Brent
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
18/424,696	01/26/2024	Brandon Dale Kofford	SDC012	5633

112823 7590 03/08/2024

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EXAMINER	
CENTRAL, DOCKET	
ART UNIT	**PAPER NUMBER**
3772	
MAIL DATE	**DELIVERY MODE**
03/08/2024	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

PTOL-90A (Rev. 04/07)

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 18/424,696	**Applicant(s)** Kofford et al.	
	Examiner FIKIRTE A GEREMEW	**Art Unit** OMBL	**AIA (FITF) Status** Yes

1. THE REQUEST FILED 26 January 2024 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to FIKIRTE GEREMEW at (703) 756-1930. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/FIKIRTE A GEREMEW/ PROGRAM SUPPORT SPECIALIST, OMBL	

CLINICAL INVESTIGATIONS

Prosthetic Abutment Height is a Key Factor in Peri-implant Marginal Bone Loss

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Abstract: *In this study, we analyzed the influence of prosthetic abutment height on marginal bone loss (MBL) around implants in the posterior maxilla. In this retrospective cohort study, the radiographically determined MBL was related to the height of the abutments of internal conical connection implants at 6 and 18 months post-loading. Data were gathered on age, sex, bone substratum, smoking habit, history of periodontitis, and prosthetic features, among other variables. A linear mixed model was used for statistical analysis. The study included 131 patients receiving 315 implants. MBL rates at 6 and 18 months were mainly affected by the abutment height but were also significantly influenced by the bone substratum, periodontitis, and smoking habit. MBL rates were higher for prosthetic abutment < 2 mm* vs. *≥ 2 mm, for periodontal* vs. *non-periodontal patients, for grafted* vs. *pristine bone, and for a heavier smoking habit. The abutment height is a key factor in MBL. MBL rates followed a non-linear trend, with a greater MBL rate during the first 6 months post-loading than during the next 12 months.*

Key Words: sinus augmentation, peri-implantitis, dental implant, dental implant-abutment connection.

Introduction

Various etiologies have been proposed for marginal bone loss (MBL). It has been attributed to inflammation from biomechanical stress due to an incorrect occlusal prosthesis design (Rungsiyakull *et al.*, 2011) or from a foreign-body reaction to cement in the soft tissues around cemented-retained prostheses (Qian *et al.*, 2012). MBL may also be increased by the presence of pathogenic microflora that promote peri-implant inflammation, increasing pocket depth and bone resorption (Lindhe and Meyle, 2008). It has been observed that resorption is reduced with greater distance between the bone and the area of inflammation induced by bacteria in the implant-crown micro-gap (Piattelli *et al.*, 2003).

The bone level around dental implants is significantly affected by clinical decisions about the biologic width (Hermann *et al.*, 2000, 2001). It has been observed that post-implantation wound healing consistently entails bone resorption and, therefore, the establishment of an angular bone defect at sites in which the mucosa is thinner than 2 mm before the abutment connection and remains similar over time (Berglundh and Lindhe, 1996). Significantly greater peri-implant bone loss was also reported when this tissue was thinner than 2 mm, regardless of the position of the micro-gap (Linkevicius *et al.*, 2009). A subsequent study found a similar magnitude of initial marginal bone loss between implants applied with a "platform-switching" or traditional implant/abutment approach in areas with mucosal thickness of 2 mm or less (Linkevicius *et al.*, 2010). These observations indicate that mucosal thickness has a major influence on the degree of early peri-implant bone loss (Wennström and Derks, 2012).

However, some authors found a higher MBL rate with a shorter prosthetics abutment, compressing the initial mucosa thickness, possibly due to a re-establishment of the biological width (Vervaeke *et al.*, 2014). Collaert and De Bruyn (2002) proposed a relationship between prosthetic abutment height and

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A supplemental appendix to this article is published electronically only at http://jdr.sagepub.com/supplemental.

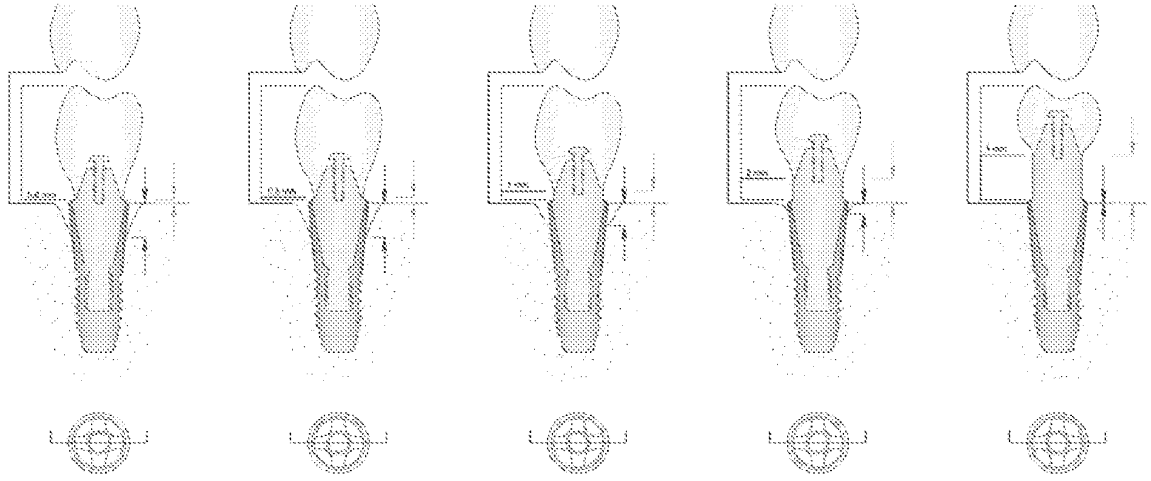
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Figure 1.
Diagram depicting the marginal bone loss (MBL) in relation to the height of the prosthetic abutment. Note that the distance between the antagonist tooth and the bone remains the same in all clinical situations but is comprised of different abutment and crown heights.



peri-implant bone loss, although the absence of statistical analysis prevented meaningful conclusions from being drawn (Collaert and De Bruyn, 2002). Similar results were observed in another study, in which the prosthetic abutment height had an even greater influence on the MBL than did the internal or external implant connection (Galindo-Moreno *et al.*, 2014b).

Hence, according to the above data, MBL around healthy implants can be attributed to the biologic width establishment or to inflammation induced by bacteria present in the micro-gap formed around the crown-implant connection, regardless of the soft-tissue width. In theory, the use of higher abutments to connect the crown to the implant would provide more space for soft-tissue adaptation and would diminish bacteria-promoted inflammation, reducing the bone resorption mediated by these mechanisms.

The main objective of this study was to test the hypothesis that the peri-implant MBL would be reduced with higher abutments, due to the greater distance between crown and bone. Secondary objectives were to evaluate the influence of tobacco consumption, history of periodontitis, and bone substratum type on the MBL around implants in the posterior maxilla and to estimate the optimal distance from the prosthetic crown to the bone surface for minimizing bone resorption.

Materials & Methods

Study Design

The eligible population for this retrospective correlational study was comprised of consecutive patients at 2 private practices who underwent functional restoration of the posterior maxilla between September 2008 and July 2010. Study inclusion criteria were: 18 to 85 yr of age, placement in the posterior maxilla of at least 2 implants splinted in the same screwed prosthetic structure, the presence of at least 5 mm of remnant crestal bone (Wang and Katranji, 2008), and performance of the surgery by the lead author (P.G.-M.). The study protocol was approved by the human research ethical committee of the University of Granada. The same implant system (Astra Tech AB, Mölndal, Sweden) was used in all patients, and all implants were surgically inserted at bone level.

Clinical Variables

Data were gathered for each patient on their age, sex, smoking habit, history of periodontal disease, implant features, height of prosthetic abutment, and type of restoration. The smoking habit of the patients at the time of the surgery was recorded, classifying them as non-smokers (0 cig/day), mild smokers (0-10 cig/day), or heavy smokers (>10 cig/day). The history of periodontal disease was determined by assessment of the clinical attachment loss (CAL) with a Michigan O probe (Hu-Friedy, Chicago, IL, USA), defining periodontal disease as the presence of at least 4 sites with CAL ≥ 3 mm. The height of uni-abutment used to fix the crown to the implant body was 0 mm, 0.5 mm, 1 mm, 2 mm, or 4 mm, as indicated by the manufacturer (Astra Tech AB, Mölndal, Sweden) (Fig. 1). The restoration type was defined as full-arch rehabilitation, fixed partial denture, or overdenture.

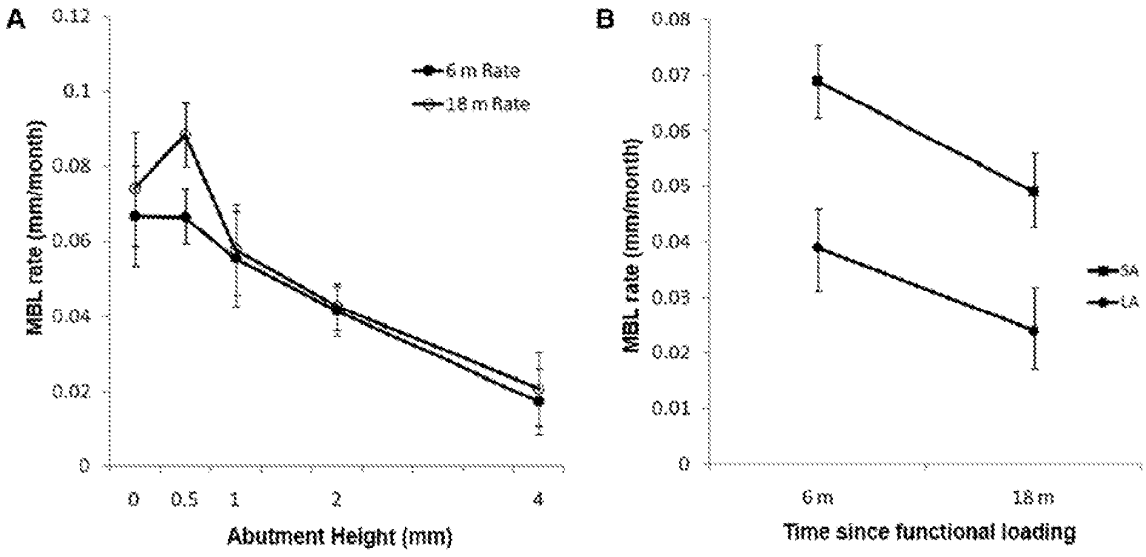
Radiographic Evaluation of MBL

Standardized digital panoramic radiographs (Kodak ACR-2000, Eastman Kodak Company, Rochester, NY, USA) taken at the surgical implant installation, at the time of final restoration delivery (baseline), and at 6 and 18 mos after the functional loading were obtained from medical records. They were analyzed by a single independent calibrated examiner using Dent-A-View v1.0 software (DigiDent, DIT, Nesher, Israel). The MBL

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Figure 2.
Marginal bone loss (MBL) rates in mm/month (**A**) in relation to prosthetic abutment height as a continuous variable and (**B**) as a function of the time since functional loading and the abutment height, classified as short (< 2 mm) or long (≥ 2 mm). Vertical bars are 95% confidence intervals.



was determined by linear measurements taken from the most mesial and distal points of the implant platform to the crestal bone on each panoramic radiograph, corrected according to the known height and width of each implant.

Statistical Analysis

Descriptive statistics, analysis of variance, the exact chi-square test, and the linear mixed model were used to examine and determine the effect of the abutment height (primary predictor) on the MBL rates (primary outcome) at 2 peri-implant sites (mesial and distal, secondary predictor) in 2 time frames (6 and 18 mos after functional loading, secondary predictor). We controlled for the following potential confounders: age, sex, smoking habit, periodontal status, restoration type, bone substratum type, and implant width and length. MBL rates were computed for the mesial and distal rates as the difference between MBL at 18 mos and 6 mos divided by the elapsed time in mos (mm/mo). The initial loss rate (in mos) was calculated as the MBL at 6 mos minus the MBL at baseline (*i.e.*, at the functional loading) divided by 6. These 2 rates were compared to determine whether the MBL rate was constant across time. When no significant difference was found between aspects (mesial/distal) or times (6 and 18 mos), mean rates were used to examine the effect of abutment height. The abutment height was treated both as a continuous variable and in 2 categories: short abutment (SA), < 2.00 mm in height; and long abutment (LA), ≥ 2.00 mm in height. A scaled-identity repeated-covariance matrix was used in all cases, following Schwarz's Bayesian information criterion. Analysis of variance and the exact chi-square test were used to analyze the potential associations of abutment height with patient characteristics and clinical features. The Bonferroni correction for multiple comparisons was applied when required.

Results

The study included 131 patients in whom 315 implants were placed. Seven implants from three patients were excluded because data were missing, Out of the final sample of 308 implants, 137 (44.5%) were LA implants (abutment ≥ 2.00 mm) and 171 (55.5%) were SA implants. Table 1 displays the socio-demographic, clinical, and peri-implant variables of the patients. Table 2 gives the MBL values (in mm) for mesial and distal aspects, and the linear mixed-model estimates for MBL rates (in mm/mo).

Appendix Table 1 exhibits the mean values with standard error for the patients' characteristics and clinical features as a function of the abutment height (SA or LA). Results of the analysis of variance (age, implant width, and implant height) and the exact chi-square test (sex, smoking, periodontal status, prosthesis, and bone substratum) indicated that an overdenture was significantly more frequent in SA *vs.* LA implants ($p = .01$), and that the implant was slightly wider in LA *vs.* SA implants ($p = .01$).

Appendix Table 2 shows the results of the linear mixed models for the effects of patient characteristics and clinical variables on MBL rates. MBL rates were higher for grafted *vs.* pristine bone ($p = .013$), for men *vs.* women ($p = .044$), for smokers *vs.* non-smokers ($p < .001$), and for periodontal *vs.* non-periodontal patients ($p < .001$). Bonferroni-corrected

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Table 1.
Clinical, Socio-demographic, and Implant-related Variables of the Study Sample

Variable	Level	N	%
Sex	Males	67	52.3
	Females	61	47.7
Smoking	Smokers	45	35.2
	Non-smokers	83	65.6
Alveolar	No	122	95.3
	Yes	6	4.7
Periodontitis	Yes	80	62.5
	No	48	37.5
Plaque	0	2	0.7
	1	155	50.3
	2	107	34.7
	3	44	14.3
Laterality	Right	146	47.4
	Left	162	52.6
Bone type	Graft	163	52.9
	Pristine	145	47.1
Implant diameter (mm)	3.5	21	6.8
	4	53	17.2
	4.5	186	60.4
	5	48	15.6
Implant length (mm)	11	20	6.5
	13	137	44.5
	15	151	49.0
Abutment height (mm)	0	20	6.5
	0.5	114	37.0
	1	37	12.0
	2	120	39.0
	4	17	5.5
Restoration type	FR	140	45.5
	FPD	138	44.8
	OD	30	9.7

Note: Imp, implant; FR, full-arch rehabilitation; FPD, fixed partial denture; OD, overdenture.

comparisons indicated that MBL rates were lower for full-arch rehabilitations than for fixed partial dentures or overdentures and were lower for fixed partial dentures than for overdentures. A significantly lower MBL rate was observed in wider implants ($p = .05$).

Mixed linear analysis of the mesial and distal rates (Table 2) yielded significant effects of abutment height, $F(1,1216) = 58.25$, $p < .01$, time, $F(1,126) = 23.53$, $p < .01$, bone type, $F(1,1216) = 6.69$, $p = .01$, smoking, $F(1,1216) = 19.30$, $p < .01$, and periodontitis, $F(1,1216) = 6.42$, $p = .01$. The abutment x time interaction was not significant, $F(1,1216) = 0.64$, $p > .4$. As shown in Table 2, MBL rates were higher for SA *vs.* LA implants, for the first time period studied (from implant loading to 6 mos post-loading) *vs.* the second (from 6 to 18 mos post loading; Fig. 2B), for periodontal (0.051 mm/mo) *vs.* non-periodontal patients (0.040 mm/mo), for a heavier smoking habit (0.0009 mm/mo), and for grafted (0.050 mm/mo) *vs.* pristine (0.040 mm/mo) bone. As observed in Appendix Table 3, the effect of the abutment height was also significant when considered as a continuous predictor ($p < .001$; Fig 2A).

Discussion

The aim of this study was to determine the influence of prosthetic abutment height on peri-implant marginal bone loss. We hypothesized that a reduced MBL would result from a greater distance between crown and bone and therefore from the utilization of a higher abutment. We found a significantly ($p < .001$) greater MBL in shorter prosthetic abutments (from 0 to 4 mm), in agreement with the finding by Vervaeke *et al.* (2014) of greater bone level changes in implants with short abutments [abutment height < 2 mm (1.17 mm at 1 yr, 1.23 mm at 2 yr); 2 mm, (0.86 mm, 1.03 mm, respectively), or 3 mm (0.38 mm; 0.41 mm)] *vs.* long (≥ 4 mm) abutments at 1 and 2 yr, respectively. In the present study, the abutment height was the variable with most influence on the MBL at both 6 and 18 mos, confirming the desirability of maximizing the distance between crown and bone to obtain a more predictable bone preservation outcome.

The MBL rates at 6 and 18 mos were also influenced by the bone substratum, smoking habit, and periodontal status of our patients. Tobacco consumption is known to promote increased marginal bone loss around implants (Galindo-Moreno *et al.*, 2005), and the present findings suggest that it exerts its effect at early stages of wound healing, possibly by reducing vascularization of the tissues or altering their homeostasis. It has also been shown that, regardless of its etiology, MBL is greater in patients with periodontitis than in those without (Cho-Yan Lee *et al.*, 2012). Increased MBL has also been reported around implants with external *vs.* internal connection (Peñarrocha-Diago *et al.*, 2013), which was reported to have the most influence

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Table 2.
Mean Marginal Bone Loss (in mm) at Mesial and Distal Aspects and Mean Marginal Bone Loss Rates (in mm/month) between 0 and 6 Months and between 6 and 12 Months Post-loading as a Function of the Main Predictor and Clinical Variables (standard error in parentheses)

	Aspect	6 months	18 months	Effect	*p*
	MBL				
SA	Mesial	0.180 (0.025)	0.565 (0.043)	SA *vs.* LA	< .01
	Distal	0.224 (0.028)	0.704 (0.053)	Time	< .01
LA	Mesial	0.063 (0.014)	0.295 (0.043)	Aspect	< .01
	Distal	0.073 (0.015)	0.312 (0.042)	Abut x Time	< .01
	MBL rates (mm/month)				
Abutment	SA	0.069 (0.004)	0.049 (0.004)	SA *vs.* LA	< .01
	LA	0.039 (0.005)	0.024 (0.005)	Time	< .01
Bone	Grafted	0.062 (0.004)	0.045 (0.004)	G *vs.* P	< .01
	Pristine	0.053 (0.004)	0.035 (0.004)		
Periodontitis	No PD	0.043 (0.004)	0.026 (0.0.04)	No PD *vs.* PD	< .01
	PD	0.065 (0.003)	0.048 (0.003)		
Smoking		0.001 (0.0003)	0.0008 (0.0002)	Slope (mm/y)	< .01

Note: SA, short abutment (< 2 mm); LA, long abutment (≥ 2 mm); Abut, abutment; G, grafted bone; P, pristine bone; No PD, no history of periodontitis; PD, history of periodontitis.

on MBL of any variable with the exception of abutment height (Galindo-Moreno *et al.*, 2014a,b).

An important secondary aim in our study was to estimate the optimal distance from the prosthetic crown to the bone surface for minimizing bone resorption. Our results demonstrated that this distance is 2 mm. According to Linkevicius and co-workers (2009, 2010), the width of the keratinized mucosa may be the key factor in maintaining peri-implant marginal bone, with 2 mm being the minimum width of keratinized tissue to preserve the marginal bone around implants, independently of the implant features. However, regardless of the keratinized tissue width, the mucosa can be compressed, as suggested by Collaert and De Bruyn (2002), through the selection of a shorter abutment. Our results indicate that the choice of a shorter abutment may increase MBL and that the keratinized tissue width is not the critical factor. For instance, if the remnant mucosa width is 3 mm after tissue healing in the second surgical stage, we can select a prosthetic abutment of 0 mm, 0.5 mm, 1 mm, or 2 mm. All of these heights will give an esthetic emergence profile, but, as demonstrated in our study, the MBL will differ according to our important clinical decision on the abutment height.

The MBL rate was elevated during the first 6 mos post-loading and decreased thereafter (Table 2). This non-linear trend in MBL progression after functional loading is consistent with the finding by Vervaeke *et al.* (2014) of no significant increase in MBL between 12 and 24 mos post-loading, based on the cumulative percentage of bone level changes after 12 mos. In fact, there is a tendency for consensus and success criteria to assume that MBL takes place largely during the first year.

The present study differs in some important respects from the very few previous studies on the influence of abutment height on MBL. Thus, unlike the studies by Collaert and De Bruyn (2002) and Vervaeke and co-workers (2014), we studied maxillary implants. Mandibular and maxillary bones differ in their stiffness and hardness because of their distinct macro- and micro-architecture. The difference in bone types between mandible (types 1 and 2) and maxilla (types 3 and 4) is known to influence the osseointegration process and the pattern of resorption around the implant neck (Davies, 2003). We studied implants placed in the posterior maxilla, which has a larger amount of keratinized tissue in comparison with that in the edentulous anterior mandible (Romanos *et al.*, 2010). It has been questioned whether the mucosal lining has the capability to function as a proper barrier tissue (Warrer *et al.*, 1995), and it is widely considered that an "adequate" area of keratinized mucosa is desirable around dental implants to prevent soft-tissue recession and to facilitate oral hygiene measures (Wennstrom and Derks, 2012). Finally, Romanos *et al.* (2010) found a greater biologic width in maxillary *vs.* mandibular sites.

A further difference from previous studies is that we compared outcomes between implants in pristine and grafted bone. Our results confirmed previous findings by our group of slight but significant increases in the MBL around implants placed in grafted *vs.* pristine bone (Galindo-Moreno *et al.*, 2014a).

We studied patients with distinct types of prosthetic rehabilitation, observing less

MBL around implants supporting a fixed partial denture than around those supporting an overdenture, which can be explained by differences in load distribution and biomechanics (Kitamura *et al.*, 2004). In the study by Vervaeke *et al.* (2014), all patients carried an overdenture supported by 2 implants.

Our study had some limitations. Being a retrospective study, it was not possible to homogenize the sample, although our statistical methodology minimized this drawback. We also used panoramic radiography, which is less sensitive than periapical techniques for MBL measurement but provides data on features of the posterior maxilla that can influence implant behavior (*e.g.*, bone type). Moreover, periapical radiography at this localization requires utilization of the bisector technique, and resulting differences in angulation may alter MBL measurements.

The height of the prosthetic abutment was the variable with the most influence on MBL, which was greater around implants with shorter abutments. This parameter must be taken into consideration for adequate maintenance of the bone level around implants over time. MBL rates around dental implants appear to follow a non-linear trend, with a faster bone loss during the first 6 mos post-loading than during the following 12 mos.

Acknowledgments

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References

Berglundh T, Lindhe J (1996). Dimension of the periimplant mucosa. Biological width revisited. *J Clin Periodontol* 23:971-973.

Cho-Yan Lee J, Mattheos N, Nixon KC, Ivanovski S (2012). Residual periodontal pockets are a risk indicator for peri-implantitis in patients treated for periodontitis. *Clin Oral Implants Res* 23:325-333.

Collaert B, De Bruyn H (2002). Early loading of four or five Astra Tech fixtures with a fixed cross-arch restoration in the mandible. *Clin Implant Dent Relat Res* 4:133-135.

Davies JE (2003). Understanding peri-implant endosseous healing. *J Dent Educ* 67: 932-949.

Galindo-Moreno P, Fauri M, Avila-Ortiz G, Fernández-Barbero JE, Cabrera-León A, Sánchez-Fernández E (2005). Influence of alcohol and tobacco habits on peri-implant marginal bone loss: a prospective study. *Clin Oral Implants Res* 16:579-586.

Galindo-Moreno P, Fernández-Jiménez A, Avila-Ortiz G, Silvestre FJ, Hernández-Cortés P, Wang HL (2014a). Marginal bone loss around implants placed in maxillary native bone or grafted sinuses: a retrospective cohort study. *Clin Oral Implants Res* 25:378-384.

Galindo-Moreno P, Fernández-Jiménez A, O'Valle F, Silvestre FJ, Sánchez-Fernández E, Monje A, *et al.* (2014b). Marginal bone loss in implants placed in grafted maxillary sinus. *Clin Implant Dent Relat Res* [Epub ahead of print 5/28/2013] (in press).

Hermann JS, Buser D, Schenk RK, Cochran DL (2000). Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. *J Periodontol* 71:1412-1424.

Hermann JS, Schoolfield JD, Nummikoski PV, Buser D, Schenk RK, Cochran DL (2001). Crestal bone changes around titanium implants: a methodologic study comparing linear radiographic with histometric measurements. *Int J Oral Maxillofac Implants* 16:475-485.

Kitamura E, Stegaroiu R, Nomura S, Miyakawa O (2004). Biomechanical aspects of marginal bone resorption around osseointegrated implants: considerations based on a three-dimensional finite element analysis. *Clin Oral Implants Res* 15:401-412.

Lindhe J, Meyle J; Group D of European Workshop on Periodontology (2008). Peri-implant diseases: Consensus Report of the Sixth European Workshop on Periodontology. *J Clin Periodontol* 35:282-285.

Linkevicius T, Apse P, Grybauskas S, Puisys A (2009). Reaction of crestal bone around implants depending on mucosal tissue thickness. A 1-year prospective clinical study. *Stomatologija* 11:83-91.

Linkevicius T, Apse P, Grybauskas S, Puisys A (2010). Influence of thin mucosal tissues on crestal bone stability around implants with platform switching: a 1-year pilot study. *J Oral Maxillofac Surg* 68:2272-2277.

Peñarrocha-Diago MA, Flichy-Fernández AJ, Alonso-González R, Peñarrocha-Oltra D, Balaguer-Martínez J, Peñarrocha-Diago M (2013). Influence of implant neck design and implant-abutment connection type on peri-implant health. Radiological study. *Clin Oral Implants Res* 24:1192-1200.

Piattelli A, Vrespa G, Petrone G, Iezzi G, Annibali S, Scarano A (2003). Role of the microgap between implant and abutment: a retrospective histologic evaluation in monkeys. *J Periodontol* 74:346-352.

Qian J, Wennerberg A, Albrektsson T (2012). Reasons for marginal bone loss around oral implants. *Clin Implant Dent Relat Res* 14:792-807.

Romanos GE, Traini T, Johansson CB, Piattelli A (2010). Biologic width and morphologic characteristics of soft tissues around immediately loaded implants: studies performed on human autopsy specimens. *J Periodontol* 81:70-78.

Rungsiyakull P, Rungsiyakull C, Appleyard R, Li Q, Swain M, Klineberg I (2011). Loading of a single implant in simulated bone. *Int J Prosthodont* 24:140-143.

Vervaeke S, Dierens M, Besseler J, De Bruyn H (2014). The influence of initial soft tissue thickness on peri-implant bone remodeling. *Clin Implant Dent Relat Res* 16:238-247.

Wang HL, Katranji A (2008). ABC sinus augmentation classification. *Int J Periodontics Restorative Dent* 28:383-389.

Warrer K, Buser D, Lang NP, Karring T (1995). Plaque-induced peri-implantitis in the presence or absence of keratinized mucosa. An experimental study in monkeys. *Clin Oral Implants Res* 6:131-138.

Wennström JL, Derks J (2012). Is there a need for keratinized mucosa around implants to maintain health and tissue stability? *Clin Oral Implants Res* 23(Suppl 6):136-146.

IN BRIEF

- Impressions of teeth and implants are differentiated.
- Accuracy of different impression copings and methods are discussed.
- Methods to transfer peri implant soft tissues are illustrated.

Impression techniques for implant dentistry

W. Chee[1] and S. Jivraj[2]

The object of making an impression in implant dentistry is to accurately relate an analogue of the implant or implant abutment to the other structures in the dental arch. This is affected by use of an impression coping which is attached to the implant or implant abutment. This impression coping is incorporated in an impression – much as a metal framework is 'picked up' in a remount impression for fixed prosthodontics. With implant copings the coping is usually attached to the implant or abutment with screws. The impression material used is usually an elastomeric impression material; the two types most widely used and shown to be the most appropriate are polyether and polyvinyl siloxane impression materials.[1]

IMPLANTS

1. Rationale for dental implants
2. Treatment planning of implants in posterior quadrants
3. Treatment planning of implants in the aesthetic zone
4. Surgical guidelines for dental implant placement
5. Immediate implant placement: treatment planning and surgical steps for successful outcomes
6. Treatment planning of the edentulous maxilla
7. Treatment planning of the edentulous mandible
8. Impression techniques for implant dentistry
9. Screw versus cemented implant supported restorations
10. Designing abutments for cement retained implant supported restorations
11. Connecting implants to teeth
12. Transitioning a patient from teeth to implants
13. The role of orthodontics in implant dentistry
14. Interdisciplinary approach to implant dentistry
15. Factors that affect individual tooth prognosis and choices in contemporary treatment planning
16. Maintenance and failures

The impression coping takes two general forms, one type is retained in the mouth when the set impression is removed – this type of impression coping is known as the transfer type impression coping. The other type is incorporated in the impression and is removed from the mouth together with the set impression and is known as a pick up type impression coping.

Characteristics or the transfer type impression coping are that they remain in the mouth on removal of the set impression, the analogue is attached to the impression coping after removal from the mouth and this assembly is replaced in the indentation left on the set impression. No custom tray is required for this type of impression.

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Characteristics of the pick up type impression coping are that they are removed from the mouth together with the set impression. They require access to the retaining screw to allow release of the screw prior to removal of the impression coping – impression assembly, the analogues are attached to the impression copings while they are embedded in the impression tray. A custom tray with access to the impression coping screws is required.

Some precautions to take are:

- Making a radiograph when the impression coping/implant or impression coping/abutment is below the level of the mucosa to insure seating of the impression copings.
- Using vinyl gloves when a polyvinyl siloxane impression is used to prevent retardation of setting of the impression material from the interaction of latex gloves with the material.[2,3]
- It has been shown that the pick up type impression coping is the more accurate type of impression as errors occur on removal and replacement of the transfer type impression copings, especially in the occluso-gingival direction.[4–7]

However, there are indications to use of the transfer type impression coping. When there is limited mouth opening they can be used as there may not be sufficient space for access to the screws retaining pick up type impression

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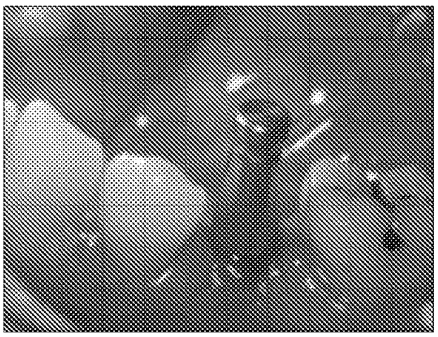


Fig. 1 Intra oral view of transfer impression coping in place.

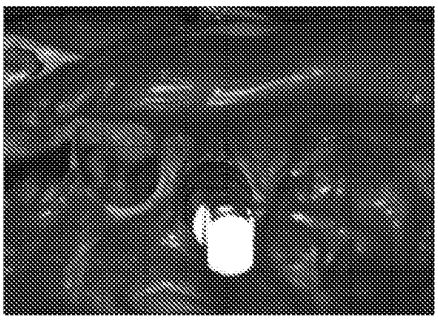


Fig. 2 Transfer impression – analogue assembly placed into elastomeric impression.

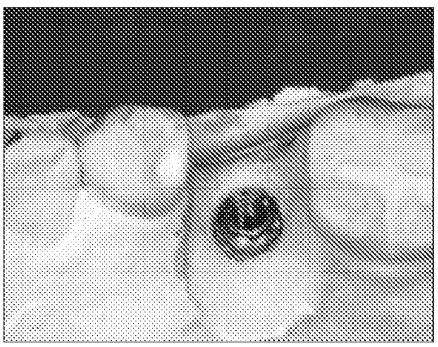


Fig. 3 Cast of implant analogue with soft tissue cast removed – allowing the technician access to the fit surface of the implant analogue.

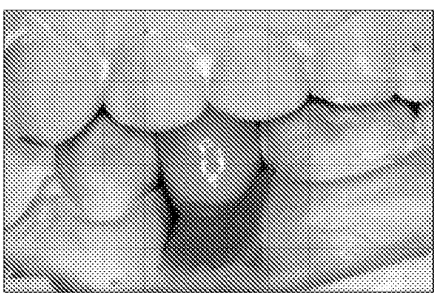


Fig. 4 Completed restoration in occlusion on working casts.

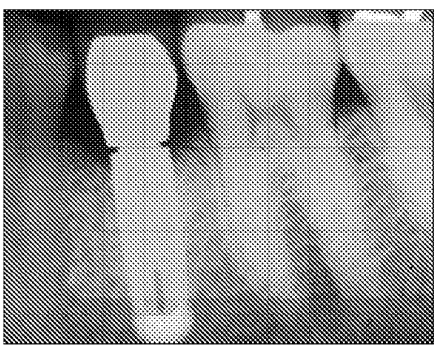


Fig. 5 Radiograph of restoration indicating poor seating due to interference of inter proximal contacts.

copings with the impression in place and in patients with an exaggerated gag reflex, when the impression has to be removed as quickly as possible.

The fidelity of the impression with respect to dimensional stability is critical; small discrepancies can lead to difficulty when the restoration is fabricated and delivered. Figures 1 to 7 illustrate a situation where a transfer type impression coping was used, showing that a slight error resulted in poor seating of the restoration due to interference with the proximal contacts. The impression was repeated with a pick up type impression and the contacts refined to allow more efficient delivery of the finished restoration with minimal adjustments to the interproximal contacts. These errors are more obvious when compared to conventional fixed prosthodontics due to the precise machine fit of implant components and to the rigid connection of implant to bone. Any discrepancy of the working cast to the mouth will manifest itself (Figs 1-7).

When impressions are required for multi implant restorations the precision of the impression is even more critical. This is because frameworks will be constructed from the master cast and mis-fit in the frameworks can lead to stress applied to the implants on screwing down the framework. Bone loss and even loss of integration has been attributed to this misfit.

Many articles have been written and many *in vivo* studies have been carried out to improve the fidelity of impressions over the use of pick up type impression copings alone. Some advocate connecting the impression copings together intra orally prior to impression making with acrylic resin.[8] These studies indicate that there is not statistically significant improvement when splinting impression copings with acrylic, however, the deviation of these impressions from the standardised cast is smaller. Others advocate use of impression plaster to connect the impression copings.[9] Manufacturers have developed impression copings with 'metal wings' that can be connected with acrylic resin to reduce the bulk of shrinking acrylic to further improve dimensional stability of the impression in order to obtain a passive framework.[10] Yet others have advocated corrected impression techniques where impression copings are connected then with only one impression coping related to the cast the other analogues are retrofitted to the cast to compensate for distortions of the impression material and the distortions of the setting die master cast material. Other authors have demonstrated that none of the above procedures are likely to improve the fidelity of the impression over use of a rigid custom tray and pick up type impression copings with an elastomeric impression material.[11-14]

Based on the above, the authors' suggestion is to use a an open custom tray which is rigid, to allow access to the retaining screws of pick up impression copings, to use a polyvinyl siloxane

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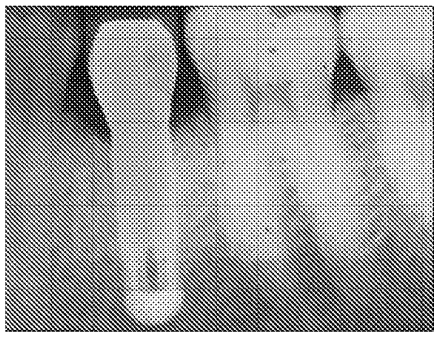


Fig. 6 Radiograph of restoration indicating seating after contacts are adjusted.

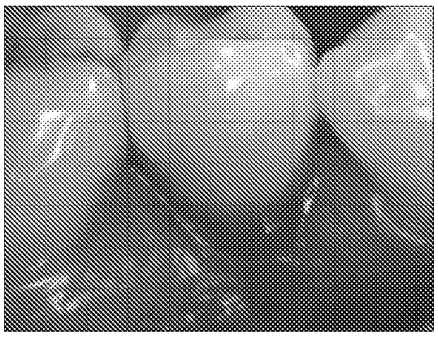


Fig. 7 Intra oral view of seated restoration.

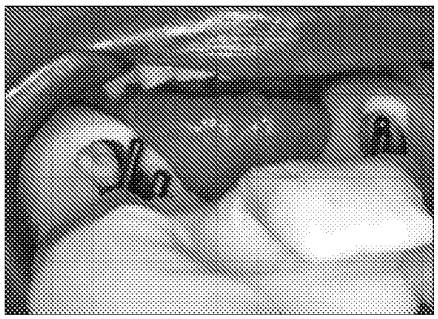


Fig. 8 Intra oral view of pick up impression copings and custom tray.

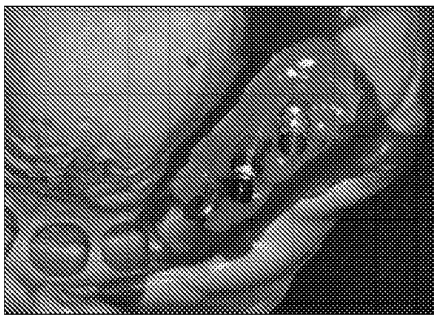


Fig. 9 Impression in Figure 8 with implant analogues assembled and soft tissue cast poured.

impression material with adhesive applied to the custom tray and poly ether as a soft tissue cast material (Figs 8-10).[15-18]

The above describes only making an impression which as accurately as possible positions the implant or abutment analogues in the master cast. This only provides the technician with part of the information he or she needs to fabricate the restoration. Other information that the technician will require about the soft tissue contours, that will frame the restoration and provide much of the aesthetics, will come from transfer of the contours surrounding the implant and also pontic areas.[19] Several methods are available to capture this information on the master cast and they will be discussed as follows:

1. fabricating a custom impression coping which is adapted to the soft tissue contours
2. replacing the provisional restoration on the master cast and forming the soft tissue around the sub muscosal areas of the provisional restoration
3. incorporating the provisional restoration into the impression.

Manufacturer supplied impression copings do not take into account soft tissue morphology formed by provisional restorations. Impressions using manufacturer supplied impression copings merely relate the implant or implant abutment to oral structures. Customised impression copings that accurately record the soft tissue can be made by attaching an analogue to the provisional restoration and placing some impression material around the sub mucosal portion of the provisional restoration. On setting of the impression material the provisional restoration can be returned to the patient. An impression coping is attached to the analogue and the space around the impression coping formed by the provisional restoration is filled with acrylic resin. The customised impression coping is then used in the impression making process. A soft tissue cast is poured around the customised impression coping producing a cast with the implant position and soft tissue representing the intra oral conditions.[20,21]

Instead of making customised impression copings, the provisional restoration can be seated on the master cast that is made routinely and the existing soft tissue cast can be removed. The provisional restorations are removed from the patient and placed onto the master cast and impression material is extruded around the provisional restoration to form the soft tissue contours presenting intra orally.[22]

Another method of transferring soft tissue information is incorporating the provisional restoration into the impression. When screw retained restorations are used, the provisional restoration itself can be used as a pick up type impression coping. A soft tissue cast is poured around the exposed provisional after an impression coping is attached, yielding a soft tissue cast which is identical to the soft tissue form intra orally. This allows communication of some vital information to the technician fabricating the definitive restorations (Figs 11-12).[23,24]

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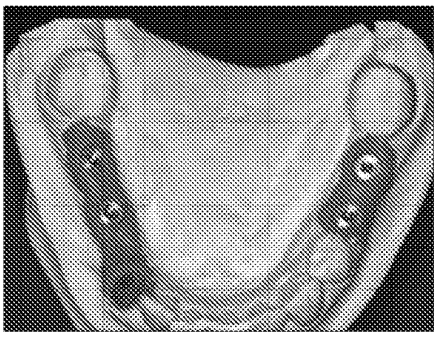


Fig. 10 Occlusal view of hard and soft tissue cast recovered from impression.

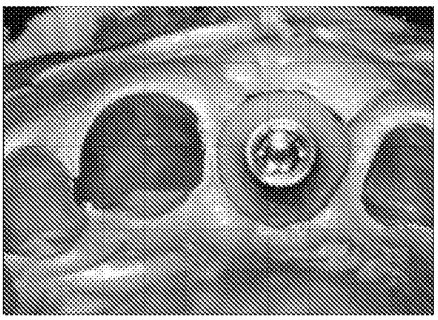


Fig. 11 Impression incorporating provisional restoration – note the sub mucosal portion of the provisional restoration.

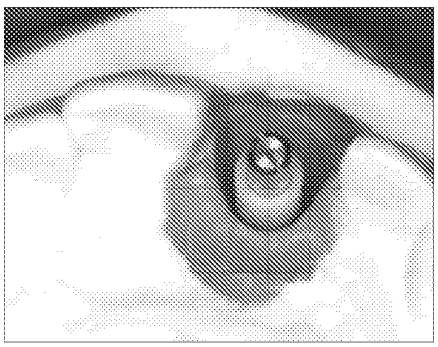


Fig. 12 Cast recovered from impression in Figure 11 with restorative cylinder in place – note the soft tissue information communicated to the laboratory technician.

DISCUSSION

A review of the literature concerning impression making in implant dentistry was presented along with suggestions for a predictable implant impression technique, when esthetics is of concern methods of transferring the soft tissue information formed by provisional restorations to the master cast were also described.

CONCLUSION

With the predictable integration of implants the emphasis is shifted toward more precision with restorative techniques and the creation of tooth like replacements for missing teeth. With careful planning dental implants can be placed in ideal restorative positions. Furthermore, with careful soft tissue management the soft tissue contours can be enhanced with early use provisional restorations. These efforts must be translated to the master cast to allow the technician to fabricate definitive restorations that have individualised peri implant soft tissue contours that will be identical to the soft tissue contours present intra orally. Using the modified impression techniques described, information regarding soft tissues can be transferred to the master cast.

1. Wee A. G. Comparison of impression materials for direct multi-implant impressions. *J Prosthet Dent* 2000; **83:** 323-331.
2. Kahn R, Donovan T E, Chee W W. Interaction of gloves and rubber dam with a Poly (Vinyl Siloxane) impression material: A screening test. *Int J Prosthodont* 1989; **2:** 342-346.
3. Chee W W, Donovan T E, Kahn R L. Indirect inhibition of polymerization of a polyvinyl siloxane impression material: a case report. *Quint Int* 1991; **2:** 133-135.
4. Liou A D, Nicholls J I, Yuodelis R A, Brudvik J S. Accuracy of replacing three tapered transfer impression copings in two elastomeric impression materials. *Int J Prosthodont* 1993; **6:** 377-383.
5. Assif D, Fenton A, Zarb G, Schmitt A. Comparative accuracy of implant impression procedures. *Int J Perio Rest Dent* 1992; **12:** 112-121.
6. Barrett M G, de Rijk W G, Burgess J O. The accuracy of six impression techniques for osseointegrated implants. *J Prosthodont* 1993; **2:** 75-82.
7. Spector M R, Donovan T E, Nicholls J I. An evaluation of impression techniques for osseointegrated implants. *J Prosthet Dent* 1990; **63:** 444-447.
8. Assif D, Marshak B, Schmidt A. Accuracy of implant impression techniques. *Int J Oral Maxillofac Implants* 1996; **11:** 216-222.
9. Assif D, Nissan J, Varsano I, Singer A. Accuracy of implant impression splinted techniques: effect of splinting material. *Int J Oral Maxillofac Implants* 1999; **14:** 885-888.
10. Carr A B, Master J. The accuracy of implant verification casts compared with casts produced from a rigid transfer coping technique. *J Prosthodont* 1996; **5:** 248-252.
11. McCartney J W, Pearson R. Segmental framework matrix: master cast verification, corrected cast guide, and analogue transfer template for implant-supported prostheses. *J Prosthet Dent* 1994; **71:** 197-200.
12. Herbst D, Nel J C, Driessen C H, Becker P J. Evaluation of impression accuracy for osseointegrated implant supported superstructures. *J Prosthet Dent* 2000; **83:** 555-561.
13. Hsu C C, Millstein P L, Stein R S. A comparative analysis of the accuracy of implant transfer techniques. *J Prosthet Dent* 1993; **69:** 588-593.
14. Inturregui J A, Aquilino S A, Ryther J S, Lund P S. Evaluation of three impression techniques for osseointegrated oral implants. *J Prosthet Dent* 1993; **69:** 503-509.
15. Chee W W, Donovan T E. Poly (Vinyl Siloxane) impression materials: a review of properties and techniques. *J Prosthet Dent* 1992; **68:** 728-732.
16. Beyak B L, Chee W W. Compatibility of elastomeric impression materials for use as soft tissue casts. *J Prosthet Dent* 1996; **76:** 510-514.
17. Cho G C, Chee W W. Distortion of disposable plastic stock trays when used with putty vinyl polysiloxane impression materials. *J Prosthet Dent* 2004; **92:** 354-358.
18. Cho G C, Donovan T E, Chee W W, White S N. Tensile bond strength of polyvinyl siloxane impressions bonded to a custom tray as a function of drying time: Part I. *J Prosthet Dent* 1995; **73:** 419-423
19. Derbabian K, Chee W W. Simple tools to facilitate communication in esthetic dentistry. *J Calif Dent Assoc* 2003; **31:** 537-542.
20. Buskin R, Salinas T J. Transferring emergence profile created from the provisional to the definitive restoration. *Pract Perio Aest Dent* 1998; **10:** 1171-1179.
21. Stumpel L J, Haechler W, Bedrossian E. Customized abutments to shape and transfer peri-implant soft-tissue contours. *J Calif Dent Assoc* 2000; **28:** 301-309.
22. Neale D, Chee W W. Development of implant soft tissue emergence profile: A technique. *J Prosthet Dent* 1994; **71:** 364-368.
23. Chee W W, Cho G C, Ikoma M M, Arcidiacono A. A technique to replicate soft tissues around fixed restoration pontics on working casts. *J Prosthodont* 1999; **8:** 44-46.
24. Chee W W, Cho G C, Ha S. Replicating soft tissue contours on working casts for implant restorations. *J Prosthodont* 1997; **6:** 218-220.

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Applicants

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CONNECTION SYSTEM FOR A DENTAL IMPLANT

Abstract

The present invention relates to a connector (1, 1', 1'', 2, 3) for connecting ceramic components of a dental implant (100, 100', 200, 300). The invention further relates to a prosthesis (120, 120', 220, 320) for a dental implant (100, 100', 200, 300). The invention moreover relates to a base body (130, 230, 330) for a dental implant (100, 100', 200, 300), with an inner thread (132, 232, 332), which is designed to match a base thread (111, 111', 111'', 211, 311) of a connector (1, 1', 1'', 2, 3), and/or with a receiver (135, 235, 325), which is designed to match a prosthesis (120, 120', 220, 320). Finally, the invention relates to a connection system for a dental implant (100, 100', 200, 300). In order to provide dental implants (100, 100', 200, 300) which satisfy the general requirements for successful implantation and use and can easily adapt to bone variations and implant availability, provision is made according to the

invention that the connector (1, 1', 1'', 2, 3) has a base portion (11, 11', 11'', 21, 31), on which a base thread (111, 111', 111'', 211, 311) is formed for screwing the connector (1, 1', 1'', 2, 3) into a base body (130, 230, 330) of the dental implant (100, 100', 200, 300), and a holding portion (12, 12', 12'', 22, 32), on which a holding thread (121, 131, 131', 221, 321) is formed for screwing a prosthesis (120, 120', 220, 320) of the dental implant (100, 100', 200, 300) onto the connector (1, 1', 1'', 2, 3) or that the prosthesis (120, 120', 220, 320) is provided with a mating holding thread (2102, 3102) for screwing the prosthesis (120, 120', 220, 320) onto a connector (1, 1', 1'', 2, 3) of the dental implant (100, 100', 200, 300).

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DESCRIPTION WO2018029650A1

[0001]

Connection system for a dental implant

[0002]

The present invention is in the field of dental implants.

It relates to a connector for connecting ceramic components of a dental implant. Furthermore, the invention relates to prosthetics for a dental implant. Furthermore, the invention relates to a base body for a dental implant. Finally, the invention relates to a connection system for a dental implant.

[0003]

Technological background

[0004]

Dental implants can be designed in one piece or in multiple pieces.

Nowadays, multi-piece dental implants have prevailed over one-piece dental implants because multi-piece dental implants offer better conformability and protection from unwanted stresses during the healing process than one-piece dental implants.

[0005]

A large number of multi-part dental implants known from the prior art are constructed in three parts and thus comprise a base body to be inserted into a jawbone, an abutment to be fastened to the base body and a superstructure to be placed on the abutment.

The base body, also known as the implant body, is intended to replace the tooth root and is usually cylindrical or conical in shape.

As a rule, the base body has a thread, via which the base body can be fixed in the jawbone by screwing it in, thereby achieving primary strength in the jawbone. While the base body and abutment are embedded in the jaw or covered by the superstructure, the latter is exposed in the oral cavity and represents the actual tooth structure. The abutment, also known as an implant abutment, serves to a certain extent as an intermediate link between the base body and superstructure and is usually screwed and/or glued into the base body.

[0006]

The base body should be made of a material that is as bioinert as possible so that it can be used largely tolerably and without complications for the patient and to prevent the gums from receding.

Both the material and the structure of the base body should enable a high degree of osseointegration. These requirements for what is known as biocompatibility and high periointegration also apply to the abutment and superstructure. Ceramic, in particular zirconium oxide, has prevailed as a material with advantageous processing properties and high biocompatibility. Titanium is often used as an alternative to ceramics, but it does not have as good biocompatibility and periointegration as ceramics.

[0007]

A reliable connection between the abutment and the base body that is sealed against bone and gums is crucial for the long-term success of an implantation.

A poor connection between the abutment and the base body can lead to loosening of the dental implant and damage to the dental implant. Leaking connections can allow bacteria to enter the implant, leading to peri-implantitis and thus i.a. can cause jaw bone loss. Furthermore, the forces occurring in the teeth place high demands on the material and construction of implants for long-term success. The implants must be able to absorb all forces occurring in the teeth without breaking, tearing or loosening. It is therefore important, both when inserting and over the entire service life of the dental implant, where and how exactly a force is introduced into the individual components of the implant.

[0008]

Depending on the position of the dental implant to be inserted in the jaw and bone availability at the position, different implant types and, in particular, different lengths or widths can be used.

Sizes of the dental implants may be required. Due to the varying suitable size of the dental implant depending on the jaw situation, series with components of different sizes are usually used, which should provide a reliable connection between the abutment and base body for a high level of long-term success, as mentioned at the beginning. For example, the series can contain several base bodies of different sizes, for example with lengths of 6, 8, 10, 12, 14 or 16 mm with different diameters of for example 3.3, 4.1 or 4.8 mm as well as different types of abutments that are straight or angled and can also be in different sizes. In summary, dental implants have to meet high requirements in terms of biocompatibility, tightness, force transmission and system flexibility.

[0009]

For example, the European patent application filed by the applicant with the publication number EP 2 735 279 A1, the disclosure of which is incorporated herein by reference in its entirety, describes a dental implant with a ceramic base body that can be anchored in a jawbone and an implant structure that can be fastened to the base body by means of a screw, wherein When the dental implant is in an assembled state, a threaded section of the screw engages in an internal thread formed in a blind hole in the base body.

The screw presses the implant abutment against the base body. A form-fit engagement between the threaded section of the screw and the internal thread of the hole exists exclusively in a lower half of the base body that faces away from the implant structure and extends over half the length of the base body.

[0010]

According to EP 2 735 279 A1, this is intended to ensure that mechanical stresses are distributed homogeneously over the entire length of the base body.

The internal thread, into which the tension is introduced directly via the screw, is located relatively far away from the contact area between the base body and the implant abutment, deep in the foot of the base body. In order to achieve reliable attachment of the base body to the implant abutment using the screw, the length of the screw must match the length of the blind hole in the base body and part of the implant abutment. Accordingly, different screws are to be provided for dental implants of different lengths. The provision of different screws is not only expensive, but also tedious to use, so it leads to unwanted additional costs and effort.

[0011]

Presentation of the invention

[0012]

It is therefore an object of the invention to provide dental implants that meet the general requirements for successful implantation and use and can at least be more easily adapted to bone variations and implant availability than dental implants known from the prior art.

According to the invention, this object is achieved by a connector according to independent claim 1 , a prosthesis according to independent claim 10 , a base body according to claim 13 and by a connection system according to claim 14 .

Preferred developments of the invention are given in the dependent claims and in the present disclosure.

[0013]

In particular, the object is achieved by a connector for connecting ceramic components of a dental implant, with a base section on which a base thread for screwing the connector into a base body of the dental implant is formed, and with a holding section on which a holding thread for screwing on a prosthesis of the dental implant molded onto the connector.

[0014]

In particular, the task is solved with a prosthesis for a dental implant, with a counter-retaining thread for screwing a prosthesis onto a connector of the dental implant.

[0015]

In particular, the object is achieved with a base body for a dental implant, with an internal thread designed to complement a base thread of a connector according to the invention and/or with a receptacle designed to complement a prosthesis according to the invention.

[0016]

In particular, the object is achieved by a connection system for a dental implant, with at least one connector according to the invention and/or with at least one prosthesis according to the invention and/or with at least one base body according to the invention.

[0017]

The solution according to the invention has the advantage over the prior art that connectors and prosthetics can be selected to match the respective base body.

For example, a large number of different prostheses can be screwed onto the base body by using the connector.

The connectors can also be adapted to the respective circumstances, or a unit connector that can be adapted to the circumstances can be used.

Thus, the invention as a connection system helps to provide a kind of modular system for tooth structures and other components of dental implants, which are used from the healing phase of the implant to its ready-to-use structure.

For example, the prosthetics can be a gingiva former for adapting the gums to a shape of an abutment that will be used later.

Alternatively or additionally, the prosthesis and connector can be used together as an implant screw in the form of a healing screw to seal the base body or implant against bacteria during healing.

[0018]

Unit connectors according to the invention

Connectors can consequently be used together with abutments and/or prosthetics according to the invention. The abutments and/or prosthetics can be used as a head or Head part of together with the connector or Unit connector formed screws are used or at least partially form a head or head part of a screw, such as an implant or healing screw. In other words, the abutment, prosthesis and/or head part can be equivalently connected to a connector or Unit connectors work together and accordingly have the configurations and features required for this, as are described herein with reference to the abutment, prosthetics and/or head part.

[0019]

The solution according to the invention can be supplemented and further improved as desired by the following additional embodiments, each of which is advantageous in itself, with a person skilled in the art clearly and unequivocally recognizing that device features of components of a connection system according to the invention correspond to steps according to the invention methods for producing and using a connection system according to the invention Justify connection system and its components and vice versa.

[0020]

According to a first further embodiment, it is provided that the connector is made of a metal or a metal alloy, preferably at least partially made of titanium.

Thus, the connector has a higher elasticity than the components of the dental implant made of ceramic, such as the base body, the prosthetics and the abutment.

In view of the fact that these ceramic components are less able to absorb tensile forces, bending moments and shearing stresses than metal components due to the corresponding material properties, the use of the metal connector helps to give the entire dental implant an advantageous fatigue strength

and resilience by benefiting from compressive strength, abrasion resistance on the one hand and biocompatibility of the ceramic and, on the other hand, the elasticity and toughness of the metallic connector.

[0021]

With such a combination of ceramic and metal, a connection system according to the invention represents a hybrid dental implant system, so to speak.

It is ideal for the gums not to have any contact with metallic connectors. According to the invention, this is achieved in that the connector is advantageously arranged within an interior space of the dental implant formed by the base body and prosthesis or at least spaced apart from the gums by the base body and/or prosthesis. The interior is advantageously hermetically sealed in that a contact surface of the prosthesis rests sealingly on a contact surface of the base body.

[0022]

According to a further advantageous embodiment it is provided that the connector has at least one shoulder element between the base section and the holding section, which at least partially protrudes in a radial direction of the connector beyond an outer circumference of the base section and/or the holding section.

The shoulder element can serve both to handle the connector as such and form a stop for the connector. The connector can thus be screwed into the base body up to the shoulder element as a stop on the base body. The shoulder element therefore helps to fasten the connector in the base body precisely and with tactile and/or visual feedback. Screwed into the base body with the base thread, the connector can provide an attachment option for a variety of prosthetics or for replacement prosthetics for wear or aesthetic reasons through the retaining thread.

[0023]

According to a further advantageous embodiment, it is provided that the at least one shoulder element is formed on an annular collar, the outside diameter of which is larger than an outside diameter of the base section and/or the holding section.

The annular collar can be arranged concentrically to the base thread and/or retaining thread. The annular collar thus contributes to an even transmission of forces between the connector and the prosthesis and/or between the connector and the base body.

[0024]

According to a further advantageous embodiment it is provided that at least one engagement means is formed on the connector for actuating the connector with a tool.

The means of engagement helps to position a tool, which is advantageously designed to be complementary to the means of engagement, precisely on the connector and to transmit forces and/or moments from the tool to the connector in accordance with the respective requirements.

[0025]

According to a further advantageous embodiment it is provided that the at least one engagement means is provided with an external profile at least in sections.

For example, the external profile can be formed as an external hexagon. An outside diameter of the outside profiling can, for example, be smaller than an outside diameter of the base thread and/or retaining thread. This enables radial play between the engagement means and other components of the dental implant, in particular the respective inner circumferences of the base body and/or prosthesis. Such radial play helps to avoid overdetermining tolerances of the components of the dental implant and to provide certain degrees of freedom when handling the components and when assembling them.

[0026]

According to a further advantageous embodiment it is provided that a head end of the connector is designed as the at least one engagement means.

The means of engagement of the connector inserted into the base body thus remains easily accessible. Accessibility can be improved, for example, by the head end of the connector protruding beyond an upper edge of the base body, counter to an insertion direction, when the connector is fully inserted into the base body. Alternatively or additionally, the means of engagement can be formed on an annular collar or as such on the connector.

[0027]

According to a further advantageous embodiment, it is provided that at least one annular groove is formed between the base section and the holder section, at which the outer circumference of the connector tapers in relation to the respectively surrounding sections.

Such an annular groove helps on the one hand to prevent undesired canting, rubbing or hitting of the connector when inserting the connector into the base body or when placing the prosthesis on the connector. On the other hand, annular grooves of this type help to give the connector the desired elasticity or to increase its flexibility at the desired point so that, for example, the connector yields rather than the contact surfaces between the connector and ceramic and/or contact surfaces between ceramics being overstrained by unbalanced loads.

[0028]

According to a further advantageous embodiment, it is provided that the base thread and/or the retaining thread is/are designed as a left-hand thread.

Threads of implants are usually designed as right-hand threads. A configuration of the base thread and/or the retaining thread as a left-hand thread helps to prevent a screw connection from loosening undesirably. If, for example, the retaining thread is designed as a right-hand thread and the base thread as a left-hand thread, then the prosthesis can be unscrewed from the retaining thread without loosening the screw connection between the connector and the base body.

[0029]

In a prosthesis according to the invention, the solution according to the invention can be improved according to a first further advantageous embodiment in that the counter-holding section is provided with a blind hole in which the counter-holding thread is arranged.

By arranging the counter-retaining thread in the blind hole, the counter-retaining thread or an upper end section of the connector can be surrounded by the prosthesis. In other words, the prosthesis can be placed on the connector like a cap. This helps to form a hermetically sealed interior of the dental implant between the prosthesis and the base body. The connector can be accommodated in this interior space, shielded from the area surrounding the dental implant, that is to say the gums and oral cavity.

[0030]

According to a further advantageous embodiment, it is provided that the counter-retaining thread runs at least in sections along an extension of the prosthesis, which is designed to engage in a receptacle of a base body of the dental implant.

The prosthesis can thus overlap with the base body in the radial direction. On the one hand, this helps to position and center the prosthesis in relation to the base body during assembly. On the other hand, the covering helps to ensure high stability of the dental implant and sealing of its interior. In a connection system according to the invention, the solution according to the invention can be improved according to a first further advantageous embodiment in that, in a final assembly state of the dental implant, the connector is accommodated in an interior space of the dental implant surrounded by the prosthesis and base body. In this way, connectors or Unit connectors arranged in the interior should be surrounded by base bodies and prosthetics preferably made of ceramic materials in order to prevent the connectors from coming into contact with the gums. It is also advantageous if the interior is hermetically sealed.

For this purpose, the prosthetics should be flush and sealed against the base body in the final assembly state.

[0031]

In a pre-assembly state of the dental implant, the connector can either first be connected to the base body or to the prosthesis before the final assembly state.

If the connector is connected to the base body in the pre-assembly state, then it can be inserted with its base thread into the base body, while its holding thread is arranged so that it is accessible from the outside of the base body in order to attach the prosthesis to it and thus move the dental implant from the pre-assembly state to the final assembly state convict. If the connector is connected to the prosthesis in the pre-assembly state, then these can be handled like an implant screw, which is screwed into the base body to transfer the dental implant from the pre-assembly state to the final assembly state.

[0032]

Alternatively or additionally, the object is achieved by an implant screw for a dental implant, with a ceramic head part and with a non-ceramic base thread that can be screwed into a base body of the dental implant.

[0033]

This solution according to the invention has the advantage over the prior art that the head part and base thread can be selected to match the respective base body.

For example, in particular, a large number of different head parts can be screwed onto the base body by using the base thread.

The base thread can also be adapted to the respective circumstances, or a connector or connector that can be adapted to the circumstances can be used. Unit connector can be used on which the base thread is formed. The head part is made of ceramic, for example, in order to ensure the highest possible biocompatibility of an implant screw according to the invention. The head part can be permanently connected to a prosthesis or formed on a prosthesis or as a prosthesis. For example, the head part or the prosthesis is designed to be rotationally symmetrical. on the headboard or A contact surface can be formed in the prosthesis, which is designed to lie flush on the base body. Thus, the base thread between the head part or Be included included prosthetics and base body. The base thread consists, for example, of a non-ceramic material. A metal or a metal alloy can preferably be used as the non-ceramic material in order to give an implant screw according to the invention the highest possible toughness.

[0034]

According to a further embodiment, it is provided that the head part is connected to the base thread via a form fit for the transmission of a torque acting about a central axis of the implant screw.

The form fit helps to prevent relative rotations between the head part and the base thread, at least around the central axis. Due to the form fit, torques can be transferred precisely and safely from the head part to the base thread and vice versa. Due to the form fit, two-part implant screws according to the invention consisting of a head part and a base thread can be handled as is possible with one-part implant screws.

[0035]

According to a further embodiment, it is provided that the head part is provided with a recess, in which a connector is accommodated at least in sections, on which the base thread is formed.

The recess is designed in the manner of a blind hole, for example. The design of the recess as a blind hole helps to preferably enclose the connector or an upper end of the connector with the recess. On the one hand, a connection that is as intimate and firm as possible can be established between the head part and the connector. On the other hand, at least partial embedding of the non-ceramic connector in the ceramic material of the head part is favored. The connector can be designed or selected according to the respective requirements. For example, the connector is bolt-shaped and/or at least partially cylindrical. Accordingly, the base thread can have the form of a threaded bolt. According to a further embodiment it is provided that a counter-retaining thread for screwing the head part onto the connector is arranged in the recess. The counter-retaining thread allows the connector to be screwed into the head part in order to create a positive connection between the head part and the connector.

The head part and connector can therefore be easily combined with one another.

[0036]

According to a further embodiment, provision is made for the counter-retaining thread to be assigned teeth connected to the head part.

For example, the toothing is formed on the prosthesis or the head part. For example, when the head part or the prosthesis is brought together with the connector, the toothing can penetrate the material of the connector and form a positive and/or non-positive connection between the head part or the prosthesis. Help bring about prosthetics and connectors.

[0037]

According to a further embodiment it is provided that the toothing encircles the counter-retaining thread.

In other words, the toothing surrounds the counter-holding thread in the form of a ring and/or overlaps with it. For example, the teeth can surround an opening to the recess or the counter-retaining thread arranged therein. This favors the most symmetrical and therefore balanced engagement of the teeth in the material of the connector.

[0038]

According to a further embodiment it is provided that the toothing has flat tooth flanks and/or steep tooth flanks, the flat tooth flanks pointing in a screwing direction of the retaining thread or the steep tooth flanks pointing counter to the screwing direction.

The screwing direction is, for example, the direction in which the counter-retaining thread and consequently the head part or the prosthesis can be screwed onto the connector. Since the flat flanks of the teeth point in the direction of screwing, they promote further screwing of the head part or the prosthesis onto the connector, even after they have come into contact with the connector, since they slide over the material of the connector. On the other hand, the steep tooth flanks cause the toothing to dig into the material of the connector when the head part or the prosthesis is moved relative to the connector in the opposite direction to the screwing direction, or displace it in such a way that an intimate positive and/or non-positive connection between the head part or Prosthetics and connectors is effected. Such a positive and/or non-positive connection prevents in particular an unintentional loosening of the screw connection between the head part or prosthetics and connectors. According to a further embodiment, it is provided that an end face connected to the head part points in the direction of the base thread and/or bears against the connector at least in sections.

For example, the front side of the headboard or Be formed prosthetics and preferably has in the axial direction, d. H. in a direction substantially parallel to the central axis. Such a front end favors the transmission of force and/or torque between the head part or Prosthetics and connectors on the one hand and between the implant screw and base body on the other.

[0039]

According to a further embodiment, it is provided that the end face is ring-shaped.

The end face can, for example, enclose an opening to the recess or the base thread or form an edge of the opening. A ring-shaped end face, preferably arranged rotationally symmetrically to the central axis, promotes the most uniform possible transmission of force and/or torque between the head part or Prosthetics and connectors on the one hand and between the implant screw and base body on the other.

[0040]

According to a further embodiment, it is provided that at least one tooth is formed on the end face, on which a tooth tip pointing away from the end face is formed.

For example, the toothing can be formed from a large number of such teeth. The tips of the teeth can protrude from the front side and thus penetrate into the material of the connector in order to achieve the most intimate possible non-positive and/or positive connection between the head part or to effect prosthetics and connectors.

[0041]

According to a further embodiment, it is provided that the at least one tooth forms the toothing at least in sections.

In other words, the toothing comprises the tooth pointing away from the end face. The at least one tooth can correspondingly have a flat and a steep tooth flank, as described above. Advantageously, a large number of teeth forming the toothing are arranged rotationally symmetrically to the central axis along the end face in order to ensure the most uniform possible transmission of force between the head part and to ensure prosthetics and connectors.

[0042]

According to a further embodiment, it is provided that the connector has a holding section on which a holding thread for screwing the head part onto the connector is formed.

The retaining thread is preferably designed to be complementary to the counter retaining thread. This promotes a reliable screw connection with as little play as possible between the head part and the manufacture prosthetics and connectors.

[0043]

According to a further embodiment, it is provided that the connector has an annular collar which, at least in sections, points in the direction of the head part.

The head part or the prosthesis, in particular its front side, can come into contact with the ring collar. On the one hand, this promotes an intimate connection between the headboard and prosthetics and connectors. On the other hand, by fitting the head part or the prosthesis flush to the ring collar of the connector, a proper union of the head part relationship between the prosthesis and the connector can be easily verified optically and/or haptically.

[0044]

According to a further embodiment, it is provided that at least one engagement means for attaching a tool for screwing in the connector is formed on the annular collar.

For example, an outer contour of the ring collar can be designed as an engagement means. The outer contour is preferably formed as an external hexagon. The means of engagement of the connector makes it easier to transmit forces and/or torques to the connector using a tool in a way that is as gentle on the material as possible.

[0045]

According to a further embodiment, it is provided that at least one engagement means for attaching a tool for screwing in the implant screw is formed on the head part.

For example, an inner contour of the engagement means of the head part or the prosthesis can be formed as a hexagon socket or a hexalobular socket. The engagement means of the head part or the

prosthesis makes it easier to transmit forces and/or torques via a tool to the head part or the prosthesis on the one hand and to the implant screw on the other hand in a way that is as gentle on the material as possible.

[0046]

According to a further embodiment, it is provided that the head part is connected to the base thread via an adhesive connection.

For example, the head part or the prosthesis is glued to the connector. The adhesive can be used as an alternative or in addition to a screw connection between the head part or Prosthetics and connectors are used to intimately connect them. In combination with a screw connection, the adhesive can act like a screw lock. between the headboard and A cavity can be formed in the prosthesis and connector, into which an adhesive can penetrate or which can be filled by the adhesive. To provide the cavity, for example, an annular groove can be formed on the base thread or in its vicinity, preferably on the connector.

[0047]

Furthermore, the invention relates to a unit connector for connecting an abutment of a dental implant to a base body of the dental implant, comprising a base section that can be inserted into the base body along an insertion direction and fixed therein and an abutment holding section for holding the abutment on the base body, the abutment holding section being at least two apart along the insertion direction spaced holding positions for the abutment.

[0048]

The invention further relates to a unitary connection system for dental implants comprising at least one unitary connector according to the invention.

With the help of the unit connector, the unit connector system can be used for a large number of different sizes and types of dental implants.

In addition to at least one unit connector, the unit connection system can also contain other elements, such as holding elements, additional holding elements and tools and/or measuring tools that interact with these and/or the unit connector.

[0049]

As a rule, both the base body and the abutment have bores which can accommodate the unit connector, with a lower area of the unit connector being located in the base body and an upper area of the unit connector being located in the abutment when the dental implant is assembled.

Depending on the length of the base body and the length of the abutment, the unit connector can protrude from the top of the abutment. The first end region can preferably be connected to the base body when the unitary connector is inserted into the base body, preferably firmly anchored. Optionally, the unit connector can be glued into the base body or alternatively connected in the manner of a bayonet catch.

[0050]

The unit connector offers the advantage that it can be used for dental implants of different sizes thanks to the variable length.

In the case of conventional solutions with conventional screws, on the other hand, the sizes or The lengths of the components must be precisely matched to the screw in order to ensure a reliable connection between the base body and the abutment. Since the unitary connector according to the invention provides at least two holding positions, it can be used both with base bodies of different sizes and with abutments of different sizes. Thus, for example, in entire series for dental implants, a positively sealed connection of the base body to the abutment can be achieved by the same unit connector, which can advantageously be anchored as deeply as possible in the base body. On the one hand, this helps to ensure a stable structure of the dental implant. On the other hand, production costs for dental implants can be reduced and their use simplified by increased variability compared to the prior art.

[0051]

Due to the operative connection of the second end region of the unit connector to the abutment, the unit connector can connect the base body to the abutment, preferably in a force-fitting and form-fitting manner.

The active connection can, among other things, be positive, non-positive and/or cohesive, including indirectly via a holding or fasteners, such as B. in the form of a sleeve. Form-fitting is to be understood within the scope of the production of the components of the dental implant, which is known to the person skilled in the art. In connection with the connection between the abutment and the base body, sealing is to be understood as meaning that the contact surfaces between the base body and the abutment are so tight that z. B. no bacteria can penetrate between base body and abutment, which helps to avoid peri-implantitis.

[0052]

A unitary connector according to the invention can be used in a particularly advantageous manner, in particular due to the sealing in multi-part dental implants made of ceramic.

In the case of such dental implants, an interior space or cavity is generally formed between the base body and the abutment. If the abutment is properly installed on the base body, the interior is hermetically sealed against the jawbone and gums. The unitary connector can therefore be accommodated in the interior, isolated from the jawbone and gums. Thus, the unit connector can also

be made of materials other than ceramic, for example stainless steel and/or titanium or the like, without having to compromise on the biocompatibility of the dental implant, because this is limited by the ceramic nature of the components of the implant encasing the unit connector is guaranteed. The solution according to the invention can be combined and further improved as desired with the following additional embodiments according to the invention, each of which is advantageous in its own right.

[0053]

According to a first further embodiment, the holding positions can be selected in an infinitely variable manner.

An infinitely variable selectability of the holding positions makes it possible to connect a large number of different base bodies and abutments with one another using the same type of unit connector. The infinitely variable selectability of the holding positions also helps to compensate for any manufacturing tolerances as well as deviations or irregularities during implantation or to compensate for the build-up of the implant.

[0054]

According to a further embodiment, it is provided that the base section has a first external thread, which is designed such that it can be brought into engagement with an internal thread of the base body and which provides at least two holding positions.

Due to the external thread, the unit connector can be easily screwed into the base body and thus connected to it in a positive and non-positive manner. The holding positions can be provided in an infinitely variable manner along the external thread.

[0055]

According to a further embodiment of a unitary connector according to the invention, it is provided that a length of the first external thread measured parallel to the direction of insertion essentially corresponds to a length of the internal thread measured parallel to the direction of insertion or is at least only slightly shorter than the length of the internal thread.

Internal threads and external threads can thus essentially completely overlap. On the one hand, this helps to provide a lower stop for the unitary connector through the dimensioning of the thread itself and thus to limit its insertion path in the direction of insertion. On the other hand, the positive and non-positive connection between the unit connector and the base body is precisely limited to the area of said thread and concentrated therein. Unnecessary threads and the associated weakening of the material are avoided.

[0056]

According to a further embodiment of a unitary connector according to the invention, it is provided that the unitary connector has a cylindrical shaft section between the base section and the abutment holding section.

Thus, the unitary connector can be manufactured as a type of stud with a thread at each end. The shank section favors receiving the unitary connector with as little play as possible, both in the base body and in the abutment. Any transverse forces or moments can be transmitted via contact surfaces dimensioned with as little or no play as possible between the shaft section and base body on the one hand and between the shaft section and abutment on the other hand, which helps to improve the robustness and longevity of the entire dental implant.

[0057]

According to a further embodiment, the shank section has at least partially a larger diameter than the base section.

A stop or a gradation can be formed in the area of the change in diameter, which helps to limit an insertion path of the unitary connector in the insertion direction. In addition, this embodiment makes it possible to design the shank section in such a stable manner that in the transverse direction or radially to the central axis of the shank section or Unit connector acting forces can be safely absorbed and removed. In contrast to this, threads in the base section and in the abutment holding section can be designed to absorb tensile forces acting parallel to the direction of insertion, which helps to optimize the dimensions of the individual components of the dental implant. Furthermore, this embodiment offers the advantage that contact between the base section and the inner wall of the bore of the base body can be minimized when the unit connector is inserted into the bore of the base body. With a thread in the base section, for example, contact between the thread and the inner wall of the bore of the base body during the insertion of the unitary connector can lead to damage, which can be particularly critical for ceramic base bodies.

A gradation can thus advantageously ensure that the unitary connector is guided through the shank and disadvantageous damage to the base body through contact of the inner wall with the base section can be minimized. Preferably, the bore of the base body in the lower area then has a narrowed bore corresponding to the first end area of the unit connector, in which the base section of the unit connector can engage or be inserted as flush as possible with it. According to a further embodiment, a holding element is provided which engages around the abutment holding section and is designed to interact with the abutment holding section in order to hold the abutment. The holding element can be designed to be fixable or lockable in the at least two holding positions on the unit connector or at least interact with the unit connector in such a way that it can absorb forces from the unit connector that act essentially parallel to the direction of insertion and transmit them to it.

Different holding elements can each be combined with the same unit connector in order to be able to use it together with different types of base bodies and/or abutments.

[0058]

According to a further embodiment of the unit connector, it is provided that the holding element has at least one holding surface, pointing at least partially counter to the direction of insertion, for holding the abutment.

The holding surface can be designed according to the respective requirements in order to transmit forces acting essentially parallel to the direction of insertion. The configuration of the holding surface can be optimized for the respective base body or the respective abutment.

[0059]

According to a further embodiment of the unit connector, it is provided that the abutment holding section is provided with at least one holding thread for positive and non-positive interaction with the holding element.

The holding element can thus be simply screwed onto the unit connector at the holding thread. The retaining element is equipped with a corresponding thread that is designed to be complementary to the retaining thread. This makes it possible to provide a large number of largely freely variable selectable and adjustable holding positions. Once the unitary connector is properly inserted into the base body, the abutment can be easily fixed in the desired position on the base body using the retaining element by screwing the retaining element onto the retaining thread of the unitary connector with an appropriate torque. Manufacturing and assembly tolerances occurring in particular in the area of the base section or the connection between the base body and the unit connector can thus advantageously also be compensated for and a connection that is as flush, stable and sealed as possible between the abutment and the base body can be produced. According to a further embodiment, the holding element is designed like a sleeve with an essentially cylindrical outer contour.

The unit connector can be connected to the abutment in a simple and effective manner via a sleeve of this type for a form-fitting, sealed connection of the abutment and the base body. In an advantageous embodiment, the sleeve is pushed over the abutment holding section so that it engages and, when engaging, presses the abutment against the base body in a form-fitting and sealing manner. In this context, the person skilled in the art understands sliding not only to be a transversal accompanying movement, but also, in general, to be positioned, with one component being accommodated in or on another. Shifting can therefore also include screwing or represent a combination of transversal sliding movement and screwing if the sleeve, for example, is first placed on the abutment holding section and screwed into a holding thread provided thereon after engaging.

[0060]

As a rule, the sleeve can be inserted into a sleeve receiving area of the bore of the abutment and is designed to be flush with it.

In one embodiment, a length of the sleeve measured essentially parallel to the direction of insertion is at least 50%, preferably at least 75%, particularly preferably at least 85% of the length of a sleeve receiving area of the through hole of the abutment, also measured essentially parallel to the direction of insertion. In an alternative embodiment, the sleeve can also be made longer than the sleeve receiving

area of the through hole of the abutment. The sleeve then sticks out over the abutment, which creates additional stability.

[0061]

According to a further embodiment, at least one additional holding element is provided which encompasses the abutment holding section and is designed to interact with the abutment holding section in order to hold the abutment.

The additional holding element can be used to lengthen the holding element or its effective area or to stabilize or counter it. In particular, the additional holding element can perform support functions in addition to the holding element. The additional holding element thus helps to use the unitary connector even more flexibly in connection with different base bodies and/or abutments. An additional holding element is available for configurations with abutments that have a bore with a holding element or Have sleeve receiving area, which is much longer (z. g. more than twice as long) than the holding element, has the advantage that after inserting the holding element, the remaining space between the abutment holding section and the inner wall of the holding element or Sleeve receiving area of the bore of the abutment can be occupied by the additional holding element. As a result, the stability of the dental implant can be increased since the support surface between the abutment and the unit connector is enlarged.

[0062]

According to a further embodiment, it is provided that the holding element and/or the additional holding element is/are provided as a type of round nut with an internal thread.

The inner thread is designed in each case to complement the thread formed on the abutment holding section. Thus, the holding element and additional holding element can be easily screwed onto the abutment holding section.

[0063]

According to a further embodiment it is provided that the holding element and/or the additional holding element has an engagement means on which a tool for actuating the holding element and/or the additional holding element can be supported.

In particular, the engagement means can be designed to be complementary to a counter-engagement means of a special tool, with which holding element or Additional holding element can be actuated. In the case of a holding element that can be screwed onto the abutment holding section or additional holding element, the engagement means is designed in such a way that a torque for screwing on the holding element or Additional holding element can be transferred to this. In one embodiment, engagement means can be located at one end of the holding element or Additional retaining element, preferably be axially symmetrically arranged and formed grooves.

[0064]

According to an additional embodiment, it is provided that a length of the unitary connector, measured essentially parallel to the direction of insertion, can be changed.

This offers the advantage that the unit connector can be shortened or lengthened in the case of dental implants of different sizes with a length that is too large or too small for the unit connector. According to a further embodiment, it is provided that the unit connector is designed so that it can be cut to length at predetermined cutting markings, depending on the size of the dental implant. The cutting marks allow the unit connector to be precisely cut to the desired length before, during or after its insertion. In particular, this offers the advantage that the unit connector can be adapted for small dental implants, for which the base body is short, by shortening the length of the unit connector. The base section and/or the abutment holding section is preferably of sufficient length so that after the unit connector has been shortened, the base section and/or the abutment holding section still have a sufficient length to ensure a connection to the base body and/or an operative connection to the abutment.

[0065]

According to a further embodiment, it is provided that the cutting marks are formed as predetermined breaking points.

The predetermined breaking points simplify precise cutting to length of the unit connector and prevent unwanted damage when cutting to length. In configurations in which the base section and/or the abutment holding section have a thread, the thread advantageously extends over such a sufficient length along the direction of insertion that, even after a shortening, a sufficient threaded piece remains to establish a connection with the base body and/or with secure the abutment. In a particularly advantageous embodiment, the abutment holding section is longer than the base section. If the unit connector is then cut to length in the area of the abutment holding section, the base section and base body remain unaffected.

[0066]

According to a further embodiment it is provided that the abutment holding section and/or the base section is designed such that it can be brought into engagement with a connector extension, preferably in the form of a bolt extension or screw extension.

Preferably, a bolt extension or screw extension can be provided for lengthening, which has an outer diameter that matches the outer diameter of the unit connector, so that there are no changes with regard to the guidance of the abutment and/or a holding element and the radial positioning of the unit connector in the through hole of the abutment result. In configurations with an external thread in the base section and a holding thread in the abutment holding section, the connector extension offers the advantage that the unitary connector can be flexibly extended at both ends as required. In configurations with a cylindrical shank section, the outside diameter of the round nut is advantageously

equal to the outside diameter of the shank section, so that a smooth transition between the shank section and the connector extension is made possible. In addition, the unit connector can be adjusted or lengthened in the case of large dental implants with a length that would otherwise be too great for the unit connector.

The bolt extension or screw extension preferably has an outer diameter which corresponds to the outer diameter of the unit connector, so that there are no changes with regard to the guidance of the unit connector and the radial positioning in the bore of the base body.

[0067]

According to a further embodiment, a unitary connector according to the invention together with any holding and/or extension elements can be designed to be reversible, so that the function of the base and abutment holding section can be interchanged as desired according to the respective requirements.

The dimensions of the base and abutment holding section can thus be based on different types of base bodies or Abutments be matched that, for example, for certain sizes and types of the base body of the base section and used in other sizes and types of the abutment holding section and thus becomes the base holding section, while this then fulfills the function of the abutment holding section. Such a turning function allows the variability of the unit connector to be increased.

[0068]

In the unitary connection system according to the invention, the solution according to the invention can be further improved in that the unitary connection system further comprises at least one base body that can be inserted into a jawbone and/or at least one abutment holding section, which are designed to interact with the unitary connector.

A base body that can be inserted into a jawbone, an abutment that can be positively connected to the base body, and a unit connector according to the present disclosure make it possible to provide series of dental implants that can be used flexibly in a particularly cost-effective manner and that include components that can be combined with one another in a modular manner. According to a further embodiment of a unitary connection system according to the invention, it is provided that the base body has a borehole for receiving the unitary connector or that the abutment has a through borehole running essentially parallel to the direction of insertion, in which at least one shoulder is arranged, which has a stop pointing counter to the direction of insertion forms for the unit connector. The abutment therefore generally has a continuous bore and on the inside of the bore a shoulder, for example in the form of a step, via which the abutment can be pressed against the base body in a sealing manner.

[0069]

According to a further embodiment, it is provided that the bore of the base body in a half of the base body facing away from the abutment has an internal thread that can be brought into engagement with the base section.

Thus, the unit connector can be easily screwed into the base body. The arrangement of the internal thread in the half of the base body facing away from the abutment makes it possible, with simultaneous lateral support of the unit connector in sections of the base body lying above the internal thread, to have tensile or compressive forces on the internal thread essentially only running parallel to the direction of insertion, which increases the risk of damage , such as fractures or cracks, are avoided in the area of the internal thread, which can occur in particular when threads and unfavorable introduction of force lead to undesirable notch effects.

[0070]

In other words, arranging the internal thread in the half of the base body facing away from the abutment offers the advantage that the forces occurring on the internal thread can be conducted into the lower area of the base body and can therefore be kept away from the contact area with the abutment.

This advantageously means that tensile and shearing stresses in the contact area between the abutment and the base body, in particular on the bearing surfaces, can be essentially avoided. Advantageously, mainly compressive stresses remain in the contact area, which is particularly advantageous for ceramic components, since the ceramic material is stable under compressive force, but tends to be unstable under tensile force. This arrangement therefore offers the advantage that the stability and thus the long-term success of the dental implant can be increased. According to a further embodiment, it is provided that a largest outer diameter of the unit connector is matched to a smallest inner diameter of the bore of the base body, at least in a lower half of the unit connector, such that the unit connector is guided in the base body essentially without play when it is inserted into the bore. The play-free guidance helps simplify the installation of the unit connector and increase the long-term stability of the entire implant.

[0071]

According to a further embodiment, it is provided that a smallest inner diameter of the through hole of the abutment is matched to a largest outer diameter of the holding element and/or the additional holding element such that the holding element and/or the additional holding element are or is guided in the abutment essentially without play.

The bore of the abutment preferably has a lower area facing the base body with a smaller diameter than the diameter of an upper area of the bore of the abutment facing away from the base body, which forms a receiving area for the holding element and/or the additional holding element, the two areas being connected via the Graduation adjoin one another in such a way that the abutment can be pressed in a form-fitting, sealing manner into the base body by striking the sleeve against the gradation in the axial direction of the dental implant. In configurations of the abutment with a gradation, the length of the sleeve is preferably at least 50%, particularly preferably at least 75%, very particularly preferably at least 85% of the length of the upper area or the sleeve receiving area of the bore of the abutment.

[0072]

According to a further embodiment, it is provided that the bore in the base body is configured as a continuous bore and has a cap at the lower end which at least partially covers the bore and which can be engaged with a part of the base section of the unit connector and when inserting the unit connector from the The base body is designed to be separable in such a way that when the base body and unit connector are fully inserted into the jawbone, the lower end of the unit connector presses the cap into the jawbone.

With the cap that can be separated from the base body, the flexibility of the dental implant can advantageously be further increased. If the unit connector is too long in relation to the base body, the unit connector can be inserted or screwed into the base body (in configurations with a first thread in the first end region) until the unit connector strikes the cap, finally separating the cap from the base body and presses further into the jawbone. The stability of the anchoring of the dental implant can advantageously be increased with the cap pressed further into the jawbone. Advantageously, the additional surface created by the separate cap can help increase the degree of osseointegration.

[0073]

Alternatively, the bore of the base body is designed as a blind hole.

The length of the blind hole is preferably at least 80%, particularly preferably at least 90%, of the total length of the base body. This offers the advantage that the entire length of the base body for absorbing forces such. B. screw forces, in the connection of the unit connector can be used with the base body.

[0074]

According to a further embodiment, a gap is formed between a largest outer diameter of the holding element and/or the additional holding element and the smallest inner diameter of the through hole of the abutment, the width of which is preferably between 0.001 mm and 0.1 mm.

The gap serves to provide sufficient play in the radial direction between the sleeve and the abutment so that overdetermination can be avoided. However, the play is advantageously small enough for the sleeve to be able to increase the stability in that the abutment can be supported on the sleeve when transverse forces occur.

[0075]

In one embodiment, the base body is made of ceramic, preferably zirconium oxide or is based on zirconium oxide.

In one embodiment, the abutment is made of ceramic, preferably made of zirconium oxide or based on zirconium oxide. The base body and/or the abutment are preferably manufactured from ceramics by powder injection molding processes in configurations. This offers the advantage of cost-effective production. The ceramic material offers the advantage of high biocompatibility and a high degree of

osseointegration. In addition, the ceramic material offers a cosmetic advantage compared to titanium in the case of receding gums, which often occurs with dental implants. In configurations of the base body made of ceramic and with an internal thread, the internal thread is preferably designed as a round thread. In an advantageous variant, the first end area of the unitary connector has a trapezoidal thread in these configurations. This offers the advantage that the thread turns of the internal thread can be protected when screwing in the unit connector. In comparison to pointed threads, which can cut into the internal thread and thus damage the ceramic material, such a unit connector with a trapezoidal thread can therefore increase the long-term success of the dental implant.

[0076]

In one embodiment, the unitary connector is made of metal, preferably stainless steel and/or titanium.

[0077]

In one embodiment, the largest transverse diameter of the unit connector in the lower half of the unit connector corresponds to the largest transverse diameter of the bore of the base body in such a way that the unit connector can be guided into the bore when receiving it.

[0078]

Optionally, there is a clearance between the portion of the unit connector that is in the base body after insertion and the inner wall of the bore of the base body, so that damage due to friction when the unit connector is inserted into the base body can be minimized.

However, the play is advantageously so small that reliable guidance or

centering of the unitary connector is provided.

[0079]

In one embodiment, a transverse diameter of the unit connector corresponds to the smallest transverse diameter of the bore of the abutment in such a way that the abutment can be guided through the unit connector when it is inserted onto the base body.

[0080]

The unit connector therefore offers the advantage that the abutment can be guided or centered when positioning on the base body.

There is preferably a clearance between the unit connector and the inner wall of the bore of the abutment, so that damage due to friction can be minimized when the abutment is positioned on the base body.

However, the play is advantageously so small that reliable guidance or

centering of the abutment is provided. In one embodiment, the largest transverse diameter of the bore of the abutment corresponds to the transverse diameter of the sleeve in such a way that the abutment can be supported on the sleeve in the transverse direction.

[0081]

In configurations with a stepped bore of the abutment and a unit connector with a cylindrical shaft and a sleeve, the smaller diameter of the bore in the lower area of the abutment facing the base body advantageously corresponds to the outside diameter of the cylindrical shaft of the unit connector.

The larger diameter of the bore in the upper area of the abutment facing away from the base body, which forms the sleeve receiving area, advantageously corresponds to the outer diameter of the sleeve, so that the abutment can be supported on the sleeve and the stability of the dental implant can be increased in the event of transverse forces occurring. In the lower area of the bore of the abutment, the abutment can advantageously be supported on the cylindrical shaft or partially on the second end area of the unit connector when transverse forces occur.

[0082]

In one embodiment, the abutment has an extension and the base body has a recess, the extension being able to be inserted into the recess.

A twist-proof form fit is preferably provided by the extension of the abutment and the recess of the base body. In one variant, the anti-twist form fit is provided by a radially non-uniform structure of the extension (i.e. in the tangential direction). In a further variant, the extension has radial projections, which form contact surfaces pointing in the tangential direction and can engage in radial grooves of the recess of the base body.

[0083]

character description

[0084]

The invention is to be explained in more detail below using exemplary embodiments in connection with the figures and the associated description.

Show it:

[0085]

1 shows a sectional illustration of a first embodiment of a unitary connector according to the invention; a sectional view of a second embodiment of a unitary connector according to the invention; a sectional view of a dental implant with a first embodiment of a unitary connection system according to the invention; a sectional view of a dental implant with a second embodiment of a unitary connection system according to the invention; a sectional view of the dental implant shown in FIG. 3 along the section line A-A drawn in FIG. 3; a schematic exploded view of a further embodiment of a dental implant according to the invention; a schematic cross-sectional view along a longitudinal axis of the dental implant shown in FIG. 6 in a pre-assembly state; a schematic cross-sectional view along the longitudinal axis of the in Figs. 6 and 7 shown dental implant in a final assembly state; a schematic exploded view of an additional embodiment of a dental implant according to the invention; a detail IX of the dental implant shown in Figure 9; a schematic cross-sectional view along a longitudinal axis of the dental implant shown in Figures 9 and 10 in a pre-assembly state; a detail XI of the one shown in Figs. 9 to 11 shown dental implant; and a schematic cross-sectional view along the longitudinal axis of the in Figs. 9 to 12 shown dental implant in a final assembly state.

implementation of the invention

[0086]

In the following, the invention is described in more detail by way of example on the basis of possible embodiments with reference to the accompanying drawings.

The feature combinations shown in these embodiments are for illustrative purposes only.

Depending on the advantages described above, individual features can also be omitted if the advantage of the respective feature is not important in certain applications. In the description of the embodiments, the same features and elements are provided with the same reference symbols for the sake of simplicity. In different embodiments, features and elements with the same or similar function can be provided with one or more apostrophes in order to assign them to an embodiment for the sake of illustration, whereby this assignment is not to be construed as limiting to the respective embodiment.

[0087]

FIG. 1 shows a sectional illustration of a first embodiment of a unitary connector 1 according to the invention.

The unit connector 1 has a base section 11 with a first external thread 111 and an abutment holding section 12 with a holding thread 121 . Between the sections 11, 12, the unit connector has a cylindrical shank section 13, so that the unit connector 1 has the shape of a stud with a central axis Mi, along which the unit connector 1 is to be inserted or screwed in an insertion direction I.

[0088]

The unit connector 1 has an overall length measured parallel to the insertion direction I.

The base section 1 1 and the external thread 1 1 1 have a length l_n or Lm, which are 0.2 to 0.3 times, preferably 0.25 times, corresponding to a quarter of the total length U. The abutment holding section 12 and the holding thread 121 have a length L12 or Ln2 which are 0.3 to 0.6 times, preferably 0.4 to 0.5 times, most preferably 0.416 times corresponding to five twelfths of the total length Li. The shaft section 13 has a length Li3 measured parallel to the insertion direction I, which is 0.3 to 0.4 times, preferably 0.333 times, corresponding to one third of the total length Li. The unit connector 1 is made of, for example, stainless steel, titanium and/or ceramics. In certain embodiments, it may be particularly advantageous to fabricate the unitary connector from stainless steel and/or titanium, particularly when received within an otherwise ceramic implant hermetically sealed from the jaw and gums, so that the issue of biocompatibility for the unitary connector 1 itself of rather secondary importance and may be subordinate to an optimization of its mechanical properties.

[0089]

Figure 2 shows a sectional view of a second embodiment of a unit connector 1 'with a base portion 1 1' and a first external thread 1 1 1 'and an abutment holding portion 12' and a holding thread 121 '.

A bolt extension 14' is attached in a suitable manner to the base section 11'. For example, the bolt extension 14' can be connected to the base section 11' by means of a screw connection in a recess on the central axis of the base section 11' or by means of an adhesive connection on its end face. The bolt extension 14' has an extension thread 141 which can be brought into engagement with an internal thread of a base body of a dental implant. The unit connector 1' can be lengthened by means of the bolt extension 14' and can therefore be used for long dental implants. Alternatively or additionally, the bolt extension 14' can also be attached to the abutment holding section 12' in an analogous manner in order to lengthen it.

[0090]

Similar to the unit connector 1, the unit connector 1' has a total length Lr measured parallel to the direction of insertion I, which can be, for example, a sum of the total length Li of the unit connector 1 plus a length Li4* of the bolt extension 14' measured parallel to the direction of insertion I.

The base section 1 1 'and the external thread 1 1 1' have a length measured parallel to the insertion direction I Lir and Luv, which are also 0.2 to 0.3 times, preferably 0.25 times, corresponding to a quarter of the total length Li. The abutment holding section 12' and the holding thread 121' have a length Li2* or lm; which are 0.3 to 0.6 times, preferably 0.4 to 0.5 times, most preferably 0.416 times, corresponding to five twelfths of the total length Li. The shaft section 13' has a length Li3', measured parallel to the insertion direction I, which is 0.3 to 0.4 times, preferably 0.333 times, corresponding to one third of the total length Li. With the help of the bolt extension 14', the above-mentioned length ratios derived from the unit connector 1' between the individual sections of the unit connector 1' in relation to its overall length l_r can be shifted or adjusted according to the respective requirements.

The shift or Adaptation of the length ratios results from the length Li4* of the bolt extension 14', the overall length Li of the unit connector 1 representing a type of basic length which can be varied using different types of bolt extension 14'.

[0091]

In the present exemplary embodiment of the unit connector 1' with bolt extension 14', the length Li4* is 0.3 to 0.4 times, preferably 0.333 times, corresponding to one third of the total length Li.

The length of the extension thread can thus in turn correspond to the length Lu v of the external thread. The unit connector 1 or 1' can thus be incrementally lengthened or optionally shortened by bolt extensions 14' by a factor of 0.3 to 0.4, preferably 0.333 times, corresponding to a third of the total length Li, if it was originally provided with at least one bolt extension 14' and is designed to be cut to length by removing the at least one bolt extension 14'.

[0092]

FIG. 3 shows a sectional illustration of a dental implant 100 with a first embodiment of a unitary connection system according to the invention.

The dental implant 100 comprises a base body 130, an abutment 120 and a tooth structure 110. The insertion direction I of the dental implant 100 is shown with an arrow. The base body 130 and the abutment 120 are preferably made of a ceramic material. The base body 130 has an external thread 133 in the form of a round thread. Furthermore, the base body 130 has a bore 131 in the form of a blind hole, the bore 131 having an internal thread 132 in the lower half of the base body 130 facing away from the abutment 120 . In order to clarify the information "above" or "below", the coordinate system is drawn in the figure. The female thread 132 is engaged with a first male thread 1 1 1" in the base portion 1 1" of a unitary connector 1" inserted into the bore 131.

[0093]

The length Lm of the first external thread 111" is slightly less than a length L132 of the internal thread 132 measured parallel to the insertion direction I.

The internal thread 132 is designed as a round thread. The diameter of the bore 131 corresponds to the diameter of the unit connector 1", so that the unit connector 1" is guided when it is inserted into the base body 130. The abutment 120 has a through hole 1200 with an upper area 1201 and a lower area 1202 , the diameter of the through hole 1200 in the upper area 1201 being larger than the diameter of the through hole 1200 in the lower area 1202 . The upper portion 1201 abuts the lower portion 1202 via a shoulder 1203 .

[0094]

The diameter of the through hole 1200 in the lower area 1202 corresponds to the diameter of the cylindrical shaft section of the unit connector 1", so that the abutment 120 is guided through the cylindrical shaft section 13" of the unit connector 1" when placed on the base body 130.

The length 3 of the cylindrical shaft section 13" is advantageously dimensioned such that it optimally supports both the abutment 120 and the base body laterally and absorbs and releases any transverse and/or shearing forces as far as possible from the base section 11" and abutment holding section 12".

[0095]

A holding element 15 is inserted into the through hole 1200 in the upper region 1201 and is engaged with the holding thread 121" in the abutment holding section 12" of the unit connector 1" or is screwed on via an internal thread 152 of the holding element 15.

The abutment holding section 12" has a length L12. The holding element 15 is also made of stainless steel, titanium and/or ceramics. The outer diameter of the holding element 15 corresponds to the diameter of the upper area 1201 of the through hole 1200 of the abutment 120, which forms the sleeve receiving area, so that the abutment 120 can bear against the holding element 15 when transverse forces occur, which increases the stability of the dental implant 100. There is a gap between the lateral outer surface of the holding element 15 and the lateral inner surface of the upper region 1201 of the through hole 1200, which ensures play. The retaining element 15 has engagement means 151 in the form of notches which can be engaged with a suitable key (not shown).

[0096]

With the right tool or

Key, the holding element 15 can be screwed onto the abutment holding section 121 "of the unit connector 1" by means of the engagement means 151. The retaining member 15 has an internal thread 152 which is engaged with the retaining thread 121" of the unit connector 1". By screwing on the holding element 15, an operative connection is established between the unit connector 1" and the abutment 120 in such a way that the abutment 120 is pressed by the holding element 15 over the shoulder 1203 onto the base body 130, thus creating a sealed form-fitting connection between the abutment 120 and the base body 130 is produced. When the holding element 15 is screwed on, the contact surface 125 of the abutment 120 rests on the contact surface 134 of the base body 130 .

[0097]

The abutment 120 also has an extension 124a,b, which is accommodated in a form-fitting receptacle 135 in the form of a depression in the base body 130.

The extension 124a,b is designed asymmetrically in the radial direction, so that a non-rotating form fit is ensured. In cross section (in the y-direction) the extension 124a,b has projections which are shown in cross section in FIG. It can be seen in FIG. 3 or 4 that the abutment holding section 12" of the unit

connector 1″ projects beyond the abutment 120. Before putting on the tooth structure 110, the unit connector 1" can be cut to length in the abutment holding section 12" if the overhang should be too large. Alternatively or in addition, a recess 1101 in the tooth structure 110, as shown in the figure, can be used, which accommodates the overhang of the abutment holding section 12".

[0098]

FIG. 4 shows a second embodiment of a dental implant 100' according to the invention.

In contrast to the dental implant 100 shown in FIG. 3, the dental implant 100' has an abutment 120', the length of which, measured parallel to the direction of insertion I, is greater than the length of the abutment 120, measured parallel to the direction of insertion I. Accordingly, an upper end of a unit connector 1″ of the dental implant 100′ protrudes less out of the through hole 1200′ over the upper edge of the abutment 120′ than in the dental implant 100.

[0099]

The dental implant 100' is provided with an additional holding element 16.

The additional retaining element 16 is screwed onto the retaining thread 121" of the unit connector 1" adjacent to the retaining element 15'. The auxiliary holding member 16 has an internal thread which is engaged with the holding thread 121'' of the unit connector 1''. The additional holding element 16 has engagement means 161, by means of which the additional holding element 16 can be screwed onto the holding thread 121″. The additional support element 16 increases the stability of the dental implant 100' since the area over which the abutment 120' can be supported is increased. The length of the holding element 15' and the length of the additional holding element 16 almost corresponds to the length of the upper region 1201' of the through hole 1200'. In this way, the abutment 120′ can rest laterally both on the preferably sleeve-shaped holding element 15′ and on the likewise preferably sleeve-shaped additional holding element 16 when transverse forces are acting on the dental implant 100′.

[0100]

The double arrow F is shown in FIG. 4 as an illustration, which is intended to represent transverse forces that occur.

The forces F can lead to torques which, without retaining elements or with short retaining elements, would essentially be concentrated on the lower area of the through hole 1200' of the abutment 120'. Long holding elements 15′ or additional holding elements 16 enable lateral support of the abutment 120′ in the event of transverse forces F, so that the torques that occur can be distributed and absorbed essentially along the entire length of the through hole 1200′.

[0101]

FIG. 5 shows the dental implant 100 shown in FIG. 3 in a schematic cross-sectional view along the section line A-A drawn in FIG.

Projection-like positive elements 126 are formed on the outside of the extension 124a, b and extend radially away from the extension 124a, b and run parallel to the insertion direction I. The receptacle 135 is provided with negative elements 136, which also run parallel to the insertion direction I and are designed to be complementary to the positive elements 126.

[0102]

The positive elements 126 interact in a form-fitting manner with the negative elements 136 in such a way that, in the assembled state, relative movements, in particular rotary movements, of the abutment 120 in relation to the base body 130 are prevented.

At the same time, positive elements 126 and negative elements 136 together define a circular grid of rotational positions along which a rotational alignment of abutment 120 and base body 130 relative to one another can be freely selected in incremental steps before they are assembled. Depending on the nature of the retaining threads 121, 121' as such and due to their variable positionability along the direction of insertion I thanks to the described ability to lengthen and/or shorten, unit connectors 1, 1' according to the invention provide a large number of retaining positions for the abutment 120 spaced apart from one another along the direction of insertion I , 120' ready.

[0103]

Fig. 6 shows a schematic exploded view of a further embodiment of a dental implant 200 according to the invention.

The dental implant 200 comprises a connector 2 preferably made of a metal or a metal alloy, such as titanium or a titanium alloy, a prosthesis 220 preferably made of ceramic, such as zirconium oxide, here for example in the form of a head of a healing screw, and a preferably also made of ceramic , such as zirconium oxide, manufactured base body 230. Connector 2, prosthesis 220 and base body 230 are arranged concentrically to a central axis M of the dental implant 200 running parallel to the insertion direction I.

[0104]

The connector 2 has a base portion 21, a holding portion 22 and a shank portion 23.

A base thread 21 1 is formed on the base section 21 and is designed to be screwed into the base body 230 in the direction of insertion I. As with the abutment holding section 12, 12', 12'', a holding thread 221 is formed around the holding section 22 (see Fig. Figures 1 to 3). The retaining thread 221 is designed to be screwed into the prosthesis 220 counter to the insertion direction I and to interact with the retaining element 15, 15' (see Fig. Characters. 3 and 4). The shank section 23 is cylindrical and arranged rotationally symmetrically to the central axis and, thanks to its cylindrical outer peripheral

surface, offers a support surface 27 which points in a radial direction R of the connector 2 running radially away from the central axis M.

[0105]

An annular collar 28 of the connector 2 is also configured cylindrically and is arranged rotationally symmetrically to the central axis M lying between the holding section 22 and the shaft section 23 .

A diameter of the annular collar 28 measured parallel to the radial direction R is greater than a diameter of the shank section 23 also measured parallel to the radial direction R. The annular collar 28 thus protrudes beyond the shank section 23 in the radial direction R and forms a shoulder element 28a pointing in the insertion direction I and a shoulder element 28b pointing counter to the insertion direction I.

[0106]

Furthermore, the connector 2 is provided with annular grooves 29, each between the base section 21 and

Base thread 21 1 and shank section 23, between shank section 23 and annular collar 28 and between annular collar 28 and holding section 22 or Holding threads 221 are arranged. The connector 2 is tapered or constricted at the annular grooves 29, so that a diameter of the connector 2 measured parallel to the radial direction R, at least at the bottom of the annular grooves 29, is smaller than the corresponding diameter of the sections of the connector 2 adjoining the annular grooves 29.

[0107]

Furthermore, an upper end section of the connector 2 running away from the holding section 22 counter to the insertion direction I is formed as an engagement means 251, on which a torque acting about the central axis M can be transmitted to the connector 2 with a tool (not shown).

A diameter of the engagement means 251 measured parallel to the radial direction R is smaller than a diameter of the retaining thread 221 measured in the radial direction R. In the present example, the engagement means 251 has an outer contour on its outer circumference, which is designed as a hexagon in the present exemplary embodiment.

[0108]

The prosthesis 220 is designed, for example, rotationally symmetrically to the central axis M and has an extension 224, a contact surface 225, a truncated cone-shaped transition section 227, a head part 228 and an engagement element 229.

Alternatively, the prosthesis 220 can also be configured asymmetrically to the central axis M. The extension has a diameter measured parallel to the radial direction R, which is smaller than the diameter of the transition section 227, also measured parallel to the radial direction R, whereby between the extension 224 and the transition section

[0109]

227

the contact surface 225 pointing in the insertion direction I is formed. That in the headboard

[0110]

228

The molded engagement element 229 is designed, for example, as a hexagon socket or, as in the present case, as a hexalobular socket and allows a torque acting about the central axis M to be transmitted to the prosthesis 220 with the aid of a tool (not shown). Like the base body 130, the base body 230 has a bore 231 in which an internal thread 232 (see Fig. Fig. 7) is formed. Like the base body 130 , the base body 230 is provided with an external thread 233 on the outer circumference. Also formed on the base body 230 as on the base body 130 is a contact surface 234 pointing counter to the direction of insertion I, which surrounds the bore 231 or its opening. An upper part of the bore 231 serves as a receptacle 235 for the extension 224 of the prosthesis 220.

[0111]

Fig. 7 shows a schematic cross-sectional view along the central axis M of the dental implant 200 in a pre-assembly state V. In the pre-assembly state V, the connector 2 is inserted into the base body 230, the base section 21 with the base thread 21 1 being arranged in a lower region of the bore 231 , where the internal thread 232 is formed in this.

The shaft section 23 of the connector 2 is arranged above the internal thread 232 of the base body 230 . Between the support surface 27 of the shank section 23 and the inner circumference of the part of the bore 231 surrounding the shank section 23, there is as little play as possible, preferably hardly any or no play at all, for example in that the shank section 23 and the bore 231 are designed with a clearance fit or transition fit in this area. Thus, the shank section 23 preferably supports the connector 2 in the bore 231 above the internal thread 232 all around, which helps to keep lateral forces acting in the radial direction R and bending moments away from the internal thread 232, so that normal forces essentially only acting in the direction of the central axis M occur there .

[0112]

The annular collar 28 or the shoulder element 28a provided by it rests on a counter-shoulder element 236 which is formed in the bore 231 .

The counter-shoulder element 236 is formed between the lower part of the bore 231 and the seat 235 and delimits the seat 235 in the insertion direction I. In other words, a diameter of the lower part of the bore 231 measured parallel to the radial direction R is smaller than one parallel to the radial direction R measured diameter of the mount 235. The holding section 22 with the holding thread 221 is arranged completely within the receptacle 235 . The engagement means 251 projects beyond the contact surface 234 out of the receptacle 235 counter to the insertion direction I and thus projects from the dental implant 200 in the pre-assembly state V, so that the engagement means 251 is arranged so that it is easily accessible for a tool. Fig. 8 shows a schematic cross-sectional view along the central axis of the dental implant 200 in a final assembly state E. The dental implant 200 can be transferred from the pre-assembly state V to the final assembly state E by screwing the prosthesis 220 onto the connector 2 in the insertion direction I.

For this purpose, the prosthesis 220 is analogous to the bore 231 of the base body 230 with a blind hole-like recess 2101 arranged concentrically to the central axis M. In a lower part of the recess 2101 , which extends essentially in the insertion direction I along the extension 224 , the recess 2101 is provided with a counter-retaining thread 2102 which is in engagement with the retaining thread 221 . The engagement means 251 is accommodated in the recess 2101 with a certain radial play relative to the recess 2101 and is enclosed therein by the head part 228 .

[0113]

In the final assembly state E, the contact surface 225 of the prosthesis 2 rests flush and sealingly on the contact surface 234 of the base body 230 .

Consequently, the receptacle 235 is hermetically sealed. It can thus be ensured that the connector 2 does not come into contact with the gums or is shielded from the entire oral cavity. The extension 224 protrudes into the receptacle 235 in the direction of insertion I, with the smallest possible to preferably hardly any or no play being present between an outer circumference of the extension 224 and an inner circumference of the receptacle 235, for example in the extension 224 and receptacle 235 in this area with a Clearance fit or transition fit are designed. In the radial direction R, a wall of the base body 230 that forms the receptacle 235 overlaps with the prosthesis 220 and the connector 2, as a result of which they form a compact and highly stable assembly. An end face 240 on the extension of the prosthesis 220 pointing in the direction of insertion I is formed on the extension 224 and arranged at a distance from the shoulder element 28b in the direction of insertion I.

[0114]

Fig. 9 shows a schematic exploded view of an additional embodiment of a dental implant 300 according to the invention.

Like the dental implant 200, the dental implant 300 comprises a connector 3 preferably made of a metal or a metal alloy, such as titanium or a titanium alloy, a prosthesis 320 preferably made of ceramic, such

as zirconium oxide, here also for example in the form of a head of a healing screw, and a base body 330, preferably also made of ceramic, such as zirconium oxide, which is shaped identically to base body 230 in the present example. Connector 3, prosthesis 320 and base body 330 are arranged concentrically to the central axis M of the dental implant 300. In the following, for the sake of brevity, the differences between the dental implant 300 and the dental implant 200 will mainly be discussed.

[0115]

The connector 3 has a base portion 31, a holding portion 32 and a shank portion 33.

A base thread 31 1 is formed on the base section 31 and is designed to be screwed into the base body 330 in the insertion direction I. As in the case of the abutment holding section 12, 12', 12'', 22, a holding thread 321 is formed on the holding section 32. The retaining thread 321 is designed to be screwed into the prosthesis 320 counter to the insertion direction I and to interact with the retaining element 15, 15' (see Fig. Characters. 3 and 4). The shaft section 33 is cylindrical and arranged rotationally symmetrically to the central axis M and thus offers a support surface 37 due to its cylindrical outer peripheral surface.

[0116]

An annular collar 38 of the connector 3 is arranged between the holding section 32 and the shaft section 33 lying rotationally symmetrically to the central axis M and is formed at least in sections as an engagement means 351 .

Similar to the engagement means 251 of the connector 2, the engagement means 351 has an outer contour which is designed to interact with a tool in order to transmit a torque to the connector 3 with the aid of the tool. The engagement means 351 is preferably designed as an external hexagon. A diameter of annular collar 38, including engagement means 351, measured parallel to radial direction R is larger than a diameter of shaft section 33, also measured parallel to radial direction R. The annular collar 38 thus protrudes beyond the shank section 33 and therefore offers a shoulder element 38b pointing counter to the insertion direction I.

[0117]

Furthermore, the connector 3 is provided with annular grooves 39, each between the base section 31 and

Base thread 31 1 and shank section 33, between shank section 33 and annular collar 38 and between annular collar 38 and holding section 32 or Holding threads 321 are arranged. The connector 3 is tapered or constricted at the annular grooves 39, so that a diameter of the connector 3 measured parallel to the radial direction R at the bottom of the annular grooves 39 is smaller than a diameter of sections of the connector 3 adjoining the annular grooves 39. The prosthesis 320 is rotationally symmetrical to the central axis M and, like the prosthesis 220, has an extension 324, a contact surface 325, a transition section 327 in the shape of a truncated cone, a head part 328 and an engagement element 329 (see Fig.

1). The extension 324 has a diameter measured parallel to the radial direction R, which is smaller than the diameter of the transition section 327, also measured parallel to the radial direction R, whereby the contact surface 325 pointing in the insertion direction I is formed between the extension 324 and the transition section 327. The engagement element 329 formed in the head part 328 is designed, for example, as a hexagon socket or, as in the present case, as a hexalobular socket and allows a torque acting about the central axis M to be transmitted to the prosthesis 320 with the aid of a tool (not shown). In contrast to the prosthesis 220, the prosthesis 330 has a specially shaped end face 340, which will be discussed in detail further below.

[0118]

Like the base bodies 130 and 230, the base body 330 has a bore 331 in which an internal thread 332 (see Fig.

Fig. 13) is formed. Like the base bodies 130 and 230 , the base body 330 is provided with an external thread 333 on the outer circumference. Also formed on the base body 330 as on the base bodies 130 and 230 is a contact surface 334 pointing counter to the direction of insertion I, which surrounds the bore 331 . An upper part of the bore 331 serves as a receptacle 335 for the extension 324 of the prosthesis 320 (see Fig. 13).

[0119]

Fig. 10 shows a detail IX of the dental implant 300 shown in Fig. 9, in particular the end face 340 of the prosthesis 320.

The end face 340 forms an annular edge around a recess 3101 of the prosthesis 320 which is designed similarly to the recess 2101 of the prosthesis 220 and is provided with a retaining thread 3102 . A toothing 341 is formed on the end face 340 . The toothing 341 is formed from a multiplicity of teeth 342 which surround the recess 3101 like a ring.

[0120]

The teeth 342 protrude from the end face 340 in the insertion direction I, similar to a so-called Hirth toothing.

Tooth tips 343 of the teeth 342 form edges running essentially parallel to the radial direction R. The teeth 342 are inclined counter to a screwing direction S of the prosthesis 320 running clockwise around the central axis in a projection along the direction of insertion I. Due to the inclination, the teeth 342 each have a flat tooth flank 344 pointing in the screwing direction S and a steep tooth flank 345 pointing counter to the screwing direction S.

[0121]

Fig. 1 1 shows a schematic cross-sectional view along a central axis M of the dental implant 300 shown in Fig. 9 and 10 in a further pre-assembly state V. In the further pre-assembly state V, the prosthesis 320 with the counter-retaining thread 3102 formed in its recess 3101 is in the direction of insertion I on the Retaining thread 321 of the retaining portion 32 of the connector 3 is screwed.

The face 340 of the prosthesis 320 is brought into contact with the shoulder member 38b. A cavity 50 is formed in the area of the annular groove 39 arranged between the holding area 32 and the annular collar 38 . The cavity 50 can be at least partially filled with an adhesive 51, for example.

[0122]

Fig. 12 shows a detail XI in Figs. 9 to 11 shown dental implant 300.

It is clear here that the teeth 342 have displaced the material of the prosthesis 320 when screwing it onto the connector 3 and thus a form fit between the prosthesis 320 and the connector 3 is brought about. Due to the inclination of the teeth 342 against the screwing direction S, this form fit is particularly effective when torques about the central axis M act against the screwing direction S on the prosthesis 320 relative to the connector 3, so that there is an intimate connection between the prosthesis 320 and the connector 3.

[0123]

The flat tooth flanks 344 promote a relative movement between the prosthesis 320 and the connector 3 when the prosthesis 320 is screwed on when the end face 340 meets the shoulder element 38b.

The steep tooth flanks 345, which, for example, run essentially parallel to the direction of insertion I or can even have an undercut, prevent the screw connection between the prosthesis 320 and connector 3 from loosening by moving the prosthesis 320 counter to the screwing direction S relative to the connector when attempting to do so 3 to rotate in its material and thus inhibit the relative rotation or at best lock the prosthesis 320 and connector 3 against each other.

[0124]

The adhesive 51 promotes an intimate connection between the prosthesis 320 and the connector 3 and can, for example, be applied to the retaining thread 321 and/or counter-retaining thread 3102 and/or, as shown, be arranged in the cavity 50 .

Indentation 341 and/or adhesive 51 can thus be used according to the invention to connect the prosthesis 320 to the connector 3 with high strength or as inseparably as possible. Serration 341 and/or adhesive 51 thus help to form a hybrid implant screw 4 comprising at least one metallic component such as connector 3 and at least one ceramic component such as prosthetic 320 .

[0125]

Fig. 13 shows a schematic cross-sectional view along the longitudinal axis of the in Figs. 9 to 12 shown dental implant in a further final assembly state E '.

In the final assembly state E', the connector 3 and the prosthesis 320 are inserted into the base body 330 together or as a hybrid implant screw 4 . For insertion, the base section 31 with the base thread 31 1 of the connector 3 or the hybrid implant screw 4 is screwed into the internal thread 332 of the base body 330 using the engagement element 329 of the prosthesis for applying a tool (not shown). The shank section 33 of the connector 3 or of the hybrid implant screw 4 is accommodated in a section of the bore 331 arranged above the internal thread 332 .

[0126]

Between the support surface 37 of the shank section 33 and the inner circumference of the bore 331 there is as little as possible to preferably little or no play, for example by the shank section 33 and bore 331 being designed with a clearance fit or transition fit in this area.

Thus, the shaft section 33 supports the connector 3 in the bore 331 above the internal thread 332, which helps to keep lateral forces acting in the radial direction R and bending moments away from the internal thread 332, so that there essentially only normal forces acting in the direction along the central axis M occur.

[0127]

In the final assembly state E', the contact surface 325 of the prosthesis 320 lies flush and sealed on the contact surface 334 of the base body 330, as a result of which the receptacle 335 is hermetically sealed.

It can thus be ensured that the connector 3 does not come into contact with the gums or is shielded from the entire oral cavity. The extension 324 protrudes into the receptacle 335 in the direction of insertion I, with preferably little or preferably hardly any play between an outer circumference of the extension 324 and an inner circumference of the receptacle 335, for example in the extension 324 and receptacle 335 in this area with a Clearance fit or transition fit are designed. In the radial direction R, a wall of the base body 330 that forms the receptacle 335 overlaps with the prosthesis 320 and the connector 3, as a result of which they form a compact and highly stable assembly. Through the use of prosthesis 320 and connector 3 as a hybrid implant screw 4, the dental implant 300 can be handled like a two-part dental implant.

[0128]

Reference List

[0129]

I, V, 1", 2, 3 unit connector or connector 4 hybrid implant screw

[0130]

II, 11', 11", 21, 31 base section

[0131]

III, 111', 111", 211, 311 base thread / lower external thread

[0132]

12, 12', 12", 22, 32 abutment holding section/holding section 121, 121', 121", 221, 321 holding thread/upper external thread)

[0133]

13, 13', 13", 23, 33 shank section

[0134]

14' bolt extension

[0135]

141 extension thread

[0136]

100, 100', 200, 300 dental implant

[0137]

110 tooth structure

[0138]

1101, 2101, 3101 recess

[0139]

2102, 3102 counter thread

[0140]

120, 120', 220, 320 abutment / prosthetics

[0141]

1200, 1200' through hole

[0142]

1201, 1201' upper area of the through hole 1202 lower area of the through hole 1203 shoulder

[0143]

124a, b, 224 process

[0144]

125, 225 contact surface

[0145]

126 positive element

[0146]

130, 230, 330 base body

[0147]

131, 231, 331 drilling

[0148]

132, 232, 332 inner thread

[0149]

133, 233, 333 external thread

[0150]

134, 234, 334 contact surface

[0151]

135, 235, 335 admission

[0152]

236, 336 counter shoulder element

[0153]

136 negative element

[0154]

227, 327 transition section

[0155]

228, 328 headboard

[0156]

229, 329 engagement element

[0157]

240, 340 face

[0158]

341 gearing

[0159]

342 tooth

[0160]

343 tooth tips

[0161]

344 flat tooth flank 345 steep tooth flank

[0162]

15, 15' holding element

[0163]

151 , 151', 251, 351 engaging means

[0164]

152, 152' inner thread

[0165]

153 holding surface

[0166]

16 additional holding element

[0167]

161 means of intervention

[0168]

27, 37 support surface

[0169]

28, 38 ring collar

[0170]

28a, 28b, 38b shoulder element

[0171]

29, 39 ring groove

[0172]

50 cavity

[0173]

51 adhesive

[0174]

E final assembly state

[0175]

I direction of insertion

[0176]

L11 , Li r Length of base section

[0177]

Ll2, Ll2' length of the abutment holding section Ll3, Ll3' length of the shaft section Ll4" length of the bolt extension

[0178]

Ln i , Li i i- length of the first external thread

[0179]

Ll 12, Ll 12' length of the abutment holding section

[0180]

Ll32 length of internal thread

[0181]

Ll 41 length of extension thread

[0182]

M central axis

[0183]

s screw direction

[0184]

R radial direction

[0185]

V, V Pre-assembly condition

CLAIMS WO2018029651A1

1.

patent claims

1.

Implant screw (4) for an implant, in particular for a dental implant (100, 100', 200, 300),

with a ceramic head part (228, 328) and

with a non-ceramic base thread (111, 111', 111", 211, 311) which can be screwed into a base body (130, 230, 330) of the dental implant (100, 100', 200, 300).

2.

Implant screw (4) according to claim 1, characterized in that the

The head part (228, 328) is connected to the base thread (111, 111', 111", 211, 311) via a form fit for transmitting a torque acting about a central axis (M) of the implant screw (4).

3.

Implant screw (4) according to Claim 1 or 2, characterized in that the head part (228, 328) is provided with a recess (1101, 2101, 3101) in which a connector (1, 1', 1", 2nd , 3) on which the base thread (111, 111', 111", 211,311) is formed.

4.

Implant screw (4) according to claim 3, characterized in that in the

Recess (1101, 2101, 3101) a retaining thread (2102, 3102) for screwing the head part (228, 328) onto the connector (1, 1', 1", 2, 3) is arranged.

5.

Implant screw (4) according to claim 4, characterized in that the

A counter-holding thread (2102, 3102) is associated with a toothing (341) connected to the head part (228, 328).

6.

Implant screw (4) according to claim 5, characterized in that the

Toothing (341) encircles the retaining thread (2102, 3102).

7.

Implant screw (4) according to Claim 5 or 6, characterized in that the teeth (341) have flat tooth flanks (344) and/or steep tooth flanks (345), the flat tooth flanks (344) pointing in a screwing direction (S) of the counter-retaining thread (2102, 3102) or the steep tooth flanks (345) point in the opposite direction to the screwing direction (S).

8.

Implant screw (4) according to at least one of the above claims 3 to 7, characterized in that an end face (240, 340) connected to the head part (228, 328) points in the direction of the base thread (1 1 1 , 1 1 1 ', 1st 1 1 ", 21 1 , 31 1) points out and/or bears against the connector (1, 1', 1", 2, 3) at least in sections.

9.

Implant screw (4) according to claim 8, characterized in that the

End face (240, 340) is annular.

10.

Implant screw (4) according to Claim 8 or 9, characterized by at least one tooth (342) formed on the face (240, 340) and on which a tooth tip (343) pointing away from the face is formed.

1 1

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Implant screw according to at least one of Claims 5 to 7 and Claim 10, characterized in that the at least one tooth (342) forms the toothing (341) at least in sections.

12.

Implant screw (4) according to at least one of Claims 3 to 11, characterized in that the connector (1, 1', 1", 2, 3) has a holding section (12, 12', 12", 22, 32), on which a retaining thread (121, 131, 131', 221, 321) for screwing the head part (228, 328) onto the connector (1, 1', 1", 2, 3) is formed.

13.

Implant screw (4) according to at least one of Claims 3 to 12, characterized in that the connector (1, 1', 1", 2, 3) has an annular collar (28, 38) which extends at least in sections in the direction of the head part (228 , 328).

14.

Implant screw (4) according to at least Claim 13, characterized in that at least one engagement means (151, 151', 251, 351) for attaching a tool for screwing in the connector (1, 1', 1", 2, 2') on the collar (28.38) is formed.

15.

Implant screw (4) of at least one of the above claims, characterized in that at least one engagement element (229, 329) for attaching a tool for screwing in the implant screw (4) is formed on the head part (228, 328).

16.

Implant screw (4) according to at least one of the above claims, characterized in that the head part (228, 328) is bonded to the base thread (111, 111', 111", 211, 311).

IMPLANT SCREW MECHANICS AND THE SETTLING EFFECT: AN OVERVIEW

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One of the most serious and prevalent problems associated with the restorative aspect of dental implants is loosening and fracturing of screws. Implant screws should be retightened 10 minutes after the initial torque application as a routine clinical procedure to help compensate for the settling effect. Mechanical torque gauges should be used instead of hand drivers to ensure consistent tightening of implant components to torque values recommended by implant manufacturers.

KEY WORDS

Implant
Screw mechanics
Preload
Torque
Settling effect

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INTRODUCTION

One of the most dramatic services the dental profession has to offer is the replacement of missing teeth with implants. Implants are not new to dentistry. Seashell fragments were used to replace 3 missing mandibular incisors as early as 600 AD, and human transplants were used in many diverse early cultures. In recent years, oral implantology has undergone a well-deserved rebirth or rediscovery, and implants are now considered the treatment of choice in an increasing number of carefully selected cases. Today, implant prosthodontics has reached the point at which it can be successfully performed by both general dentists and specialists.

One of the most serious and prevalent problems associated with the restorative aspect of dental implants is loosening and fracturing of the screws that attach the prosthesis to the implant. Screw loosening may be an early warning of inadequate biomechanical design and/or occlusal overloading. In order to attempt to solve the problem of loose screws, the clinician must first understand the mechanics involved with the screw joint.

SCREW MECHANICS

McGlumphy et al[1] defined the screw joint as 2 parts tightened together by a screw, such as an abutment and implant being held together by a screw. A screw is tightened by applying torque. The applied torque develops a force within the screw called the preload. As a screw is tightened, it elongates, producing tension. Elastic recovery of the screw pulls the 2 parts together, creating a clamping force.[2] The preload in the screw, from elongation and elastic recovery, is equal in magnitude to the clamping force.[1]

Opposing the clamping force is a joint-separating force, which attempts to separate the screw joint. Screw loosening occurs when the joint-separating forces acting on the screw joint are greater than the clamping forces holding the screw unit together.[1] Excessive forces cause slippage between threads of the screw and threads of the bore, resulting in a loss of preload.[3]

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Straumann USA Exhibit 1020

It is not necessary to eliminate separating forces, only to minimize them.[1] Minimizing separating forces and maximizing clamping forces will act to prevent screw loosening.

When the clinician applies a torque to a screw to tighten its components together, the tightening torque creates a preload in the screw. The preload is determined by the applied torque and other factors, such as the screw alloy, screw head design, and abutment surface. The established preload is proportional to the applied torque. The torque value can be controlled by the clinician and can be reproduced from implant prosthesis to implant prosthesis. Too little torque may allow separation of the joint and result in screw fatigue, loosening, and failure. Too large a torque may strip the screw threads.[1]

Increasing the torque will increase the preload. Increasing the preload maximizes the stability of the screw joint by increasing the clamping threshold that separating forces must overcome to cause screw loosening. The amount of torque than can be applied is limited by the ultimate strength of the screw. McGlumphy et al[1] have stated that the optimal torque value is 75% of the torque needed to cause screw failure.

Another variable in the amount of torque that can be applied is how the torque is produced by the clinician. Torque can be applied manually or with a mechanical device. Until the introduction of mechanical torquing devices to the profession, implant components were tightened manually. The novice or inexperienced clinician often undertightened the screws in an implant system. Dellinges and Tebrock[4] found that the average torque applied with a screwdriver is only 10 N-cm.

In a pilot study, Jaarda et al[5] found that test subjects with little implant experience were not generally able to provide the recommended torque to implant prosthesis–retaining slotted gold screws. The investigators also reported that experienced test subjects tended to generate more than the recommended torque, and none of the test subjects were able to generate consistent torque values (Figure 1).

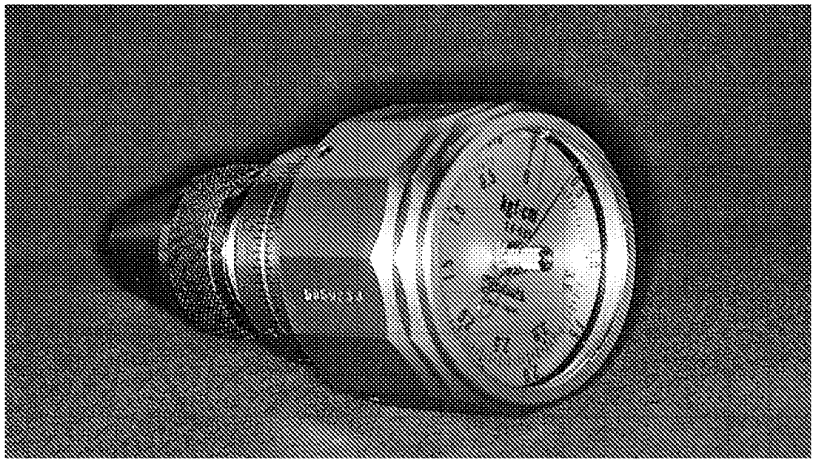


FIGURE 1. Tohnichi torque gauge used for research in Jaarda et al,[5,7] Bakaeen et al,[9] Siamos et al,[10] and Winkler et al (unpublished data, 2003), (Tohnichi America Corporation, Northbrook, Ill).

Joint-separating Forces

Clinically, the screw unit within an implant prosthesis is constantly subject to external joint-separating forces. Such intraoral separating forces may include off-axis occlusal contacts, lateral excursive contacts, interproximal contacts between natural teeth and implant restorations, protrusive contacts, parafunctional forces, and nonpassive frameworks that attach to the implants. Once external forces exceed the screw joint preload, the joint becomes unstable. The external load rapidly erodes the preload, resulting in vibration and micromovement that lead to screw loosening. Once loosening occurs, the screw joint ceases to perform the function for which it was intended and can be considered as failed.[3]

The clinician must recognize the possible forces that will be acting on the screw joint, so that screw loosening and other possible complications can be minimized or avoided.

Clinicians are urged to use some type of mechanical torque-applying instrument to ensure consistent tightening of implant components to the specified torque values recommended by implant manufacturers.

Settling Effect

A significant mechanism that results in screw loosening of implant-supported restorations is the settling effect. The settling effect (embedment relaxation), which plays a critical role in screw stability, is the result of no surface being completely smooth. No matter how carefully machined an implant surface is, it is slightly rough when viewed microscopically. Because of this microroughness, no two surfaces are completely in contact with one another.

Settling occurs as the rough spots flatten under load, since they are the only contacting surfaces when the initial tightening torque is applied. When the screw interface is subjected to external loads, micromovement occurs between the surfaces. Wear of the contact areas brings the 2 surfaces closer together. It has been reported that 2% to 10% of the initial preload is lost as a result of settling.[6] As a result, the torque necessary to remove a screw is less than the torque initially used to place the screw.[7]

The extent of settling depends on the initial surface roughness, surface hardness, and magnitude of the loading forces. Rough surfaces and large

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external loads increase the settling. When the total settling effect is greater than the elastic elongation of the screw, the screw works loose because there are no longer any contact forces to hold it in place.[8]

Thread friction is higher for the first tightening and loosening of a screw, and then decreases after repeated tightening and loosening cycles.[8] A number of authors have suggested tightening of implant screw joints after the initial screw insertion and periodically thereafter.[2,9,10]

Bakaeen et al[9] have reported that when prosthetic gold screws were tightened to 10 N-cm according to the manufacturer's instructions, the untightening torque of the different groups tested was about 2 to 3 N less than the tightening torque. These observations correspond to the findings of Sakaguchi and Borgersen,[6] who reported a 2% to 10% reduction in preload within the first few seconds or minutes after tightening as a result of the settling effect.

Siamos et al,[10] as a result of an in vitro investigation, also suggested that retightening abutment screws 10 minutes after initial torque applications should be routinely performed. The investigators also reported that increasing the torque values for abutment screws above 30 N-cm can be beneficial for abutment-implant stability and to decrease screw loosening.

To reduce the settling effect, implant screws should be retightened 10 minutes after the initial torque application.[2,9,10] This technique should be used as a routine clinical procedure.

In vitro studies

In vitro studies examining the dynamics of screw loosening using servohydraulic testing machines have limitations due to the difficulty of reproducing the complex nature of the chewing cycle. Clinical variables, such as intermittent high impact loads, varying angles of load application, and varying positions of load application in relation to the implant axis, may have significant damaging effects on the implant-abutment interface leading to screw loosening and failure.[11(p68)]

Ideally, load application and duration applied during testing should simulate these normal functional parameters. Cyclic fatigue studies frequently report maximum load applications of 100 to 200 N, which are at the low range of reported data for maximum bite forces (200–3500 N).[11(p68)] It is assumed that an individual has 3 episodes of chewing per day, each 15 minutes in duration, at a chewing rate of 60 cycles per minute. This produces an equivalent of 2700 chewing cycles per day or 10^6 cycles per year.[12,13] Accurately simulating these normal functional parameters is both time consuming and technically challenging.

DISCUSSION

Generally, simple tightening or replacement of loose retaining or abutment screws is all that is necessary, which is an inconvenience for both the clinician and the patient. Often extensive repair is involved, especially if abutment screws cannot be retrieved. This may necessitate abandonment of the involved implant and/or require modification or remake of the affected prosthesis.

Bakaeen et al[9] found that screw loosening can be reduced by narrowing the occlusal table of molar single-tooth implants when using 1 implant for support.

Ongoing research at Temple University School of Dentistry (S. Winkler et al, unpublished data, 2003) suggests that the percentage of difference between the applied torque and the counter torque increases significantly at lower initial torque values. The research also indicates that high initial torque values recommended by some manufacturers for their implant screws are beyond the limitations of the screws provided and may result in stripping, breakage, and other problems.

CONCLUSIONS

To reduce the settling effect, implant screws should be retightened 10 minutes after the initial torque application as a routine clinical procedure. Mechanical torque instruments should be used instead of hand drivers to ensure consistent tightening of implant components to the specified torque values recommended by implant manufacturers.

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REFERENCES

1. McGlumphy EA, Mendel DA, Holloway JA. Implant screw mechanics. *Dent Clin N Am.* 1998;42:71–89.

2. Haack JE, Sakaguchi RL, Coeffy JP. Elongation and preload stress in dental implant abutment screws. *Int J Oral Maxillofacial Implants.* 1995;10:529–536.

3. Lang LA, May KB, Wang RF. The effect of the use of a counter-torque device on the abutment-implant complex. *J Prosthet Dent.* 1999;81:411–417.

4. Dellinges MA, Tebrock OC. A measurement of torque values obtained with hand-held drivers in a simulated clinical setting. *Int J Prosthodont.* 1993;2:212–214.

5. Jaarda MJ, Razzoog ME, Gratton DG. Providing optimum torque to implant prostheses: a pilot study. *Implant Dent.* 1993;2:50–52.

6. Sakaguchi RL, Borgersen SE. Nonlinear contact analysis of preload in dental implant screws. *Int J Oral Maxillofac Implants.* 1995;10:295–302.

7. Jaarda M, Razzoog M, Gratton D. Effect of preload torque on the ultimate tensile strength of implant prosthetic retaining screws. *Implant Dent.* 1994;3:17–21.

8. Jorneus L, Jemt T, Carlsson L. Loads and designs of screw joints for single crowns supported by osseoin-

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tegrated implants. *Int J Oral Maxillofac Implants*. 1992;7:353–359.

9. Bakaeen LG, Winkler S, Neff PA. The effect of implant diameter, restoration design, and occlusal table variations on screw loosening of posterior single-tooth implant restorations. *J Oral Implantol*. 2001;27:63–72.

10. Siamos G, Winkler S, Boberick KG. The relationship between implant preload and screw loosening on implant-supported restorations. *J Oral Implantol*. 2002;28:67–73.

11. Craig RG. *Restorative Dental Materials*. 11th ed. St Louis, Mo: CV Mosby; 2002.

12. Binon PP, McHugh MJ. The effect of eliminating implant/abutment rotational misfit on screw joint stability. *Int J Prosthodont*. 1996;9:511–519.

13. Wiskott HW, Nicholas JL, Belser UC. Stress fatigue: basic principles and prosthodontic implications. *Int J Prosthodont*. 1995;8:105–116.

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(54) Title: DENTAL IMPLANT DEVICE, SYSTEM AND METHOD OF USE

(57) Abstract: The present invention relates to a dental implant device and a method for using the same and in particular, to such a device and method in which the implant device projects the implant anchor's location, orientation and axis while facilitating the treatment of the peri-implant tissues.

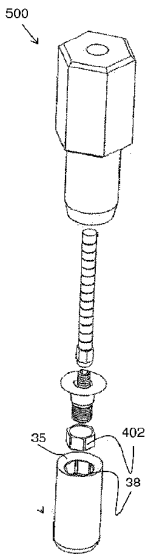


FIG. 1A

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DENTAL IMPLANT DEVICE, SYSTEM AND METHOD OF USE

FIELD OF THE INVENTION

The present invention relates to a dental implant device and a method for using the same and in particular, to such a device and method in which the implant device projects the implant anchor's location, orientation and axis while facilitating the treatment of the peri-implant tissues.

BACKGROUND OF THE INVENTION

Dental implants are well known in the art and typically include a dental implant anchor securely inserted into the patient's jawbone, an abutment member attached to the dental anchor, and a prosthodontic restoration coupled thereon.

The method of implantation generally occurs over various stages where that generally initiates with the implant anchor's introduction into the jawbone and ends with loading the implant anchor with an abutment and restoration. There are a number of intermediates steps and procedures that are undertaken between the implant anchor's introduction and loading that can be spread over a three to nine month period.

The intermediate steps generally involve allowing the host tissue, gingiva and peri-implant tissues to heal and to be modeled in preparation for receiving the abutment and restoration. These intermediates steps are lengthy and require about eight individual medical procedures and/or iterations with a professional caregiver, where following each procedure and/or iteration requires a healing period.

Each intermediate steps requires different implant devices to facilitate the tissue healing and modeling process, for example cover screws, healing abutments, impression copings.

SUMMARY OF THE INVENTION

State of the art dental implant devices utilized during the intermediate steps of the implant procedure require multiple invasive and costly procedures.

Following the implantation of a dental implant anchor, the anchor is not easily discoverable following the healing period. This is due to that fact that during the healing process, the morphology of the gingival tissue covering the anchor is restored, making it difficult to locate and/or discover the underlying anchor. The

exact location of the anchor is not known, nor readily visible to the practitioner. The approximate implant anchor site is estimated and thereafter located by way of surgical exploratory probing, often utilizing inaccurate surgical incisions.

During the anchor uncovering process much of the host tissue is needlessly lost. Such tissue loss can lead to various medical drawbacks for example, vertical bone loss, prolonged re-healing period, formation of closed and inaccessible voids, pockets, cysts, formation of fibrotic tissue, improper sealing possibly leading to contamination, overlapping of the anchor's margins with proliferated neo-tissue leading to inadequate abutment coupling and loosening.

Once the implant anchor is discovered the host tissue must be prepared for implant loading with various devices such as a healing abutment, to allow the peri-implant tissue to be modeled in preparation for implant anchor loading.

The dental implant device, system and method of use according to embodiments of the present invention provide for a non-invasive and a-traumatic method that remotely treats the peri-implant tissue to promote faster healing, while significantly reducing the number of procedures and care-giver iterations required between anchor implantation and loading. The dental implant device of the present invention further facilitates the implantation process by providing for readily identifying the location, orientation and axis of the implanted dental implant anchor in a non-invasive manner, for example by visual inspection. The dental implant device according to embodiments of the present invention further provides for minimizing peri-implant host tissue loss during the process of discovering and uncovering of the implant anchor, which takes place prior to implant loading.

Optionally and preferably the device according embodiments of the present invention provides for projecting the anchor's axis relative to surrounding structures for example including but not limited to anatomical structures, the opposing jaw, the same jaw, adjacent teeth or prosthodontic elements, morphological elements, or any combination thereof.

Optionally and preferably embodiments of the device according to the present invention provides for a minimally invasive and a-traumatic method for discovering and uncovering the implant anchor.

There is an unmet need for, and it would be highly useful to have, a dental implant device, system and method that provides for seamlessly discovering the implant's anchor. Moreover it would be highly advantageous to have an

implantable device capable of identifying the anchor's position, orientation and axis while allowing for identifying a projection of the anchor, relative to surrounding prosthodontic elements and/or anatomic structures such as the teeth on the same and/or opposite jaw.

Furthermore optional embodiments according to the present invention may provide a platform on which an abutment assembly, or the like prosthodontics elements may be built.

Optionally prosthodontic elements may be coupled and/or otherwise associated with and/or functionally associated with the dental implant device of the present invention may for example include but is not limited to a transfer and/or attachment (ball attachment), abutment, the like or any combination thereof.

The dental implant device according to optional embodiments of the present invention may further provide for partial and progressive loading of the implanted anchor. Optionally the implant device according to optional embodiments of the present invention, most preferably while coupled with at least one or more optional prosthodontic elements, provides for progressive and/or gradual loading of the anchor, such that the anchor may be adjusted in dynamic relation to the progression and/or rate of bone remodeling and the healing process of the hard tissues.

Optional embodiments of the device of the present invention provides for facilitating treatment of the host tissue surrounding the implant therein providing for the maintenance, treatment and therapy of the host tissues. Preferably such treatment is accomplished in a non-invasive and a-traumatic manner without directly infiltrating the peri-implant and host tissue.

Optionally the device may comprise a treatment port and/or lumen to facilitate applying medical treatment to the surrounding host tissues. Therein optionally the device provides for at least one or more treatments of the host tissue with a flowing fluid for example including but not limited to applying and introducing medicaments, flowing fluids, gasses, antiseptics, irrigating fluids, antibiotics, probiotics, anesthetics, analgesics, dissolvable medicaments, evaporating medication the like or any combination thereof.

An optional embodiment of the present invention provides a dental implant device for associating with an implanted dental implant anchor immediately following implantation, the device provided for facilitating identifying the location, orientation and axis of the implanted dental anchor the device having a distal

portion , a medial portion and an proximal portion that are defined between a distal end and a proximal end ;the distal portion provided for securely associating the device with the dental implant anchor along the implant borehole ; that is defined between the distal end and medial portion ; the medial portion provided for covering the proximal end of the dental implant anchor ;the proximal portion defined from the medial portion to the proximal end , provided for projecting the location, orientation and axis of implant anchor , characterized in that the proximal portion is a shaft extending proximally from the medial portion corresponding to the plane of the implant anchor's proximal end to assume the orientation and axis of anchor and to readily reveal the location of anchor by way of visual inspection.

Preferably the medial portion and the distal portion are screw form.

Optionally the proximal portion has a smaller diameter than medial portion .

Optionally at least a portion of the distal portion is configured and shaped according to the implant anchor's borehole to provide for coupling therewith.

Optionally the distal portion may be coupled with a mediating member to facilitate coupling with the implant anchor.

Optionally the device may be coupled with the implant anchor via a fixation screw.

Optionally the distal portion may be configured and shaped according to the implant anchor's anti-rotational connection platform aperture.

Optionally the medial portion may be shaped to complement the configuration of the anchor's proximal end so as to allow closure of the implant anchor's borehole

Optionally the medial portion is configured to have an upper surface overlying the peri-implant tissue configured to act as a protective cover of the peri-implant tissues from tissue cutting.

Optionally the medial portion may comprise a lower surface configured to correspond to the distal end of the implant anchor .

Optionally the medial portion may comprise a peri-implant tissue collar portion configured to allow the peri-implant tissue to heal and to assume its final shape.

Optionally the collar portion may be configured and shaped according to the apical portion of the trans-gingival collar of a dental implant abutment.

Optionally and preferably the device features a continuous central channel disposed between the distal end to the proximal end . Optionally and preferably the channel features at least one or more openings along its length. Optionally and preferably the channel may be utilized for non-invasively and remotely introducing a flowing fluid for treating the peri-implant tissue.

Optionally external surface of proximal portion is configured to facilitate coupling with prosthodontic elements . for example including but not limited to an abutment assembly, abutment, transfer, copying device, tools, dental hand piece, the like or any combination thereof.

Optionally the diameter of the proximal portion may be configured to be from about 1mm to about 5 mm.

Optionally the external surface of proximal portion may be configured and shaped according to the implant anchor's anti-rotational connection platform .

Optionally the external surface of proximal portion may feature graduations or markings hat are indicative of height above the bone level.

Optionally the external surface of proximal portion comprises a reference marker along the length of proximal portion characterized in that the reference marker is correlated to the shape of the implant anchor's connection platform . Preferably the reference marker is indicative of and infers the implant anchor's orientation and the shape of the connection platform therein facilitating the implant impression coping and transfer process.

Optionally the shape of proximal portion, and particularly the external surface of the proximal portion is configured to reflect the shape of the implant anchor's connection platform .

An optional embodiment of the present invention provides a dental implant device for associating with an implanted dental implant anchor immediately following implantation, the device provided for facilitating identifying the location, orientation and axis of the implanted dental anchor following a healing period, the device having a distal portion , a medial portion and an interchangeable proximal portion ;a) the distal portion provided for securely associating the device with the dental implant anchor along the implant borehole ; the distal portion having a threaded channel disposed central within the distal portion body; the threaded channel provided for receiving and securely coupling with the proximal portion , the channel having threading selected from cylindrical threading or conical

threading; b) the medial portion provided for covering the proximal end of the dental implant anchor ; wherein the medial portion comprises a tooling aperture that is continuous with the distal portion threaded channel the tooling aperture provided in the form of anti-rotational tooling recess for manipulating the device; and c) the interchangeable proximal portion provided for projecting the location, orientation and axis of implant anchor ; is a shaft having a diameter from about 1mm to about 5mm, that extends proximally from the plane of the implant anchor's proximal end to assume the orientation and axis of anchor ; the proximal portion having a distal end including threading configured to complement and couple with the threaded channel threading.

An optional embodiment of the present invention provides for a dental implant system and/or kit including an optional implant device a mediating member , and a device cover and/or plug. .

Optionally the system and/or kit may further comprise a tubular tissue punch provided for uncovering the gingival tissue overlying the dental implant anchor and dedicated driving tools for manipulating the implant device according to the present invention.

Optionally the system and/or kit may further comprise a gingival tissue depth measuring probe configured to measure the peri-implant tissue depth by inserting the probe into the proximal portion channel , the probe characterized in that it is shaped and configured according the luminal surface of channel ; the probe having graduations or markings indicative of the probe height.

Optionally the measuring probe may have a length of up to about 15mm.

An optional embodiment of the present invention provides a method for marking the position, axis and orientation of a dental implant anchor at the time of anchor placement so as to allow for: a-traumatic, minimally invasive uncovering of a dental implant anchor and to facilitating an impression coping of the dental implant anchor while reducing the number of procedures required to load the implant with a dental implant abutment, the method comprising: a) coupling a dental implant device according to the present invention with a dental implant anchor at the time of anchor placement; b) suturing the gingival tissue at the implantation site wherein the proximal portion extends above the gingival tissue level wherein the proximal portion provides for identifying the location and orientation of anchor by visual inspection; c) adjusting the length of the

proximal portion relative to the gingival tissue by way of cutting or extending the proximal portion ; d) apply a remote a-traumatic non-invasive tissue treatment of the peri-implant tissue through a proximal portion channel (420, 422) of the device; e) undertaking either a digital or analog impression coping of the implantation site wherein at least one of: a marker disposed on along the length of proximal portion , the external surface of proximal portion , inner luminal surface of channel , proximal end aperture , serve as a reference correlating and corresponding to the orientation and geometry of the anti-rotational connection platform aperture of implant anchor; f) a-traumatically anesthetizing the peri-implant tissue by introducing analgesics through proximal portion channel through at least one exit pore; g) uncovering the implant anchor and minimizing the peri-implant tissue loss over the implant anchor's occlusal portion by guiding a tissue punch device along the device's proximal portion ; and h)disassociate device from anchor and proceed to load the implant with an abutment and restoration.

Optionally the method may further comprise associating a measuring probe with the device of the present invention within the lumen of a proximal portion channel prior to undertaking a digital impression by way of an oral digital scan and inferring from the scan the gingival tissue height.

An optional embodiment of the present invention provides a method for introducing a flowing fluid to the peri-implant tissues and host tissue surrounding an implant anchor using the implant device according to the present invention, the device is coupled to an implanted dental implant anchor for anesthetizing or irrigating the peri-implant tissue with the flowing fluid, the method comprising introducing the flowing fluid into the lumen and allowing the fluid to flow from the distal end through the exit pores disposed adjacent to the peri-implant tissues. The flowing fluid may for example include but is not limited to at least one or more of: medicaments, flowing fluids, gasses, antiseptics, irrigating fluids, antibiotics, probiotics, anesthetics, analgesics, dissolvable medicaments, evaporating medication, the like or any combination thereof.

An optional embodiment of the present invention provides a method for determining the peri-implant tissue depth by introducing a measuring probe into the lumen of implant device according to the present invention and obtaining a reading determining the lumen length utilized to infer the tissue depth.

An optional embodiment of the present invention provides a method for reducing the number of intermediate procedures required between a dental anchor placement to the abutment and restoration loading during a dental implant restoration procedure, the method comprising: a) Associating the implant device having a medial portion including a peri-implant collar portion, that is coupled with a dental implant anchor during implant anchor placement; b) Monitoring the healing of the gingival tissue while providing a-traumatic and minimally invasive treatment to the peri-implant tissue as needed via proximal portion channel, the treatment selected from, tissue irrigation, introduction of a medicament to the peri-implant tissue, shaping and protecting the peri-implant tissue with medial portion having a peri-implant collar; c) Facilitating digital or analog impression coping of the implantation site wherein the proximal portion of the implant device facilitates the identification of the orientation and geometry of the connection platform aperture of the implant anchor with at least one feature selected from : a marker disposed on along the proximal portion , the external surface of proximal portion , inner luminal surface of channel , proximal end aperture , the feature serves as a reference correlating and corresponding to the orientation and geometry of the anti-rotational connection platform aperture of implant anchor; d) a-traumatically anesthetizing the peri-implant tissue by introducing anesthetics from the proximal portion channel through at least one exit pore ; e) uncovering the implant anchor and minimizing the peri-implant tissue loss over the implant anchor's occlusal portion by guiding a tissue punch device along the proximal portion of the implant device of the present invention ; and f) disassociating the implant device from the anchor and proceeding to load the implant with an abutment and restoration.

Within the context of this application the term prosthodontics elements is to refer to any elements utilized for dental implant restoration for example including but not limited to abutments, sleeves, interface members, transfers, restorations, impression copying, abutment extension, guide members, bistouries, scalpels over denture abutment, over denture attachment (for example, ball attachment), healing cap, any combination thereof or the like.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to

which this invention belongs. The materials, methods, and examples provided herein are illustrative only and not intended to be limiting.

Implementation of the method and system of the present invention involves performing or completing certain selected tasks or steps manually, automatically, or a combination thereof.

There are many inventions described and illustrated herein. The present inventions are neither limited to any single aspect nor embodiment thereof, nor to any combinations and/or permutations of such aspects and/or embodiments. Moreover, each of the aspects of the present inventions, and/or embodiments thereof, may be employed alone or in combination with one or more of the other aspects of the present inventions and/or embodiments thereof. For the sake of brevity, many of those permutations and combinations will not be discussed separately herein.

As used herein, the indefinite articles "a" and "an" mean "at least one" or "one or more" unless the context clearly dictates otherwise.

Herein the term "proximal" generally refers to the side or end of a device that is intended to be closer to the performing practitioner, further from the location of the intervention. The term "distal" generally refers to the side or end of a device that is intended to be closer to or at the location of the intervention, and therefore further away from the performing practitioner.

Importantly, this Summary may not be reflective of or correlate to the inventions protected by the claims in this or continuation/divisional applications hereof. Even where this Summary is reflective of or correlates to the inventions protected by the claims hereof, this Summary may not be exhaustive of the scope of the present inventions.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention is herein described, by way of example only, with reference to the accompanying drawings. With specific reference now to the drawings in detail, it is stressed that the particulars shown are by way of example and for purposes of illustrative discussion of the preferred embodiments of the present invention only, and are presented in order to provide what is believed to be the most useful and readily understood description of the principles and conceptual aspects of the invention. In this regard, no attempt is made to show structural details of the

invention in more detail than is necessary for a fundamental understanding of the invention, the description taken with the drawings making apparent to those skilled in the art how the several forms of the invention may be embodied in practice.

In the drawings:

FIG. 1A-C are schematic illustrative diagrams of exemplary dental implant device and system according to optional embodiments of the present invention;

FIG. 2A-Q are schematic illustrative diagrams of optional implant device according to optional embodiments of the present invention; FIG. 2A-D show a perspective view of optional configurations of implant device; FIG. 2E-N show optional implant device featuring a fluid delivery channel; FIG. 2E shows an optional system featuring a measuring probe and a fluid delivery channel; FIG. 2I-K show an optional implant device featuring a peri-implant tissue protective segment; FIG. 2L-N show optional implant devices featuring a continuous open channel; FIG. 2O-Q show a top view of optional implant devices featuring optional reference markings;

FIG. 2R-S are schematic illustrative diagrams of an optional mediating members according to optional embodiments of the present invention;

FIG. 3A-B are schematic illustrative diagrams of optional implant device according to optional embodiments of the present invention;

FIG. 4A-F are schematic illustrative diagrams of optional implant device of according to optional embodiments of the present invention;

FIG. 5A-B are schematic illustrative diagrams of optional dental implant tissue exposing device according to an optional embodiment of the present invention;

FIG.6A-F are illustrative depictions of an exemplary method according to the present invention;

FIG. 7 is a flowchart of an exemplary method for utilizing the dental implant device and systems, as depicted in FIG. 6A-F according to an optional embodiment of the present invention; and

FIG. 8A-C are schematic illustrations of an extension member according to and optional embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention relates to a dental implant device and a method for using the same and in particular, to such a device and method in which the implant device provides a projection of the implant anchor's connection platform, location, orientation and axis while facilitating a-traumatic, non-invasive treatment of the peri-implant tissues from a remote location above the host peri-implant tissue.

The dental implant device, system and method of use according to embodiments of the present invention provide for a non-invasive and a-traumatic method that remotely treats the peri-implant tissue to promote faster healing, while significantly reducing the number of procedures and care-giver iterations required between anchor implantation and loading. The dental implant device of the present invention further facilitates the implantation process by providing for readily of identifying the location, orientation and axis of the implanted dental implant anchor in a non-invasive manner, for example by visual inspection. The dental implant device according to embodiments of the present invention further provides for minimizing peri-implant host tissue loss during the process of discovering and uncovering of the implant anchor.

The device of the present invention is preferably coupled with an implant anchor at the time of implant anchor placement and thereafter provides for reducing the number of intermediate procedures required between implant anchor placement and anchor loading, while facilitating non-invasive and a-traumatic care of the peri-implant tissues.

The device comprises a distal portion preferably for coupling with the implant anchor, a medial portion preferably for covering the distal end of the implant anchor, and a proximal portion preferably for projecting the implant anchor location, orientation and axis. Optionally the proximal portion provides for a non-invasive and a-traumatic care of the peri-implant tissues.

The present invention is of a dental implant device, system and a method of use during a dental implantation. Most preferably the dental implant device provides for allowing a practitioner to seamlessly discover the implant's anchor site, its orientation, and the anchor's axis by utilizing a projection thereof. Most preferably the device is discoverable by way of visual inspection without requiring unnecessary exploratory surgery to find the implant anchor.

Optional embodiments of the implant device of the present invention provides for facilitating treatment of the peri-implant tissue by way of remotely introducing a therapeutic agent and/or medicament to the host tissue surrounding the implant therein providing for the maintenance, treatment and therapy of the host tissues.

Optionally the implant device may comprise a treatment port channel for delivering a therapeutic agent to facilitate applying medical treatment to the surrounding host tissues, therein optionally providing for at least one or more treatments of the host tissue during the healing period following implantation. Therapeutic agents and/or substances that may be delivered and/or introduced through the port may for example include but is not limited to a therapeutic agent, flowing fluids, gasses, antiseptics, irrigating fluids, antibiotics, probiotics, anesthetics, analgesics the like or any combination thereof.

Preferably the device according to optional embodiments of the present invention provides for reducing the healing time and reduces the number of procedures required for a full dental restorative process, in particular during the intermediate stages between implant placement and implant loading.

The principles and operation of the present invention may be better understood with reference to the drawings and the accompanying description. The following figure reference labels are used throughout the description to refer to similarly functioning components are used throughout the specification hereinbelow.

12e extension member;
12t extension member coupling threading;
32 anchor;
34 implant anchor internal borehole;
35 anchor proximal end or coronal end;
38 anchor aperture connection platform;
400 system;
402 anchor mediating member;
404 distal mediating member;
404 anti-rotational surface
406 proximal portion measuring probe;
408 proximal portion cover/plug;
410 dental implant device;
410d distal end;
410p proximal end/occlusal end;
412 proximal portion / occlusal portion;

412a adjustment portion;
412b proximal base;
412n correlated external reference marking;
412m reference marker
412r anti-rotational aperture;
412s occlusal surface;
412t proximal threading; coupling
414 medial portion;
414a medial aperture;
414b abutment platform;
414c implant cover portion
414p peri-implant tissue collar;
414n narrow medial portion;
414r rimmed medial portion;
414w wide medial portion;
416 distal portion (anchor) portion;
416a,b,d distal couplers;
416c coupling portion;
416s sealing portion;
416r coupling recess
416t distal threading;
416u universal distal portion;
420 lumen/medicament channel port;
420m correlated inner luminal reference marker;
420d lumen distal end;
420e lumen exit pores;
420p lumen proximal end;
422 full channel;
500 anchor exposer;
512 distal portion;
512s exposing surface;
514 proximal end handle;
516 exposer central lumen;
516d distal end;
516p proximal end;
518 anchor projection guide;
518b guide base;
518g guide shaft;

Now referring to FIG. 1A-C, FIG.2E-F that show optional forms of a dental implant device 410 according to the present invention that functions as an integral member of system 400. Optionally system 400 may be provided in the form of a kit. Further optional systems are depicted in FIG.2E-F showing system 400 comprising device 410 with a measuring probe 406, as shown in FIG. 2E, and a plug 408 as shown in FIG. 2F.

System 400 and kits thereof comprises device 410 and at least one additional member selected from an anchor mediating member 402 (FIG. 1A-C), mediating member 404 (FIG. 2R-S), guide 518 (FIG. 8C), measuring probe 406 (FIG.2E), plug 408 (FIG.2F), extension member 12e (FIG. 8A-B), and anchor exposing device 500 (FIG. 5A-B).

FIG. 1C shows system 400 comprising a device 410 and mediating member 402. Preferably mediating member 402 provides for interfacing and forming a seal with the internal lumen of dental implant anchor 32.

FIG. 1B shows system 400 similar to that of FIG. 1C however further comprising an extension member 12e, that will be described in greater detail in FIG. 8A-B. Extension member 12e facilitates utilizing device 410 in associating and building an abutment assembly thereon, for example the dental implant abutment assembly described in co-owned PCT Application No. PCT/IB2012/053829, incorporated herein by reference as if fully set forth.

FIG. 1A shows system 400 similar to that depicted in FIG. 1B however further comprising a dedicated tissue exposing device 500, described in greater detail in FIG. 5A-B. Most preferably anchor exposing device 500 is provided to perform precise incision and remove minimal amount of tissue necessary to uncover both the anchor's 32 location, orientation. Preferably exposing device 500 is characterized in that it may be guided toward the location anchor 32 by at least one of the proximal portion 412 of device 410 and/or an extension 12e associated therewith and/or a guide 518.

Most preferably device 410 and system 400 are provided to interface with a dental implant anchor 32 that has already been prepared and implanted in the jawbone as is known in the art. Optionally and preferably device 410 may be further provide for mediating and/or interfacing between both anchor 32 and an implant abutment (not shown).

The following description describing device 410 collectively and interchangeably refers to aspects of the dental device 410 as shown in FIG. 1-4.

Most preferably device 410 is generally a unitary screw form device having a proximal end 410p and a distal end 410d comprising three segments and/or portions, a proximal portion 412, a medial portion 414 and a distal portion 416. Most preferably the medial portion 414 and distal portion 416 take the screw-form, where medial portion takes the form of a screw-head and distal portion takes the form of a screw body, while proximal portion 412 is a rod like body that extends proximally from the medial portion 414. Optionally proximal portion 412 has a generally smaller diameter than the medial portion 414.

Optionally and preferably each portion of device 410 may be individually configured.

Optionally device 410 may be provided as a two piece device comprising a proximal portion 412 that may be securely fastened to a screw form body including the distal portion 416 and medial portion 414, characterized in that the distal portion and medial portion form a single body having a central a recess adapted for receiving and securely coupling with and optional proximal portion 412.

Most preferably device 410 comprises proximal portion 412 defining an occlusal extension, associated with an implant anchor 32 via distal portion 416 and medial portion 414. Such an occlusal extension 412 facilitates readily locating the implant anchor 32 while identifying the implant anchor's (32) orientation and axis of implantation within the bone by visual inspection following the healing period. Device 410 therefore affords to reduce the number of physician visits required, intermediate steps during implantation, following the initial anchor 32 placement from about eight visits to about two visits. Furthermore device 410 obviates the need for healing caps, healing abutments, coping transfer, and serves to streamline and reduce the overall dental implantation procedure.

Most preferably distal portion 416 provides for associating and/or coupling device 410 with an implanted anchor 32 along the anchor's internal lumen 34 that is usually utilized to couple an abutment and/or a fixation screw. Coupling may optionally be achieved by optional means for example including but not limited to threading, Morse angle, snap fit, friction fit, connectors, fixation screws or the like coupling means that is configured according to the anchor 32 utilized.

Distal portion 416 may comprise a coupling portion 416c and a sealing portion 416s, both provided to facilitate associating device 410 with anchor 32. Preferably coupling portion 416c and sealing portion 416s are configured according to the anchor's 32 borehole 34.

Optionally distal portion 416 may be provided in the form of a universal distal portion 416u that is devoid of sealing portion 416s and coupling portion 416t. Preferably universal distal portion 416u, FIG. 2N allows for associating device 410 with any anchor 32 utilizing a fixation screw (not shown) and a mediating member 404 (FIG. 2R-S) discussed in greater detail below.

Distal portion 416 may comprise coupling means in optional forms that are disposed along coupling portions 416c. Optionally coupling portion 416c may be provided in the form of threading 416t for example as shown in FIG. 1A-C, 2A-D, 2F-K, 3A-B, 4A-4C and FIG. 4F.

Optionally coupling portion 416c may be fit with snap fit distal coupling members 416a, b, d, for example as shown in FIG. 4D-F. Optionally distal coupling members 416a,b,d may be fit with threading for example as shown in FIG. 4F depicted distal coupling member 416d having both a snap fit configuration and threading. Optionally snap fit coupling member 416a,b,d may be adapted with an optional mediating member 402, 404 to assume other form coupling forms.

Optionally distal portion 416 may be devoid of threading, for example as shown in FIG.2E and FIG.2L-M. Distal portion 416 that are devoid of threading may be securely fastened to implant anchor 32 along borehole 34 threading with a fixation screw to securely couple device 410 to implant anchor 32. Optionally a fixation screw, not shown, may be introduced at the distal portion 416 through an open channel 422 spanning the length of device 410, for example as shown in FIG. 2M.

Optionally the sealing portion 416s of distal portion 416 may be configured according to anchor 32 and in particular the connection platform aperture 38 of anchor 32 and/or borehole 34 of anchor 32. For example as shown in FIG. 2L-N, the distal portion of sealing portion 416s is configured according to the geometry of the implant anchor's 32 connection platform 38. Such that sealing portion 416s matches the shape of connection platform 38. In such configuration distal portion 416 may be devoid of a coupling segment and may therefore be coupled with anchor 32 via a fixation screw (not shown).

Optionally and preferably sealing portion 416s may be configured according to at least one or more parameter for example selected from size, angle, shape, slope, surface, diameter, length or the like, or any combination thereof.

Optionally sealing portion 416s may be provided with optional surface configuration for example including but not limited to circular, oval, conical, polygonal of n sides where n is equal to at least 3 (n>2), lobular, tri-lobe, internal hex, external hex, internal octagonal, Morse, the like, any combination thereof, or the like connection platform as is known in the art.

Optionally sealing portion 416s may be configured to assume the anti-rotational connection platform 38 of anchor 32, for example as shown in FIG. 2L-FIG.2M.

Optionally, the length of sealing portion 416s may be short, for example as depicted in FIG. 4A-F, or may be minimal to altogether removed as shown in FIG.

2D, for example, or may be of average and/or standard length for example as shown in FIG. 2A-C and FIG.3A-B.

Optionally and preferably distal portion 416 and in particular sealing portion 416s may be further fit with and/or mediated to fit within borehole 34 of implant anchor 32 with an external sealing member for example in the form of mediating members 402, 404, for example as shown in FIG. 1A-C and FIG.2R-S .

Optionally mediating member 402, 404 may be formed from biocompatible materials, titanium, silicone, sealing material, the like or any combination thereof. Most preferably mediating member 402, as shown in FIG. 1-C, provides for mediating between sealing portion 416s and the connection platform 38 and/or inner borehole 34 surface of anchor 32. Optionally and preferably the outer surface of mediating member 402 is provided to fit with and/or assume the inner borehole surface 34 or connection platform 38 of anchor 32.

Optionally distal portion 416 and in particular sealing portion 416s may feature at least one or more recess 416r along its external surface, for example as shown in FIG. 2G-2M. Preferably recess 416r is provided to facilitate sealing when utilizing a flexible mediating member 402, for example provided from flexible and/or shape deformable materials such as silicone. Preferably recess 416r is adapted to house portion of mediating member 402 when a flexible mediating member 402, for example made of silicone, is pressed between the external surface of sealing portion 416s and the internal borehole wall 34 of anchor 32. Accordingly, recess 416r provides for firmly associating and retaining device 400 within the borehole of anchor 32.

Varying views of an optional mediating member 404 are shown in FIG. 2R-S. Mediating member 404 is optionally provided from non-flexible biocompatible materials for example medical grade titanium, steel, alloys, polymers or the like biocompatible materials as is known in the art. Preferably mediating member 404 is provided to convert the distal portion 416 to correspond to and fit with the anti-rotational connection platform aperture 38 of an implant anchor 32. Optionally and preferably mediating member 404 may be utilized to convert a non-specific and/or universal distal portion 416 of device 410, for example in the form of a universal distal portion 416u, as shown in FIG. 2N.

Universal distal portion 416u is provided so as to allow device 410 to be non-selectively and/or universally fit into a plurality of dental implant borehole's

34. Mediating member 404 preferably has an external anti-rotational surface 404a that is specific to match the anti-rotational connection platform 38 of an implant anchor 32. Most preferably mediating member 404 is provided with an internal surface 404b configured to complement and/or to facilitate coupling to universal distal portion 416u. Accordingly, a universal portion 416u may be coupled with mediating member 404 along its internal surface 404b so as to allow a device 410 having universal distal portion 416u to specifically and securely with implant anchor 32 along it anti-rotational aperture 38.

Most preferably medial portion 414 is fluid with distal portion 416 and provides for covering the distal end 35 of anchor 32 as well as the connection platform aperture 38 of anchor 32. Optionally and preferably at least one surface of medial portion 414 is configured to assume the shape of distal end 35 having a generally planar circular configuration capable of covering distal end 35. Optionally medial portion 414 may be configured to be substantially cylindrical having varying diameters along the length of medial portion, for example as shown in FIG.2I-K.

Optionally medial portion 414 may be configured to have a substantially cylindrical configuration, further provide for modeling and protection the peri-implant tissue to create a peri-implant collar adjacent to implant anchor 32.

Most preferably medial portion 414 provides for capping and/or sealing the distal opening 35 of anchor 32, and may therefore be configured according to the shape, size, geometry of the coronal portion 35 of anchor 32, particularly about its borehole aperture 38. Therein optionally medial portion 414 provides for covering the borehole of anchor 32, for example acting as a lid.

Optionally medial portion 414 may be provided in optional configurations and shape for example including but not limited to wide, narrow, thin, thick, or just in the form of a flange surface, the like, or any combination thereof. Optional formations and/or configurations of medial portion 414 are shown in FIG. 1- 4. Specifically, FIG. 1-2B and 3A show a wide medial portion 414w, configuration that assumes a flange discoid shape. FIG. 3B shows narrow medial portion 414n, while FIG. 2D shows rimmed medial portion 414r, having minimal profile.

Optionally and preferably medial portion 414 may be provided with optional profiles configured to fit with and correspond to anchor 32. For example, optional profiles of medial portion 414 are depicted in FIG. 4A-C, showing that the angle,

slope and direction of medial portion 414 may be configured and vary, most preferably based on the configuration of anchor 32, particularly along borehole 34. FIG. 4A shows a cylindrical configuration of medial portion 414; FIG.4B-C show trapezoidal configurations of medial portion 414 with opposite orientation.

Most preferably the occlusal surface of medial portion 414 may comprise an aperture 414a, as shown in FIG. 3A-B, configured with an anti-rotation geometry. Optionally and preferably the aperture 414a is provided to facilitate manipulating cover-screw 410 with corresponding tools, for example to couple cover-screw 410 to anchor 32.

Optionally and preferably aperture 414a may further provide an interface and/or recess for receiving a portion of an extension member 12e, or the like abutment portion.

Optionally medial portion 414 may be configured to model and/or mold the peri-implant tissue during the healing period and to protect the peri-implant tissue when uncovering the implant anchor 32. Most preferably the protective medial portion comprises an upper surface 414b for sheltering the underlying peri-implant tissue, a lower surface 414c for covering distal end 35 of anchor 32, and a peri-implant tissue collar portion 414p disposed therebetween provided a surface for modeling the peri-implant tissue during healing.

Preferably upper surface 414b overlies the peri-implant tissue configured to act as a protective cover of said peri-implant tissues from tissue cutting. Optionally upper surface 414b may be configured to have a diameter selected from about 2.5mm up to about 10mm, about 3mm to about 7mm, about 2mm, about 5mm, about 6mm, up to about 10mm, or the like.

Optionally the diameter of upper surface 414b may be configured according to at least one or more of implant anchor 32, abutment, tissue cutting device, tissue punch (500), the like or any combination thereof. Optionally the diameter of upper surface 414b may be configured to be larger than the diameter of tissue punch 500 (FIG. 5A-B).

Preferably lower surface 414c is configured to correspond to and/or match distal end 35 of implant anchor 32 wherein upper surface 414b is configured extending above the distal end 35 of implant anchor's 32, therein forming collar portion 414p.

Preferably peri-implant tissue collar portion 414p is configured to allow the peri-implant tissue to heal and to assume its final shape.

Optionally the external surface and shape of collar portion 414p may be configured and shaped according to the apical portion of the trans-gingival collar of a dental implant abutment. Optionally collar portion 414p may be configured to have a height of from about 0.3mm up to about 4mm, more preferably about 1mm.

Optionally collar portion 414p may further comprises at least one or more exit port 420e for introducing a flowing fluid and/or medicament to the peri-implant tissue, as will be described in greater detail below.

Most preferably proximal portion 412 (also referred to as occlusal portion and/or occlusal extension) is disposed opposite the distal portion 416 and extending from and/or projecting from medial portion 414 toward proximal end 410p. Preferably proximal portion 412 is fluid and continuous with medial portion 414 and distal portion 416 forming a unitary device. Optionally proximal portion 412 may be coupled with a unitary distal portion 416 and medial portion 414 therein providing device 410 configured to have at least two parts.

Proximal portion 412 is an elongated shaft having a diameter from about 1mm to about 5mm, and a height that may be readily adjusted and/or cut to size during the anchor placement procedure such that it protrudes above the gum line after implant anchor implantation.

Proximal portion 412 most preferably provides for readily and visibly discovering the location, orientation and axis of anchor 32 following implantation and after the healing period, preferably by visual inspection. Therein device 410 having an elongated proximal portion 412 saves unnecessary prodding and/or exploratory surgery utilized today to find and identify the location of implant anchor 32 following the healing period.

Optionally, proximal portion 412 may further provide and facilitate the build-up of an abutment assembly onto anchor 32 via device 410. For example, proximal portion 412 may facilitate coupling anchor 32 with optional prosthodontics elements.

Optionally the proximal portion 412 may provide for associating with optional abutment assembly member for example including but not limited to extension member 12e (FIG. 8A-B) that may be utilized to form and build up an

abutment assembly for example as described in co-owned PCT Application No. PCT/IB2012/053829.

Optionally proximal portion 412 may be utilized to interface and/or couple additional optional prosthodontic elements for example by way of threading. Optional prosthodontic element may for example include but is not limited to: impression coping, transfer, extension 12e, anchor guides (518, FIG. 8C), overdenture abutment, overdenture attachment, ball attachment, prosthetic elements, the like or any combination thereof.

Most preferably proximal portion 412 provides for interfacing an abutment assembly and dental restoration. Optionally and preferably proximal portion 412 may be configured according to at least one or more parameters for example including but not limited to shapes, sizes, clinical parameters, restoration parameters, abutment assembly parameters, the like or any combination thereof. For example as shown in FIG. 2-3 the proximal portion 412 may be configured to assume a plurality of optional configurations.

Most preferably proximal portion 412 provides an occlusal extension to anchor 32. Most preferably proximal portion 412 provides for identifying the location, orientation and axis of anchor 32.

Optionally the length of proximal portion 412 may be configurable. Optionally the length of proximal portion 412 may be long or short. Optionally the length of proximal portion 412 may be adjustable by way of milling and/or cutting its length with dental tools such as a dental hand piece. Optionally proximal portion 412 may be adjustable so as to assume a plurality of angles and/or configurations.

Optionally proximal portion 412 may be provided with a base 412b, for example as shown in FIG. 2A-D, 2F-G, 2J. Optionally and preferably base 412b extends occlusally beyond the occlusal surface of medial portion 414, as shown.

Optionally base 412b may be configured within medial portion 414, such that it does not extend beyond the surface of medial portion 414, for example as shown in FIG. 3B, within a recess and/or medial portion anti-rotational aperture 414a, as shown.

Optionally base 412b may be provided with an anti-rotation configuration, for example a hexagon as shown, so as to facilitate manipulation of device 410 with a tool. Optionally base 412b may be provided in any shape or anti-rotational

configuration for example including but not limited to polygon of n sides where n is at least 3 or more, or the like as is known in the art.

Optionally proximal portion 412 may comprise threading 412t along its external surface, for example a shown in FIG. 1-A-B, 2A, 2D, 3A-B. Threading 412t is preferably provided to couple and/or otherwise associate with other prosthodontic restorative structures known in the art.

Optionally threaded proximal portion 412t may optionally comprise adjustment points 412a about its length, as shown in FIG. 2A , 2D. Optionally adjustment points 412a may provide for cutting and/or bending or the like manipulation of proximal portion 412.

Optionally threading 412t may provide for coupling with extension member 12e or a guiding member 518, shown in FIG. 8A-C, that may be utilized to extend the length of occlusal portion 412 or to act as a guiding member. Optionally and preferably extension member 12e, and guiding member 518 preferably comprise threading 12t corresponding threading 412t to facilitate coupling thereof.

Optionally threading 412t may be utilized to serve as a base onto which an abutment assembly, for example as disclosed in co-owned PCT Application No. PCT/IB2012/053829, may be built. Optionally an abutment assembly may be built onto a proximal portion 412 coupled with an extension member 12e along threading disposed along its length.

Optionally occlusal portion 412 may be provided with optional external surfaces 412s for example as depicted in FIG. 2A-N. Optionally external surface 412s may be provided with threading 412t (FIG. 2A,2D), anti-rotational shaped (FIG.2E), smooth cylindrical (FIG.2B,2F), graduation and/or markings 412m, 412n (FIG. 2N), segmentations (FIG.2G), snap-ring coupling structure (FIG.2C), coatings, bio-absorbable materials, respobable materials any combination thereof or the like.

Optionally proximal portion 412 may optionally comprise anti-rotational geometry aperture 412r disposed about its proximal end 410p, for example as shown in FIG. 3A-B, depicting two optional configurations. Optionally aperture 412r may provide for facilitating tool manipulation and/or facilitating abutment coupling.

Optionally proximal end 410p may comprise anti-rotational geometry along external surface 412s and/or along internal surfaces 412r, for example as shown in

FIG.2E. Optionally the external surface 412s or a portion thereof, for example in the form of markings 412n, may be configured to duplicate and/or replicate and/or reproduce the anti-rotational aperture 38 of anchor 32, above the gingiva, for example as shown with cover-screw 410 depicted in FIG. 2E. Most preferably in replicating aperture 38 of implant anchor 32 cover-screw 410 provides for projecting the direction, angle of implant anchor 32 and the shape of the connection platform aperture 38 to facilitating the transfer and impression process.

Optionally external surface 412s may be provided with external markings 412n configured to complement anti-rotational aperture 38 of anchor 32 so as to provide a reference correlated to the implant anchor's anti-rotational geometry, without having to remove gingival tissue to expose the implant anchor 32. FIG. 2O-P show a top view of external surface 412s comprising external reference markings 412n that are configured to correlate to the implant anchor's 32 anti-rotational connection platform aperture 38.

Optionally external surface 412s may feature external graduations and/or markings 412m, for example as shown in FIG. 2N. Optionally the markings or graduations 412m are indicative of height above the bone level where the implant 32 is placed. . Optionally marking 412m may be shaped to facilitated identification and/or calculating the bone level height may for example be selected from triangular, trapezoidal or polygonal of n sides where n>2 or the like. Optionally markings or graduations 412m may be scored and/or etched and/or painted onto the external surface 412s.

Optionally the internal surface of proximal end 410p may form an aperture 412r at proximal end 410p that may be configured to duplicate and/or replicate and/or reproduce the anti-rotational aperture 38 of anchor 32, above the gingiva, for example as shown with cover-screw 410 depicted in FIG. 2E. Most preferably external surface 416s, as shown in FIG. 2E, provides for associating with anti-rotational aperture 38 of anchor 32, while external surface 412s having the shame shape mirrors that surface above the gingiva. Most preferably external surface 416s and 412s are configured to correspond with one another and to the anti-rotational aperture 38 of anchor 32 such that surfaces 416s and 412s effectively replicate the geometry, orientation and direction of aperture 38 and implant anchor 32.

Optionally proximal portion 412 may be configured to have an extendible compressed spring core, for example provided in a spring form for example a stent-

like material such as nitinol that may extend the length of proximal portion over time. For example, proximal portion 412 may comprise spring like core that is compressed and configured to decompress and therefore expand proximally over time. Optionally the compressed spring core defining proximal portion 412 may be coated with bio-absorbable materials to define its external surface 412s, for example surface 412s may be formed from bio-absorbable sutures that undergo resorption over time gradually allowing the spring-core to decompressing and extend proximally, to reveal the location, orientation and axis of implant anchor 32.

Optionally distal portion 412 core may be realized as a self-inflating capsule that expands by osmotic principles.

Optionally device 410 may feature a central fluid lumen and/or channel 420,422 that may span from the proximal end 410p to the distal end 410d. Most preferably channel 420, 422 span the length of proximal end 412, preferably from proximal end 420p to base 412b, for example as shown in FIG. 2E-2N. Most preferably channels 420,422 comprise at least one or more exit pores 420e to allow for delivery of a flowing fluid introduced from the proximal 410p. Most preferably channel 420,422 facilitate non-invasively and a-traumatically, by remotely introducing a flowing fluid that may be utilized to treat the peri-implant host tissue.

FIG. 2F and 2E shows a schematic illustration of an optional device 410 according to the present invention wherein proximal portion 412 comprises a channel 420 and a plurality of exit pores 420e that optionally and preferably provides for introducing a flowing fluid for example, a medicament and/or therapeutic agent, to the tissue surrounding anchor 32.

Optionally lumen 420 may span the length of cover-screw 410, for example spanning proximal end 410p to distal end opening 410d, and feature at least one or more exit pores 420e disposed along the length of device 410. Optionally exit pores 420e may be provided along at least one or more segment of device 410 for example proximal portion 412, medial portion 414, distal portion 416. Optionally medial portion 414 may comprise exit pores 420e along the peri-implant tissue collar 414p.

Optionally lumen 420 may span the length of proximal portion 412 of cover-screw 410, from proximal end 420p ending adjacent to medial portion 414, and features at least one or more exit pores 420e adjacent to medial portion 414 on the proximal portion 412.

Preferably lumen 420 facilitates applying medical treatment to the surrounding host tissues, therein optionally providing for at least one or more treatments of the host tissue for example including but not limited to applying and/or introducing medicaments, therapeutic agents, flowing fluids, gasses, antiseptics, irrigating fluids, antibiotics, probiotics, anesthetics, the like or any combination thereof.

Optionally and preferably lumen 420 may further allow for introducing retrograde flow of anesthetic material to infiltrate the host tissue adjacent to exit pores 420e, therein alleviates the need for multiple trans-gingival needle-prick near anchor 32.

Most preferably such retrograde flow allows therapeutic agent and/or materials, for example periochip, optionally deposited and/or stored and or placed within the lumen of anchor 32, to penetrate host tissues adjacent to exit pores 420e by way of retrograde flow where such therapeutic active agents flow from distal end 420d toward exit pores 420e through lumen 420.

Optionally channel 422 spanning the length of device 410, for example as shown in FIG. 2L-N, provides for introducing a fixation screw to couple device 410 to anchor 32.Optionally channel 420, 422 may be utilized to house a controlled release capsule and/or medicament adjacent to exit pores 420e to allow for controlled and time release of a therapeutic agents into the peri-implant tissue.

Optionally the internal surface of channel 420, 422 may feature a correlated inner luminal reference marker 420m, as shown in FIG. 2Q, configured to complement anti-rotational aperture 38 of anchor 32 so as to provide a reference correlated to the implant anchor's anti-rotational geometry, without having to remove gingival tissue to expose the implant anchor 32. FIG. 2Q shows a top view of channel 420, 422 comprising correlated reference markings 420m that are configured to correlate to the implant anchor's 32 anti-rotational connection platform aperture 38.

Optionally the internal surface of channel 420,422 may be configured to match the anti-rotational connection platform aperture 38, facilitating the transfer coping process.

Channel 420, 422 may be utilized to introduce a measuring probe 406, FIG. 2E, provided to determine the height of the gingival tissue. Preferably measuring probe 406 is shaped to match the shape of channel 422, 420. Optionally probe 406

is configured to a have a preset length of up to about 15mm so as to act as a reference point for measuring the height of the gingival tissue. Optionally probe 406 may feature graduations or markings along its length indicative of the probe height.

Optionally channel 420, 422 may be plugged and/or covered at proximal end 420p with a plug and/or cover 408 for example as shown in FIG. 2F, depicting and optional system 400. Preferably plug 408 provides for closing the proximal open end 420p of channel 420,422.

Optionally lumen 420 and exit pores 420e may further provide a means and method for splinting and confining anchor 32 and cover-screw 410 to the maxilla, particularly over the maxillary sinus. Most preferably lumen 420 and exit pores 420e may be utilized to confine anchor 32 and cover-screw 410 disposed adjacent to maxillary sinus so as to prevent migration and loss of anchor 32 into the maxillary sinus cavity. Optionally exit pores 420e and lumen 420 may be utilized to introduce sutures, and/or fixation wires or the like, to suture and/or wire device 410 to the maxilla, most preferably to act as a stopper that prevents potential migration of anchor 32 into the maxillary sinus. Optionally a plurality of exit pores 420e in a single device 410 may be sutured and/or wired to the maxilla. Optionally a plurality of exit pores 420e spanning at least two or more, or more preferably a plurality of cover-screws 410, may be jointly sutured and/or wired to the maxilla, preferably to act as a stopper that prevents potential migration of anchor 32 into the maxillary sinus.

FIG. 5A-B shows views of an optional non-limiting configuration of anchor exposing and/or surfacing tool 500. FIG. 5A shows a perspective view while FIG. 5B shows the corresponding cross-sectional view.

Most preferably anchor exposing tool 500 is provided as a single piece device that may be manipulated manually. Optionally anchor exposer 500 may be configured to be associated with a manually manipulating handle and/or arm. Optionally exposer 500 may be coupled or otherwise associated with a motorized auxiliary device provided to facilitate its manipulation, for example including but not limited to a dental hand-piece, or the like.

Exposing tool 500 most preferably comprises a proximal portion having proximal portion 514 and a distal portion 512. Optionally and preferably distal portion 512 comprises a sharp exposing surface 512s provided for exposing and/or

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surfacing the anchor 32 from below the gingival surface. Exposing surface 512s is a sharp edge surface that facilitates cutting the gingival surface covering anchor 32.

Optionally exposer 500 may be configured to be as a single use disposable device. Optionally exposer 500 may be configured to be a multi-use device that may be readily sterilized for example by way of an autoclave.

Most preferably proximal portion 514 provides a manipulating handle that may be manipulated manually or utilized with additional tools for example a handle as previously described. Optionally and preferably proximal portion 514 is provided with a shape that may be readily handled by tools.

Most preferably anchor exposing device 500 comprises a continuously open lumen 516 spanning both proximal portion 514 and distal portion 512. Most preferably open lumen 516 may be shaped to facilitate receiving at least a portion of device 410 and/or anchor 32. More preferably distal end 516d of open lumen 516 may be configured and/or shaped and/or sized to receive a portion of anchor 32 and/or a distal portion 416 of device 410. More preferably proximal end 516p of open lumen 516 may be configured and/or shaped and/or sized to receive a proximal portion 412 of device 410.

Optionally exposer 500 may be associated with anchor axis projection guide 518, FIG. 8C, or proximal portion 412 of device 410 that provides for guiding exposer 500 toward anchor 32. Optionally exposer 500 is associated with guide 518 along guide shaft 518g or proximal portion 412 through lumen 516 allowing exposing surface 512s to be guided along shaft 518g or proximal portion 412 toward guide base 518b or medial portion 414 allowing surface 512s to come into contact with the gingival surface overlying anchor 32, therein most preferably minimizing the amount of host tissue lost in and around anchor 32 while exposing the anchor, therein alleviating the need for suturing, and significantly reducing the healing period.

Optionally exposing tool 500 may be provided in various sizes and shapes. Optionally the size and shape of exposer 500 may be provided relative to the size and/or diameter of the implant anchor 32 and/or cover-screw 410.

FIG. 6A-F and FIG. 7 provide depiction of a preferred method according to the present invention for utilizing device 410 and system 400 provided to reduce the number of intermediate procedures and physician iterations required between implant anchor placement and implant loading.. FIG.7 provides a flowchart of the

method while FIG. 6A-F provide corresponding schematic illustrations of the method.

First in stage 700 the implantation site is prepared, as is known in the art, for example as illustrated in FIG. 6A. FIG. 6A shows the initiation of the implantation process starts by exposing an implantation site by creating a gingival flap, for example a midline flap, as is known in the art. This is followed by creating of a recess (surgical alveoli) is formed for receiving a dental implant anchor 32 and implanting implant anchor 32within the recess (surgical alveoli). Next in stage 701 and as shown in FIG. 6B, the anchor 32 is securely placed within the recess.

Next in stage 702 and as shown in FIG. 6C the anchor 32 is coupled with device 410 along the anchor's borehole 34 while covering distal end 35. Most preferably device 410 and in particular distal portion 416 is configured to fit securely with anchor 32 about borehole 34 and/or aperture 38, while medial portion 414, 414c is provided to cap the anchor's distal end 35, and allowing proximal portion 412 to project from the anchor's distal end 35.

Optionally distal portion threading 416t may be utilized to couple with the anchor's internal threading disposed along borehole 34. Optionally distal portion 416 may be coupled via a fixation screw introduced through channel 422. Optionally distal portion 416 may be coupled with anchor 32 utilizing a mediating member 402 to interface with recess 416r. Optionally distal portion 416u may be fit with mediating member 404 to correspond to connection platform aperture 38 while coupling to anchor 32 with a fixation screw.

Next in stage 703, as shown in FIG. 6D the implantation site and/or anchor site is closed to allow for healing.

Next in state 704, as shown in FIG. 6D, the proximal portion 412 of cover-screw 410 may be adjusted, sized and/or cut-down according to the needed level following closure of the implantation site.

Optionally proximal portion 412 may be left exposed above the gingival tissue and not cut down relative to the gingiva.

Optionally proximal portion 412 may be capped with cover 408. Optionally proximal portion 412 may be capped with filling material, temporary filling materials or the like.

Optionally proximal portion 412 is sized and exposed such that it does not interfere with the placement of a temporary restoration. Optionally an exposed

proximal portion 412 may further constitute a lever for the surrounding elements to remove significant forces acting on anchor 32.

Optionally the gingival tissue may enclose over and/or cover the anchor and device 410 with the gingival flap such that the proximal end 412 of device 410 is covered and/or submerged beneath by the gingival tissue.

Optionally and most preferably the gingival tissue is sutured over to cover anchor 32 and cover-screw 410 such that at least a portion of the proximal end 412 of cover-screw 410 remains exposed during the healing phase, and therein protrudes through the gingival tissue. Optionally proximal end 412 exposed through the gingival surface may be coupled or otherwise associated with a dedicated cap 408.

Most preferably the proximal end 410p is adjusted relative to the gingiva so as to allow visualization of the anchor location, orientation and axis by visual inspection. Most preferably proximal end 410p of proximal portion 412 comprises correlated external reference marking 412n, 420m indicative of the connection platform aperture 38.

Optionally following sizing of proximal portion 412 in stage 704 an analog or digital impression of the oral cavity may be taken, as outlined in stage 706, so as to capture the position, orientation and axis of implant anchor 32 and connection platform aperture 38 from reference markings 412n, 420m, 412r therein facilitating the transfer and impression processes.

Next in stage 705 the implantation site may be allowed to heal as necessary as is known in the art. Preferably during the healing period the peri-implant tissue may be treated remotely via channels 420,422 to irrigate and/or introduce a medicament in and around the peri-implant tissue, that are delivered through exit pores 420e, for example as schematically shown in FIG. 6D. FIG. 6D depict remote and non-invasive introduction of a flowing fluid from a syringe to the peri-implant tissue as indicated with the positional arrow through channel 420, 422 via exit pores 420e.

Optionally when utilizing device 410 having medial portion comprising a peri-implant tissue collar portion 414p, as shown in FIG. 2I-K, the portion 414p provides for modeling the peri-implant tissues therein facilitating the healing process and obviating the need for a healing abutment.

Optionally healing period may not be required in an immediate loading configuration of anchor 32 and cover-screw 410 according to an optional embodiment of the present invention.

Next in stage 706, optionally and preferably following the healing periods, the impression and transfer process of the implantation site is facilitated with device 410. Device 410 may facilitated either digital or analog impression transfer of the implantation site. Impression coping and /or the transfer process is facilitated by device 410 in that exposure of the implant anchor 32 is not required to carry out the impression and transfer process, as is currently implemented in the art. Device 410 provides for maintaining implantation site without exposing anchor 32 by utilizing proximal portion 412 to remotely indicate the position, orientation and axis of anchor 32 and connection platform aperture 38. Most preferably reference markings 412n, 420m, 412r and/or external surface 412s are correlated to the shape and orientation of connection platform aperture 38 therein facilitating the transfer and impression processes by projection the configuration of aperture 38 on proximal portion 412 making it readily available.

Next in stage 707, following the healing process and impression of the implantation site, prior to the uncovering of the implant anchor 32 as depicted in stage 708, the peri-implant tissue may be remotely and a-traumatically anesthetized by delivering anesthesia via channel 420, 422, to the peri-implant tissue via exit pores 420e, for example as shown in FIG. 6E. FIG. 6E shows a syringe comprising anesthetics delivered to the peri-implant tissue, as shown by directional arrow, through proximal end 420p of channel 420.

Next in stage 708 the implant anchor 32 is uncovered by removing the gingival tissue above the anchor. Most preferably, device 410 provides for removing minimal tissue by providing tissue removal device 500 with a guide utilizing proximal portion 412, 518 to guide device 500 toward anchor 32, for example as shown in FIG. 6E. Exposer 500 provides for exposing the anchor directly in a minimally invasive manner that does not require poking and prodding as the implantation site is readily viewable due to the projection provided by proximal portion 412 of cover-screw 410. Most preferably minimal gingival tissue covering anchor 32 is excised with exposing surface 512s, FIG. 5A-B, to reveal anchor 32 and cover-screw 410, as they are received into proximal end lumen 516.

Most preferably this further provides for saving gingival tissue while exposing the anchor both in its location and implantation axis.

Next in stage 709 the implant loading process is undertaken as is known in the art. Optionally and preferably device 410 is disassociated from anchor 32 allowing abutment loading as is known in the art.

Optionally device 410 comprising proximal end threading 412t may be retained and associated with anchor 32 to allow for an abutment assembly, an over denture attachment or additional prosthetic elements, may be built, coupled or otherwise associated directly onto cover-screw 410 about its proximal end 412 optionally utilizing extension member 12e, for example as shown in FIG. 6F. Optionally an abutment assembly may be built on proximal portion threading 412t and/or extension member 12e, for example as described in co-owned PCT Application No. PCT/IB2012/053829, incorporated herein by reference as if fully set forth.

Optionally exposer 500 may be utilized to facilitate abutment assembly buildup about proximal end 412. Optionally, distal end opening 516d and central lumen 516 may be utilized to facilitate introducing an optional extension member 12e to facilitate the initiating an abutment buildup about anchor 32, for example as shown in FIG. 6E-F.

While the invention has been described with respect to a limited number of embodiment, it is to be realized that the optimum dimensional relationships for the parts of the invention, to include variations in size, materials, shape, form, function and manner of operation, assembly and use, are deemed readily apparent and obvious to one skilled in the art, and all equivalent relationships to those illustrated in the drawings and described in the specification are intended to be encompassed by the present invention.

The foregoing is considered as illustrative only of the principles of the invention. Further, since numerous modifications and changes will readily occur to those skilled in the art, it is not described to limit the invention to the exact construction and operation shown and described and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

It is appreciated that certain features of the invention, which are, for clarity, described in the context of separate embodiments, may also be provided in combination in a single embodiment. Conversely, various features of the invention, which are, for brevity, described in the context of a single embodiment, may also be provided separately or in any suitable sub-combination or as suitable in any other described embodiment of the invention. Certain features described in the context of various embodiments are not to be considered essential features of those embodiments, unless the embodiment is inoperative without those elements.

Citation or identification of any reference in this application shall not be construed as an admission that such reference is available as prior art to the invention.

Section headings are used herein to ease understanding of the specification and should not be construed as necessarily limiting.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention may be made.

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What is claimed is:

1) A dental implant device (410) for associating with an implanted dental implant anchor (32) immediately following implantation, the device (410) provided for facilitating identifying the location, orientation and axis of the implanted dental anchor (32) following a healing period, the device (410) having a distal portion (416), a medial portion (414) and an proximal portion (412) that are defined between a distal end (410d) and a proximal end (410o);
   a) the distal portion (416) provided for securely associating said device (410) with the dental implant anchor (32) along the implant borehole (34); that is defined between said distal end (410d) and medial portion (414);
   b) the medial portion (414) provided for covering the proximal end (35) of the dental implant anchor (32);
   c) the proximal portion (412) defined from said medial portion to said proximal end (410p), provided for projecting the location, orientation and axis of implant anchor (32), characterized in that said proximal portion (412) is a shaft extending proximally from said medial portion (414) corresponding to the plane of the implant anchor's proximal end (35) to assume the orientation and axis of anchor (32) and to readily reveal the location of anchor (32) by way of visual inspection.
2) The device of claim 1 wherein said medial portion (414) and said distal portion (416) are screw form.
3) The device of claim 1 wherein said proximal portion has a smaller diameter than medial portion (414).
4) The device of claim 2 wherein said distal portion (416) is configured and shaped according to the implant anchor's borehole (34) to provide for coupling therewith.
5) The device of claim 2 wherein said distal portion (416) comprises a coupling portion including threading (416t) configured to couple with threading internal to the implant anchor's borehole (34).
6) The device of claim 2 wherein said distal portion (416) comprises a sealing portion (416s) disposed distally to said medial portion (414).
7) The device of claim 6 wherein said sealing portion (416s) is configured according to and to fit with the implant anchor's borehole (34).

8) The device of claim 6 wherein said sealing portion (416s) comprises a coupling recess (416r).

9) The device of claim 1 wherein said distal portion (416) is configured to associate with and receive a mediating member (402, 404) that facilitates for coupling with the implant anchor's borehole (34).

10) The device of claim 8 wherein said distal portion (416) further comprises threading (416t) configured to couple with threading internal to the implant anchor's borehole (34); wherein said threading (416t) is disposed distally to said coupling recess (416r).

11) The device of claim 1 wherein said distal portion (416) is configured to be coupled with an implant anchor (32) by way of utilizing an external fixation screw that features threading complementing the threading internal to the implant anchor's borehole (34).

12) The device of claim 11 wherein said distal portion (416) is configured and shaped according to the implant anchor's (32) anti-rotational connection platform (38).

13) The device of claim 11 wherein said distal portion (416) is configured to associate with a mediating member (404) wherein the external surface of said mediating member (404) is configured and shaped according to the implant anchor's (32) anti-rotational connection platform (38).

14) The device of claim 1 wherein said medial portion (414) is shaped to complement the configuration of the anchor's proximal end (35) so as to allow closure of borehole (34) with said medial portion (414).

15) The device of claim 1 wherein said medial portion (414) is configured to have an upper surface (414b) overlying the peri-implant tissue configured to act as a protective cover of said peri-implant tissues from tissue cutting.

16) The device of claim 14 wherein the diameter of said upper surface (414b) is configured according to at least one or more of implant anchor 32, abutment, tissue cutting device, tissue punch (500).

17) The device of claim 15 wherein the diameter of said upper surface (414b) is configured to be larger than the diameter of tissue punch (500).

18) The device of claim 1 wherein said medial portion (414) comprises a lower surface (414c) configured to correspond to the distal end (35) of implant anchor (32).

19) The device of claim 1 wherein said medial portion (414) comprises a peri-implant tissue collar portion (414p) configured to allow the peri-implant tissue to heal and to assume its final shape.

20) The device of claim 19 wherein said collar portion (414p) is configured and shaped according to the apical portion of the trans-gingival collar of a dental implant abutment.

21) The device of claim 19 wherein said collar portion (414p) further comprises at least one or more exit port (420e).

22) The device of claim 1 wherein said medial portion (414) is configured to have an upper surface (414b), a lower surface (414c) and a collar portion disposed therebetween;

a) wherein said an upper surface (414b) is overlying the peri-implant tissue configured to act as a protective cover of said peri-implant tissues from tissue cutting;

b) wherein said medial portion 414 comprises a lower surface (414c) configured to correspond to the distal end (35);

c) wherein said collar portion (414p) configured to allow the peri-implant tissue to heal and to assume its final shape.

23) The device of claim 1 wherein said device features a continuous central channel (420, 422) disposed between said distal end (410d) to said proximal end (410p).

24) The device of claim 23 wherein said channel (420,422) comprises an open end defined at said proximal end (410o).

25) The device of claim 23 wherein said channel (420,422) comprises two open ends defined at each of said proximal end (410o) and distal end (410d).

26) The device of claim 23 wherein said channel (420,422) comprises at least one exit pore (420e) along its length.

27) The device of claim 26 wherein said channel (420,422) comprises a plurality of exit pores (420e).

28) The device of claim 26 wherein said at least one exit pore (420e) is disposed along the proximal portion (412).

29) The device of claim 27 wherein at least one exit pore is disposed along the proximal portion (412) and at least one exit pore is disposed along the medial portion (414).

30) The device of claim 28 wherein said at least one exit pore (420e) is disposed along the proximal portion (412) and is adjacent to medial portion (414).

31) The device of claim 23 wherein said channel (420,422) is closed with a removable plug or cover.

32) The device of claim 24 wherein said channel (420) is defined between said proximal end (410p) and the upper surface (414b).

33) The device of claim 24 wherein said channel (420) is defined between said proximal end (410p) and the lower surface (414c).

34) The device of claim 1 wherein the proximal portion (412) is a hollow shaft defining a continuous channel (420) between proximal end (410p) and medial portion (414), said channel (420) having an open end (420p) defined at the proximal end (410p) and at least one exit pore (420e) disposed along the length of said proximal portion (412).

35) The device of claim 34 wherein said at least one exit pore (420e) is disposed adjacent to medial portion (414).

36) The device of claim 1 wherein the external surface (412s) of proximal portion (412) is configured to facilitate coupling with prosthodontic elements.

37) The device of claim 36 wherein said prosthodontic elements are selected from abutment assembly, abutment, transfer, copying device, tools, dental hand piece, any combination thereof.

38) The device of claim 36 wherein at least a portion of said external surface (412s) comprises threading.

39) The device of claim 36 wherein said external surface (412s) further features adjustment points (412a).

40) The device of claim 36 wherein said external surface (412s) features a tooling interface disposed along its base (412b) adjacent to medial portion (414).

41) The device of claim 1 wherein the length of said proximal portion (412) is adjustable.

42) The device of claim 1 wherein the diameter of said proximal portion (412) is from about 1mm to about 5 mm.

43) The device of claim 1 wherein the external surface (412s) of proximal portion (412) is configured and shaped according to the implant anchor's (32) anti-rotational connection platform (38).

44) The device of claim 1 wherein the external surface (412s) of proximal portion (412) features graduations or markings (412m).

45) The device of claim 44 wherein said markings or graduations (412m) are indicative of height above the bone level.

46) The device of claim 44 wherein said markings (412m) are selected from triangular, trapezoidal or polygonal of n sides where n>2.

47) The device of claim 44 wherein said markings or graduations (412m) are scored onto said external surface (412s).

48) The device of claim 1 wherein the external surface (412s) of proximal portion (412) comprises a reference marker (412n) along the length of proximal portion (412); and wherein said distal portion (416) is configured and shaped according to the implant anchor's (32) to assume the shape of the anti-rotational connection platform (38); characterized in that said reference marker (412n) is correlated to the shape of said connection platform (38).

49) The device of claim 48 wherein said reference marker (412n) is indicative of and infers the implant anchor's (32) orientation and the shape of the connection platform (38) provided to facilitate implant impression coping and transfer process.

50) The device of claim 1 wherein the external surface (412s) of proximal portion (412) comprises a reference marker (412n) along the length of proximal portion (412); and wherein the distal portion (416) is configured to associate with a mediating member (404) wherein the external surface of said mediating member (404) is configured and shaped according to the implant anchor's (32) anti-rotational connection platform (38); characterized in that said reference marker (412n) is correlated to the shape of said connection platform (38).

51) The device of claim 1 wherein the shape of proximal portion (412) is configured to reflect the shape of the implant anchor's (32) connection platform (38).

52) The device of claim 1 wherein the proximal; portion (412) comprises an anti-rotational connection platform aperture(412r) at proximal end (410p) wherein said aperture (412r) is reflective of the anti-rotational aperture (38) of implant (32) is configured to reflect the shape of the implant anchor's (32) connection platform (38).

53) The device of claim 40 wherein said base (412b) comprises at least one or more exit pores (420e).

54) The device of claim 1 wherein the upper surface of medial portion (414) comprises a tooling aperture (414a) in the form of an anti-rotational tool recess.

55) A dental implant device (410) for associating with an implanted dental implant anchor (32) immediately following implantation, the device (410) provided for facilitating identifying the location, orientation and axis of the implanted dental anchor (32) following a healing period, the device (410) having a distal portion (416), a medial portion (414) and an interchangeable proximal portion (412);

a) the distal portion (416) provided for securely associating said device (410) with the dental implant anchor (32) along the implant borehole (34); the distal portion (416) having a threaded channel disposed central within the distal portion body; said threaded channel provided for receiving and securely coupling with said proximal portion (412), the channel having threading selected from cylindrical threading or conical threading;

b) the medial portion (414) provided for covering the proximal end (35) of the dental implant anchor (32); wherein the medial portion comprises a tooling aperture (414a) that is continuous with said distal portion threaded channel said tooling aperture (414a) provided in the form of anti-rotational tooling recess for manipulating said device; and

c) the interchangeable proximal portion (412) provided for projecting the location, orientation and axis of implant anchor (32); is a shaft having a diameter from about 1mm to about 5mm, that extends proximally from the plane of the implant anchor's proximal end (35) to assume the orientation and axis of anchor (32); the proximal portion (412) having a distal end including threading configured to complement and couple with said threaded channel threading.

56) A dental implant system (400) comprising: a device according to any of claims 1-55, a mediating member (402,404), and a plug (408) wherein said plug is provided for covering the proximal end (410p) .

57) The system of claims 56 further comprising , a tubular tissue punch (500) provided for uncovering the gingival tissue overlying the dental implant anchor (32) and dedicated driving tools for manipulating device (410).

58) A dental implant system of claim 56 further comprising a gingival tissue depth measuring probe (406) configured to measure the peri-implant tissue depth by inserting the probe into the proximal portion (412) channel (420, 422), the probe characterized in that it is shaped and configured according the luminal surface of channel (420,422); the probe having graduations or markings indicative of the probe height.

59) The system of claim 58 wherein said probe (406) has a length of up to about 15mm.

60) A method for marking the position, axis and orientation of a dental implant anchor at the time of anchor placement so as to allow for: a-traumatic, minimally invasive uncovering of a dental implant anchor (32) and impression coping of the dental implant anchor (32) while reducing the number of procedures required to load the implant with a dental implant abutment, the method comprising:

a) coupling a dental implant device (410) according to any one of claims 1-60 with a dental implant anchor (32) at the time of anchor placement;

b) suturing the gingival tissue at the implantation site wherein the proximal portion (412) extends above the gingival tissue level wherein said proximal portion provides for identifying the location and orientation of anchor (32) by visual inspection;

c) adjusting the length of the proximal portion (412) relative to the gingival tissue by way of cutting or extending the proximal portion (412);

d) apply a remote a-traumatic non-invasive tissue treatment of the peri-implant tissue through a proximal portion (412) channel (420, 422) of said device (410) ;

e) undertaking either a digital or analog impression coping of the implantation site wherein at least one of: a marker (412n) disposed on along the length of proximal portion (412), the external surface (412s) of proximal portion (412), inner luminal surface(420m) of channel (420), proximal end aperture (412r), serve as a reference correlating and corresponding to the orientation and geometry of the anti-rotational connection platform aperture (38) of implant anchor (32);

f) a-traumatically anesthetizing the peri-implant tissue by introducing analgesics through proximal portion (412) channel (420, 422) through at least one exit pore (420e);

g) uncovering the implant anchor (32) and minimizing the peri-implant tissue loss over the implant anchor's occlusal portion (35) by guiding a tissue punch device (500) along the proximal portion (412); and

h) disassociate device (410) from anchor (32) and proceed to load the implant with an abutment and restoration.

61) The method of claim 61 further comprising associating an extending member with said proximal portion to act as an external guide for the tissue punch (500).

62) The method of claim 61 further comprising associating a measuring probe (406) within the lumen of channel (420,422) prior to undertaking a digital impression coping by way of an oral digital scan and inferring from the scan the gingival tissue height.

63) A method for introducing a flowing fluid to the peri-implant tissues and host tissue surrounding an implant anchor using the device of claim 34 or 35 that is coupled to an implanted dental implant anchor (32) for anesthetizing or irrigating the peri-implant tissue with said flowing fluid, the method comprising introducing said flowing fluid into the lumen (420) and allowing the fluid to flow from the distal end (420d) through the exit pores (420e) disposed adjacent to the peri-implant tissues.

64) The method of claim 63 wherein said flowing fluid is selected from the group consisting of medicaments, flowing fluids, gasses, antiseptics, irrigating fluids, antibiotics, probiotics, anesthetics, analgesics, dissolvable medicaments, evaporating medication, any combination thereof.

65) A method for determining the peri-implant tissue depth with the system of claim 58 wherein a measuring probe (406) is introduced into the lumen of channel (420, 422) and obtaining a reading determining the lumen length utilized to infer said tissue depth.

66) A method for reducing the number of intermediate procedures required between a dental anchor placement to the abutment and restoration loading during a dental implant restoration procedure, the method comprising

a) Associating the implant device (410) according to any one of claims 1-60 with a dental implant anchor (32) during implant anchor placement;

b) Monitoring the healing of the gingival tissue while providing a-traumatic and minimally invasive treatment to the peri-implant tissue as needed via proximal portion channel (420), the treatment selected from, tissue irrigation, introduction of a medicament to the peri-implant tissue, shaping and protecting the peri-implant tissue with medial portion (414, 414p, 414b, 414c); and

c) Facilitating digital or analog impression coping of the implantation site wherein the proximal portion (412) of device (410) facilitates the identification of the orientation and geometry of aperture (38) of implant anchor (32) with at least one of: a marker (412n) disposed on along the length of proximal portion (412), the external surface (412s) of proximal portion (412), inner luminal surface(420m) of channel (420), proximal end aperture (412r), that serve as a reference correlating and corresponding to the orientation and geometry of the anti-rotational connection platform aperture (38) of implant anchor (32);

d) a-traumatically anesthetizing the peri-implant tissue by introducing anesthetics through proximal portion (412) channel (420, 422) through at least one exit pore (420e);

e) uncovering the implant anchor (32) and minimizing the peri-implant tissue loss over the implant anchor's occlusal portion (35) by guiding a tissue punch device (500) along the proximal portion (412); and

f) disassociate device (410) from anchor (32) and proceed to load the implant with an abutment and restoration.

67) The device of claim 1 or claim 55 wherein said proximal portion (412) is realized in the form of a self-inflating capsule that expands by osmotic principles.

68) The device of claim 1 or claim 55 wherein said proximal portion (412) may be configured to have an extendible compressed spring core that may extend the length of proximal portion over time.

69) The device of claim 68 wherein said proximal portion (412) comprises a spring like core that is compressed and configured to decompress over time.

70) The device of claim 68 wherein said compressed spring core may be coated with bio-absorbable materials to defining external surface (412s).

71) The device of claim 70 wherein said external surface (412s) is formed from bio-absorbable sutures that undergo resorption over time gradually allowing the spring-core to decompress and extend proximally, to reveal the location, orientation and axis of implant anchor (32).

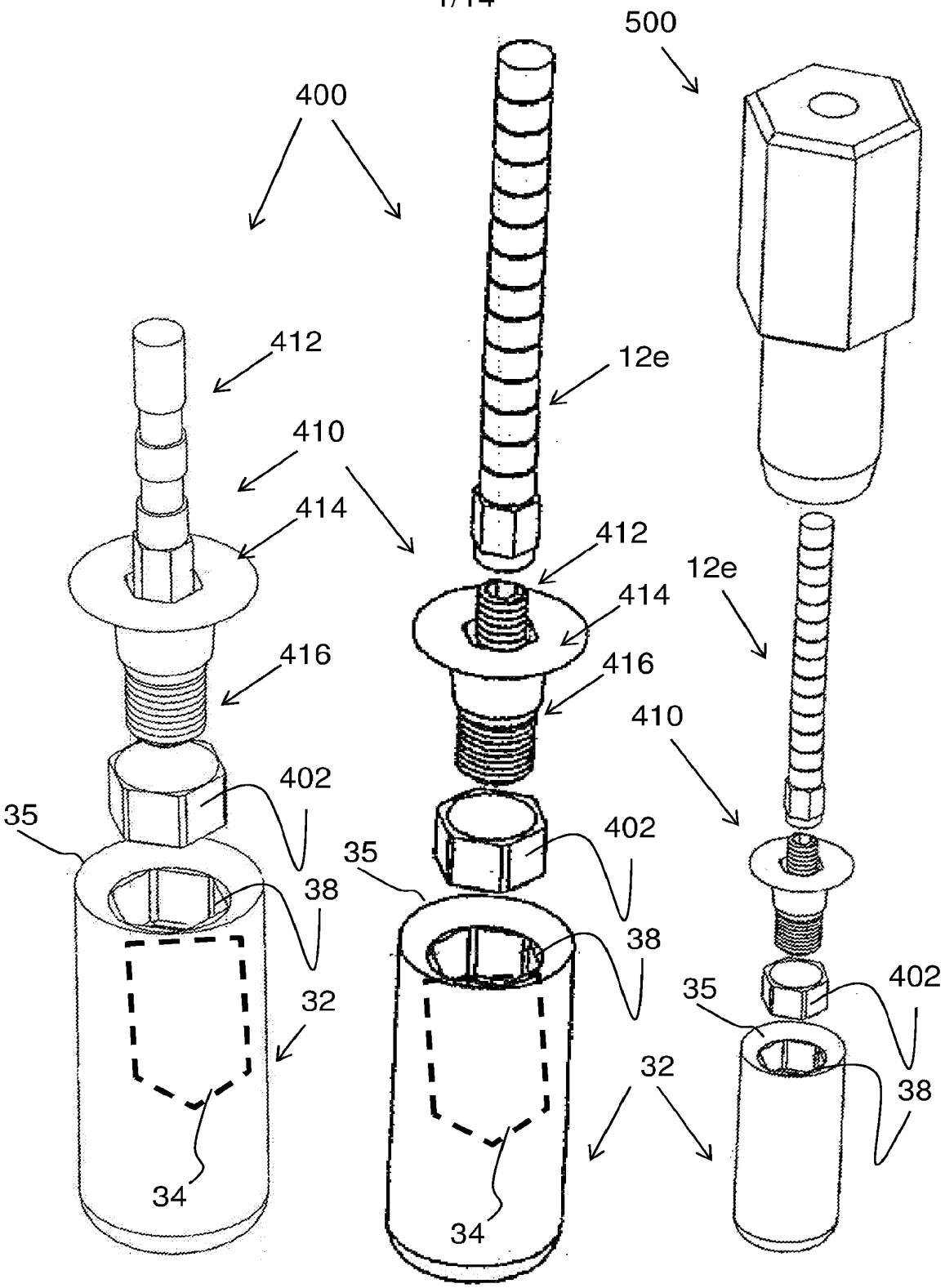


FIG. 1C FIG. 1B FIG. 1A

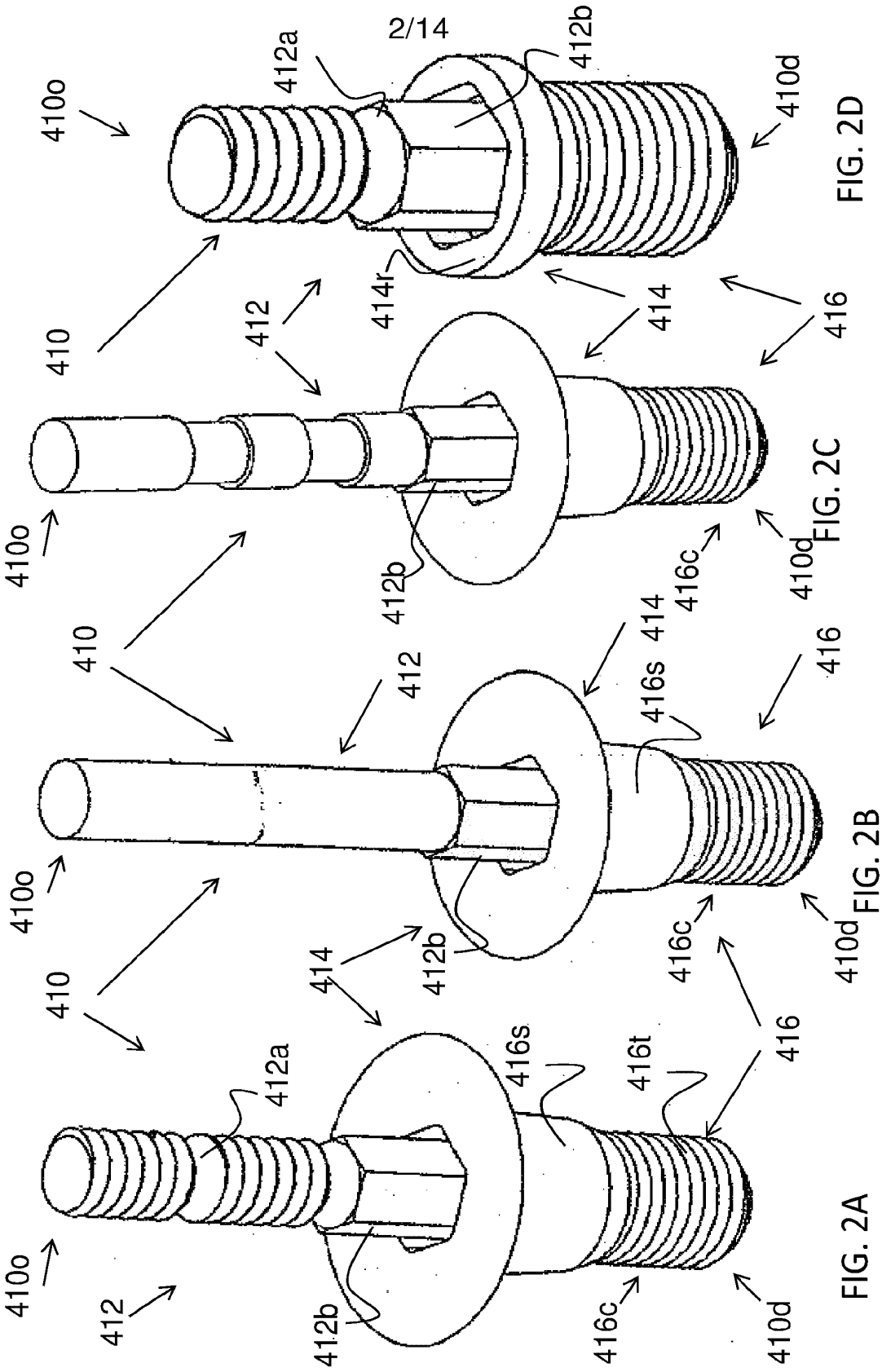


FIG. 2D

FIG. 2C

FIG. 2B

FIG. 2A

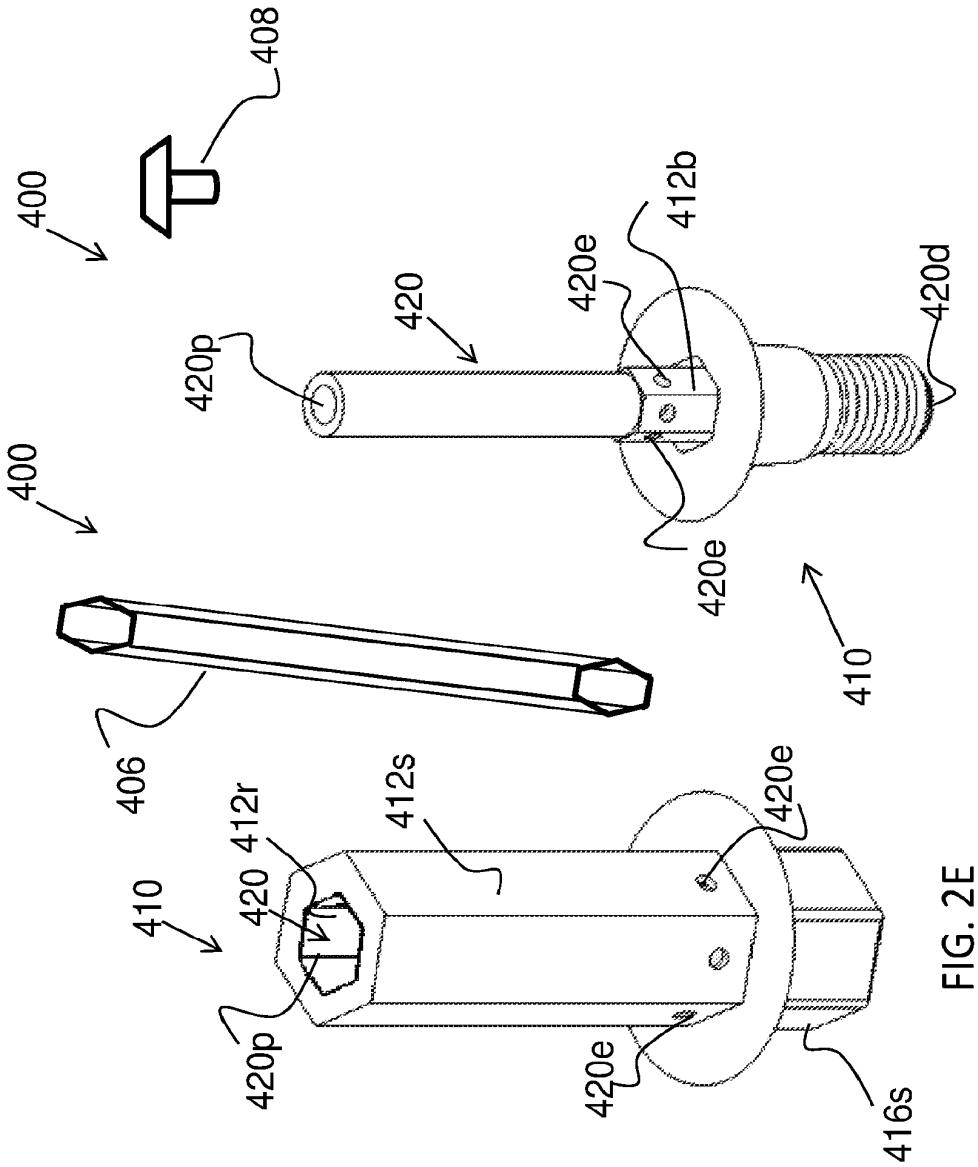

400
408
420
420p
412b
420e
420d
420e
400
406
410
410
420
412r
412s
420e
420p
420e
416s

FIG. 2F

FIG. 2E

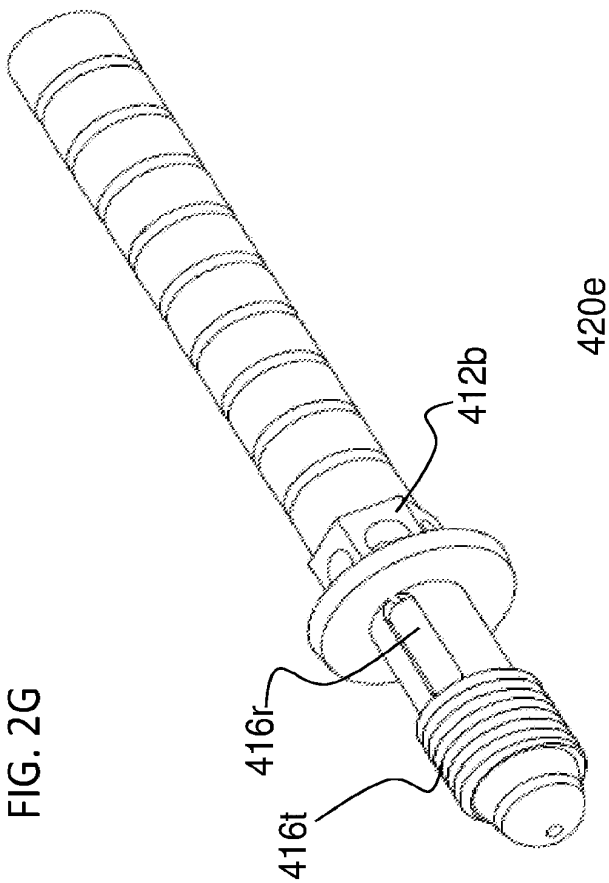


FIG. 2G

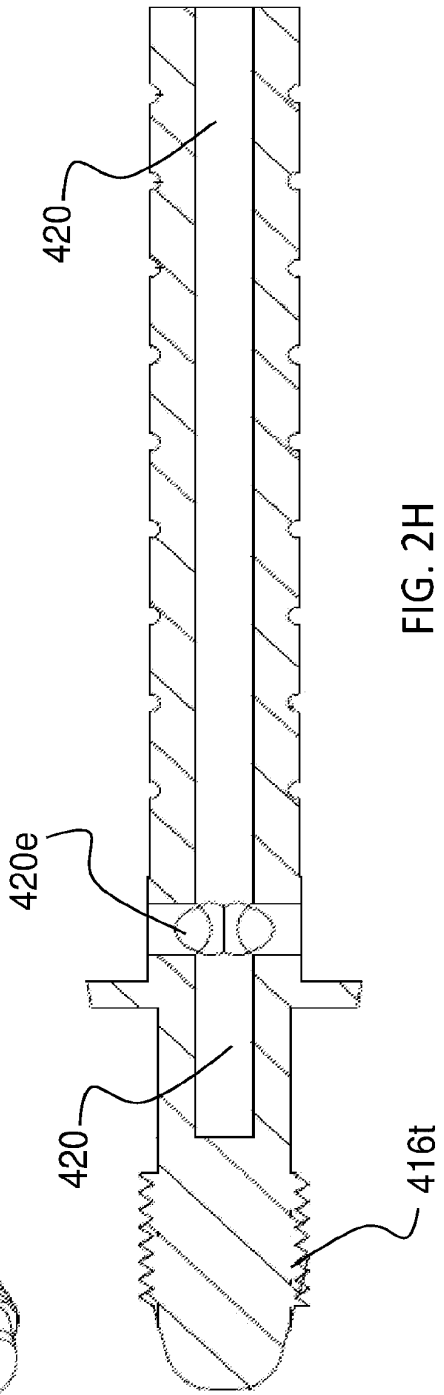
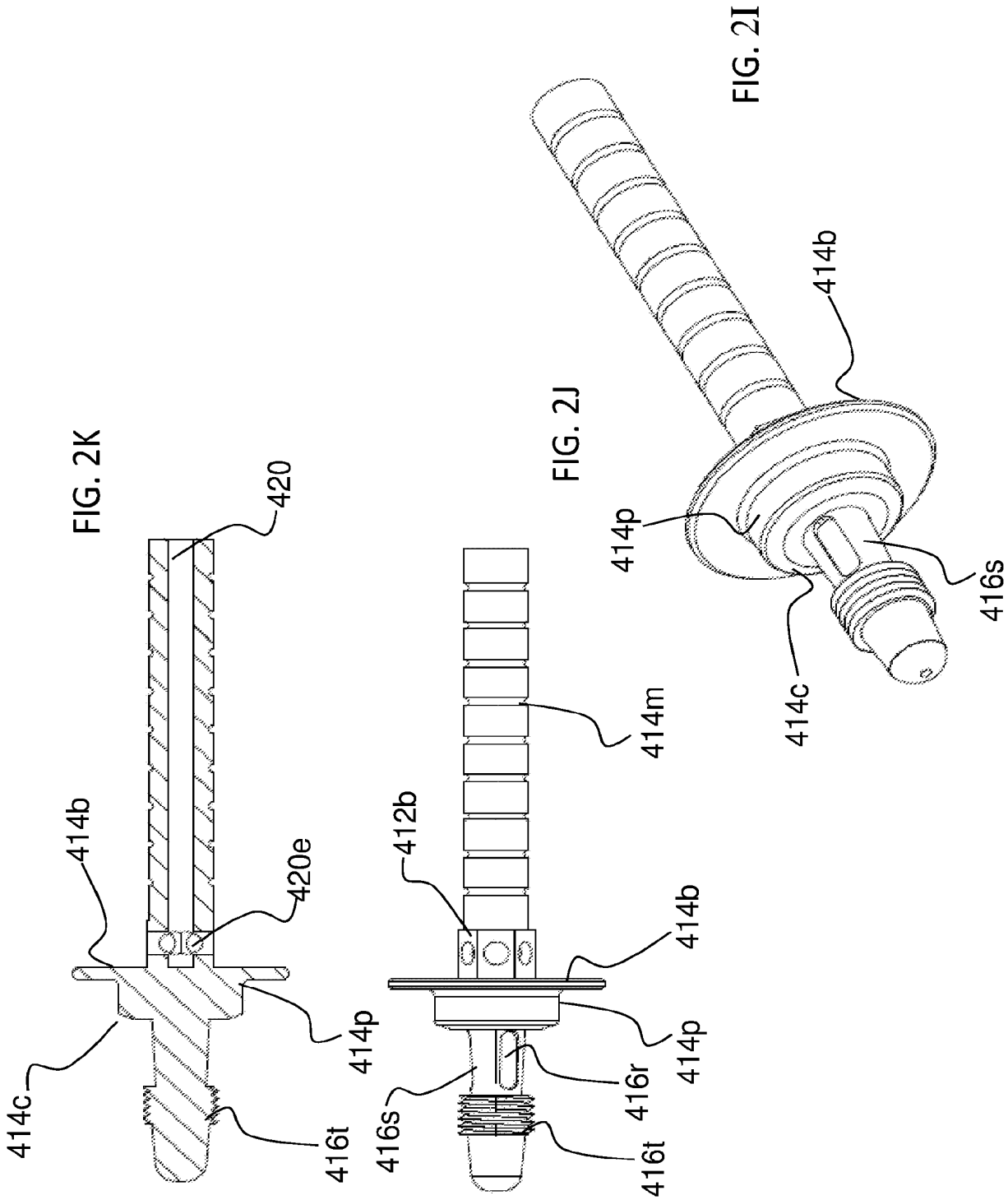


FIG. 2H


FIG. 2K
420
414b
420e
414p
414c
416t
FIG. 2J
412b
414m
414b
414p
416r
416s
416t
FIG. 2I
414b
414p
416s
414c

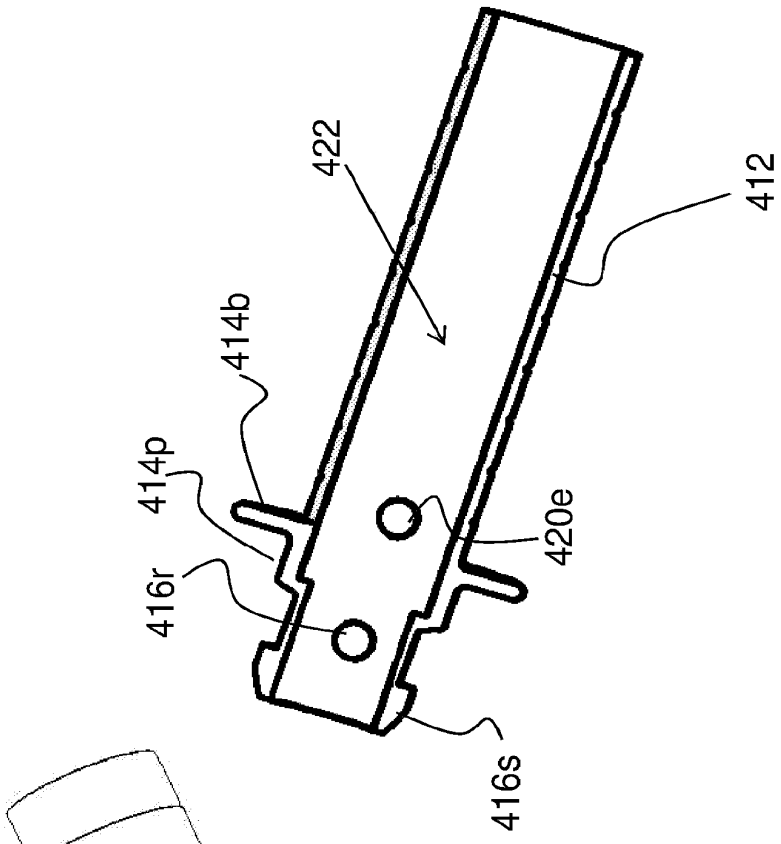


FIG. 2M

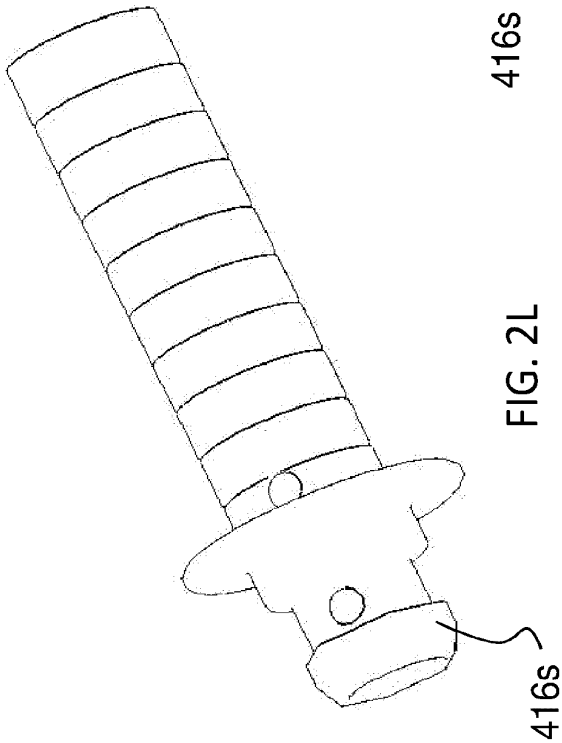


FIG. 2L

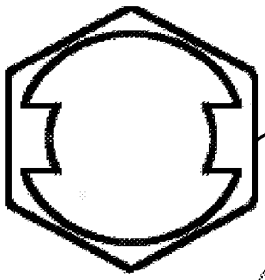


FIG. 2R

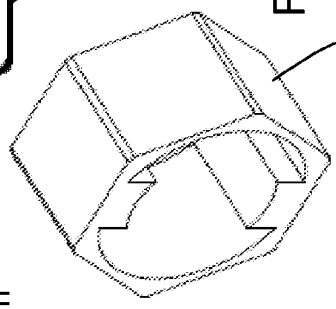


FIG. 2S

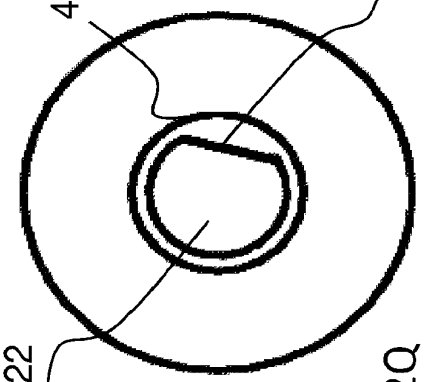


FIG. 2Q

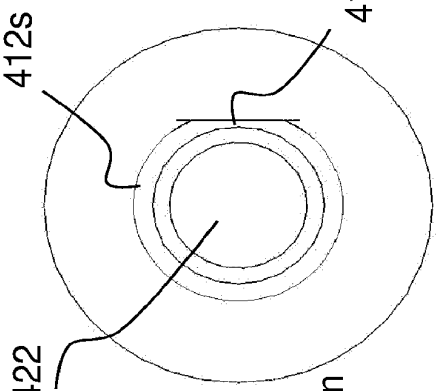


FIG. 2P

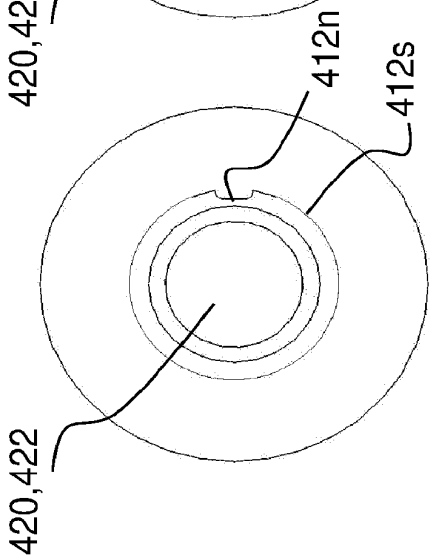


FIG. 2O

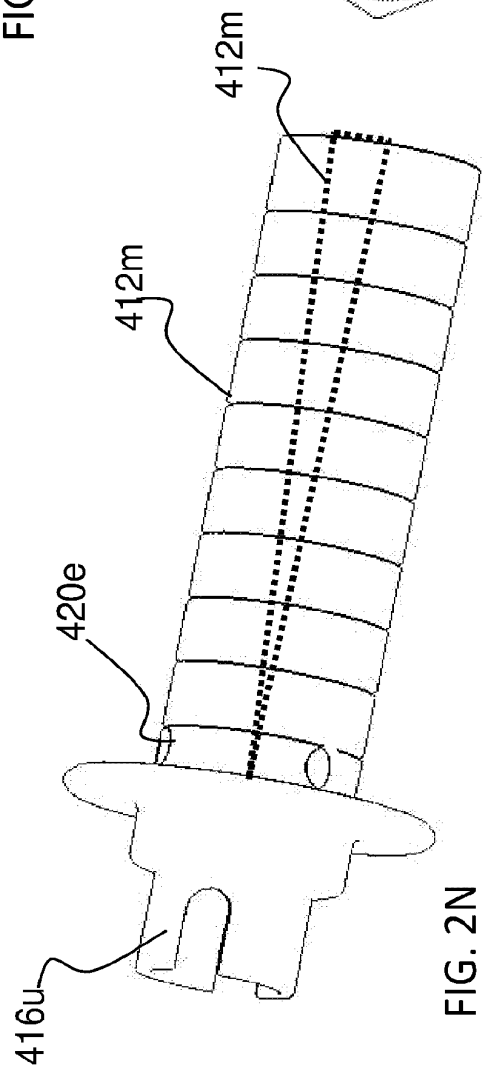


FIG. 2N

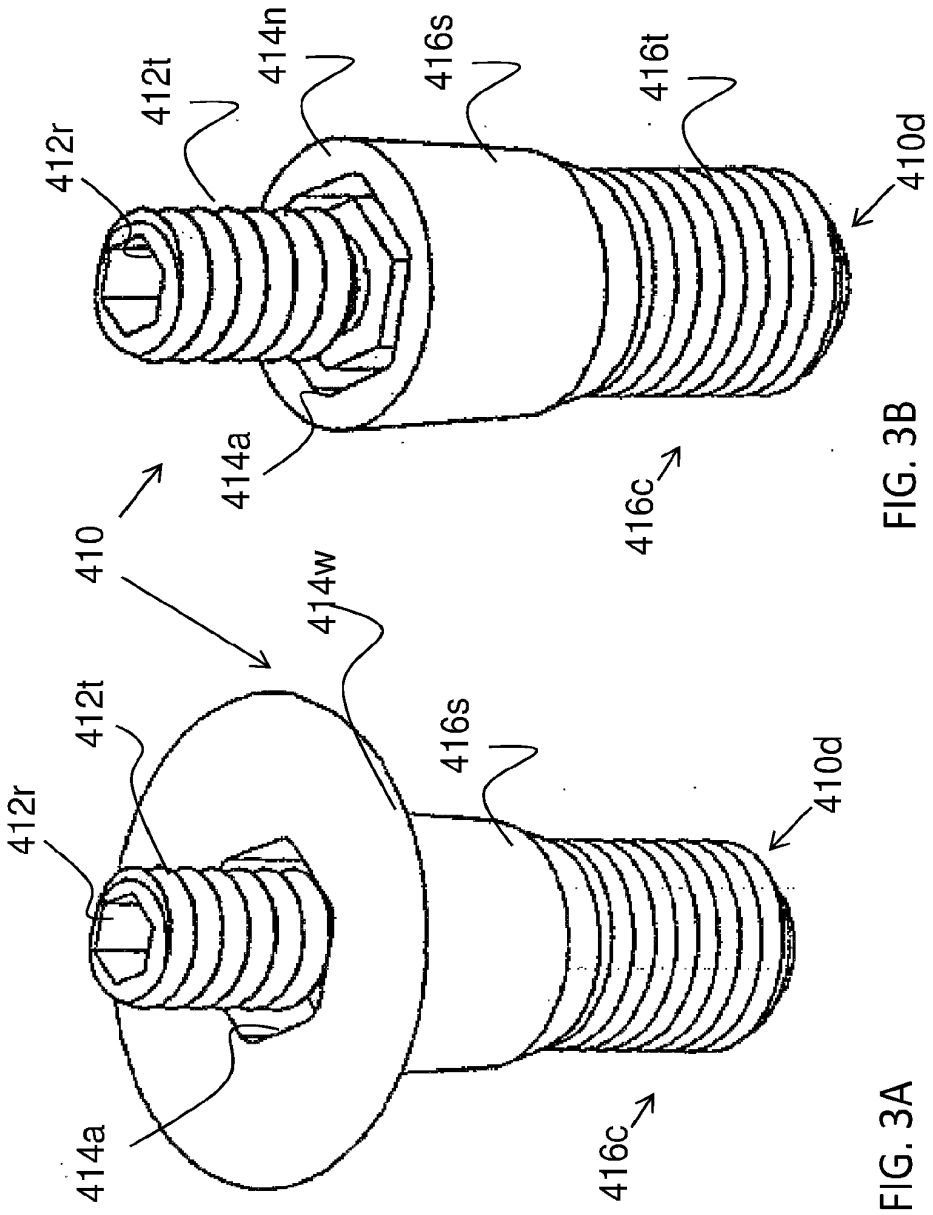


FIG. 3B

FIG. 3A

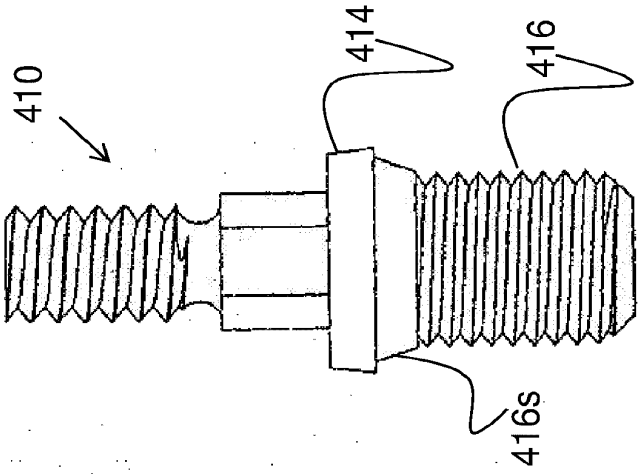


FIG. 4C

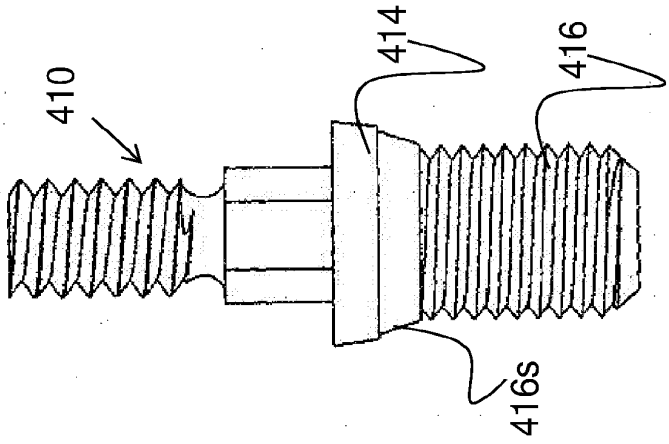


FIG. 4B

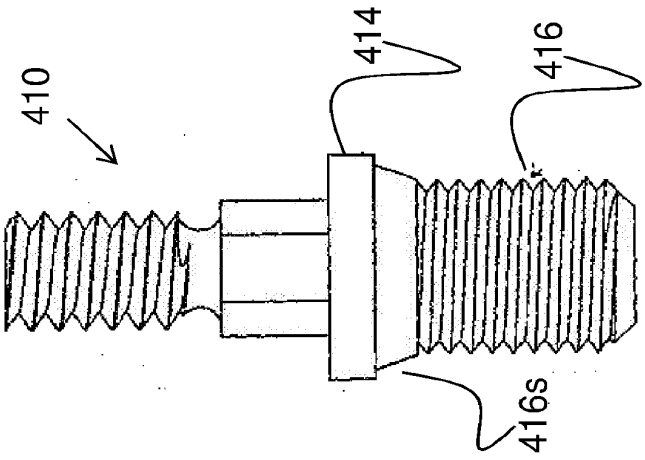


FIG. 4A

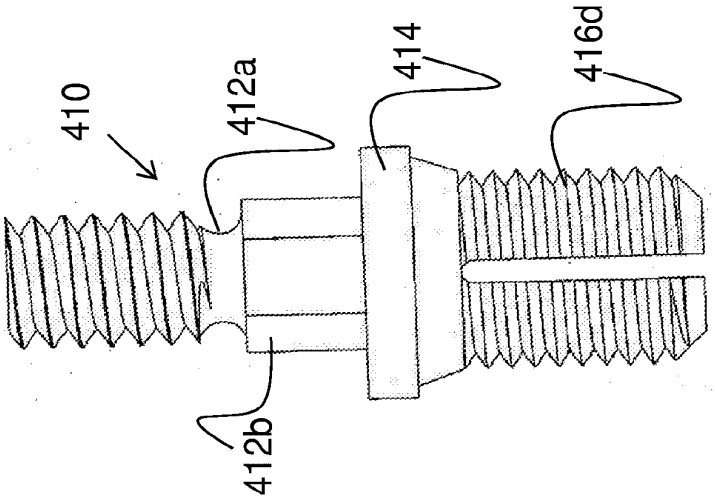


FIG. 4F

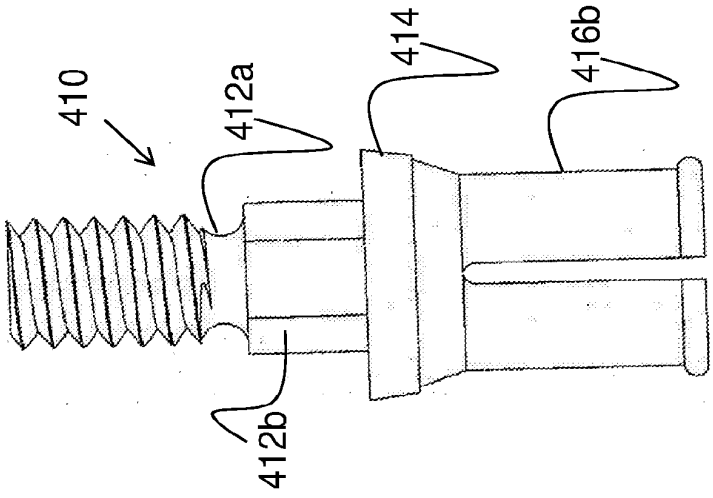


FIG. 4E

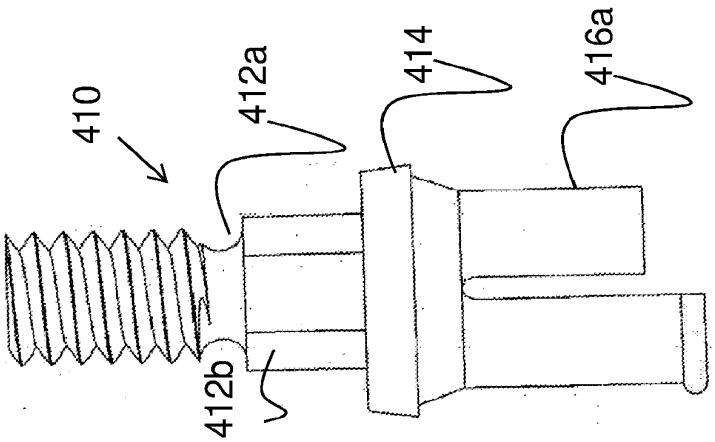


FIG. 4D

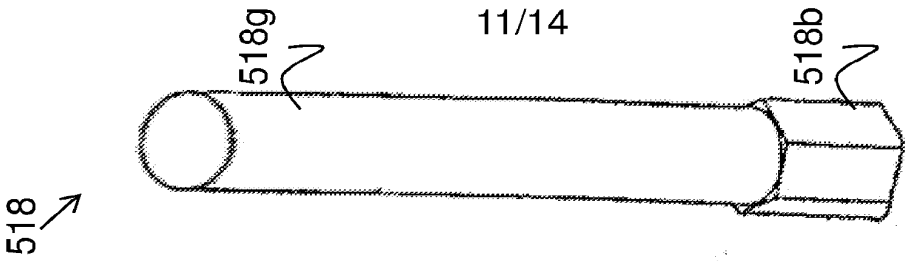


FIG. 8C

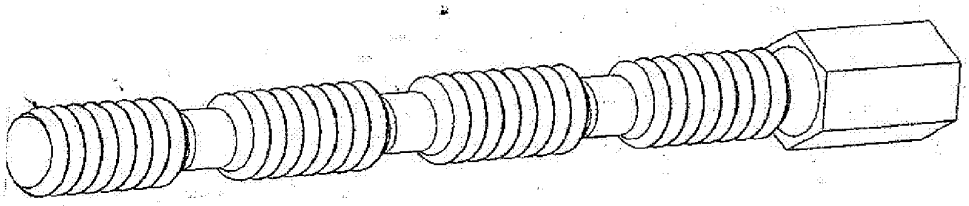


FIG. 8B

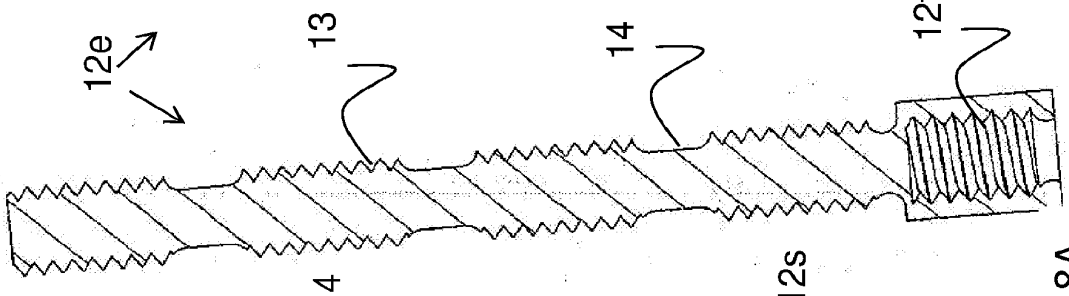


FIG. 8A

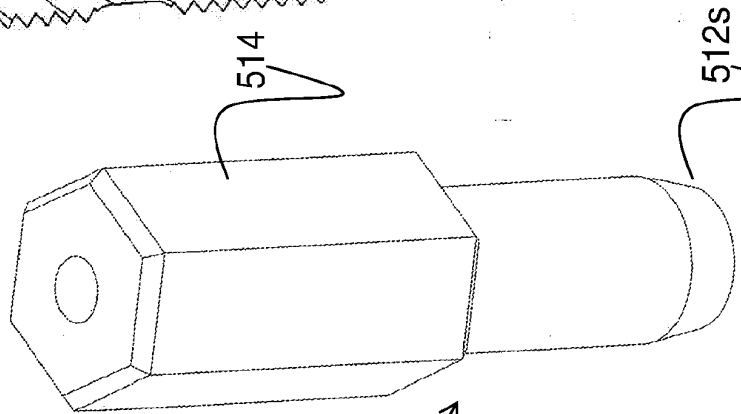


FIG. 5A

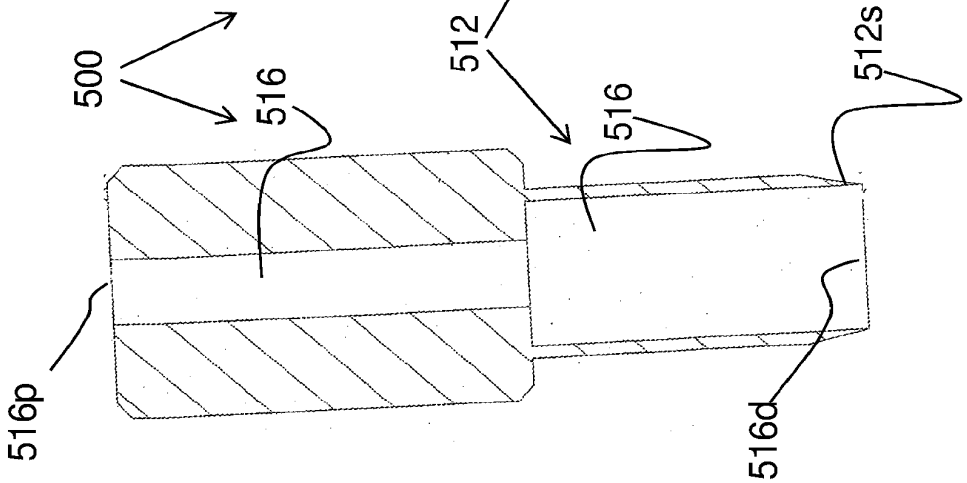


FIG. 5B

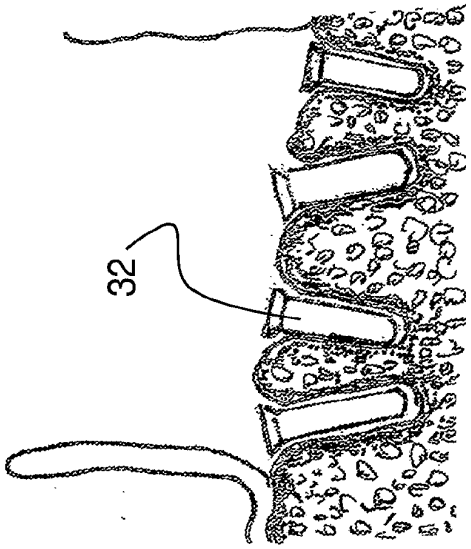


FIG. 6B

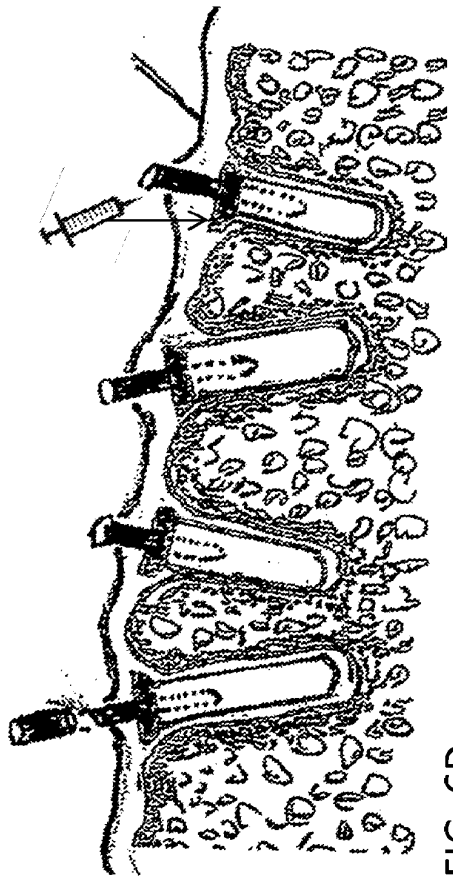


FIG. 6D

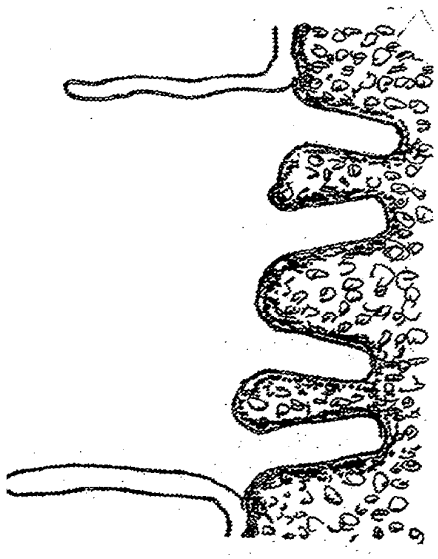


FIG. 6A

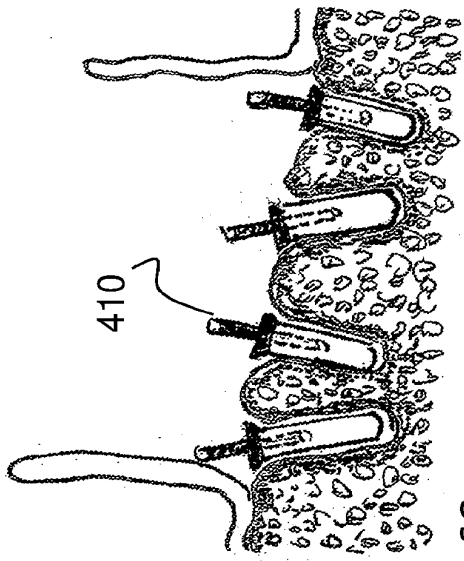


FIG. 6C

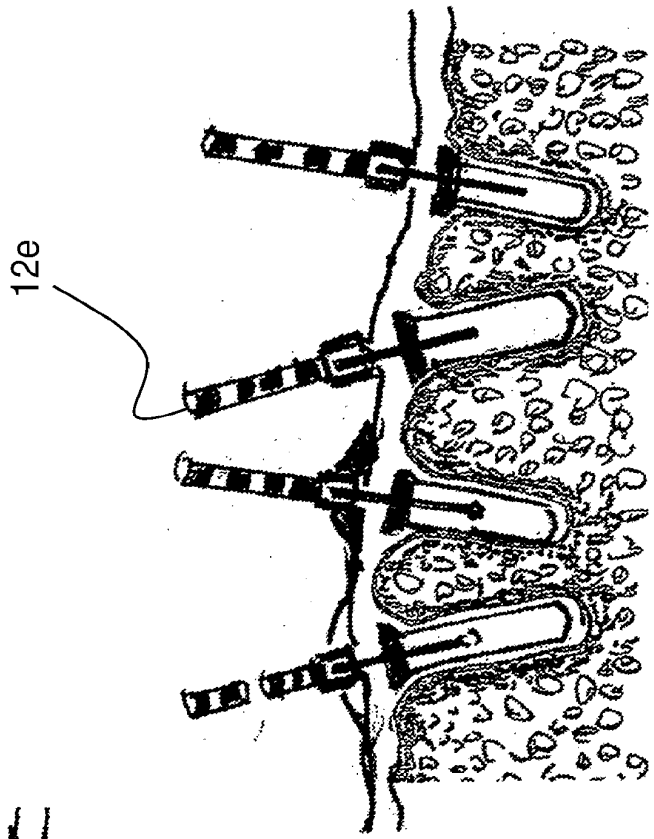


FIG. 6F

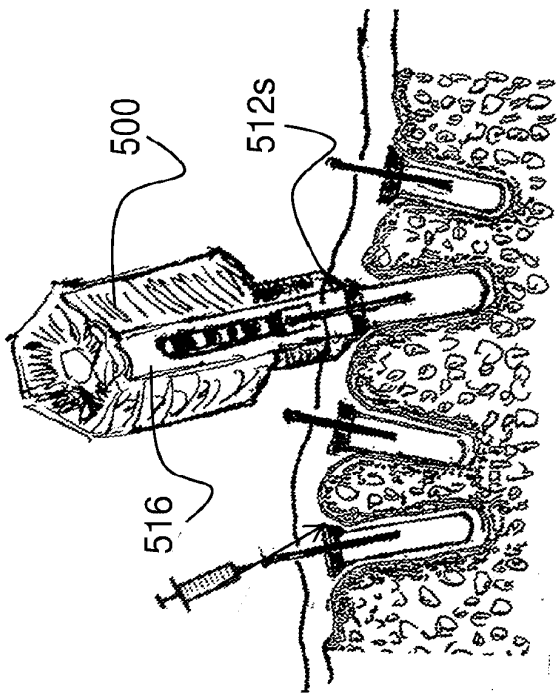


FIG. 6E

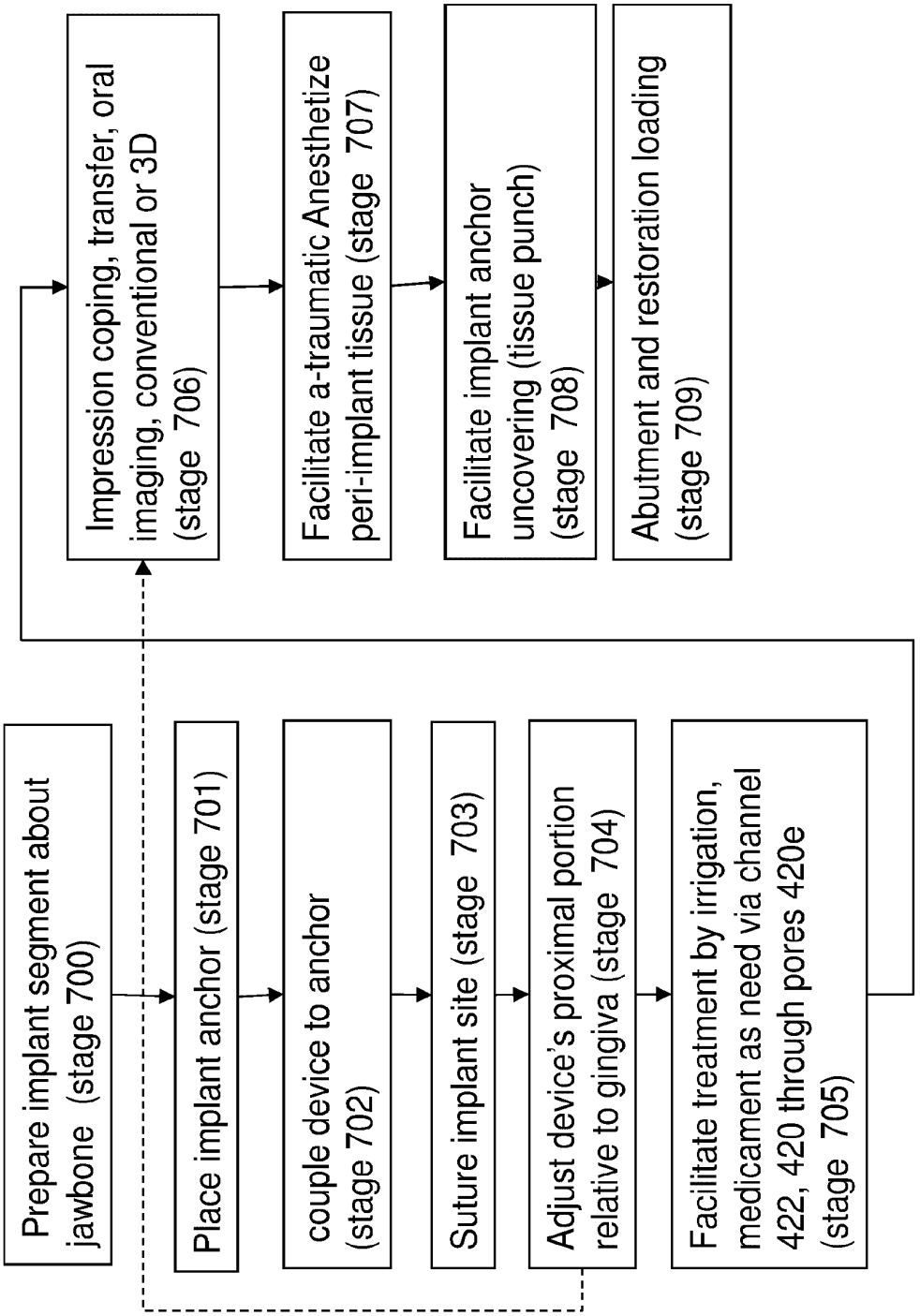

Prepare implant segment about jawbone (stage 700)
Place implant anchor (stage 701)
couple device to anchor (stage 702)
Suture implant site (stage 703)
Adjust device's proximal portion relative to gingiva (stage 704)
Facilitate treatment by irrigation, medicament as need via channel 422, 420 through pores 420e (stage 705)
Impression coping, transfer, oral imaging, conventional or 3D (stage 706)
Facilitate a-traumatic Anesthetize peri-implant tissue (stage 707)
Facilitate implant anchor uncovering (tissue punch) (stage 708)
Abutment and restoration loading (stage 709)

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IL2014/050511

A. CLASSIFICATION OF SUBJECT MATTER
IPC (2014.01) A61C 8/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC (2014.01) A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Databases consulted: THOMSON INNOVATION, FamPat database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	US 2012/0295223 A1 (BIOMET 3i, LLC) 22 Nov 2012 (2012/11/22) paragraphs [0011], [0041], [0042], [0050], [0055]; figures 1A-B, 6A-B	1-4,8-13,18-20, 23-25,31-33,41-43,50-52, 54,56-59,65 44-49
X	US 2007/0275351 A1 (PARK ET AL.) 29 Nov 2007 (2007/11/29) paragraphs [0044]-[0048], [0063]-[0068], [0072]-[0073]; figures 3, 8	1-8,10,14-18,41,42, 52
X	US 5816809 A (GENETIC IMPLANT SYSTEMS, INC.) 06 Oct 1998 (1998/10/06) Abstract; column 3, line 45 - column 4, line 31; column 5, lines 12-30; figure 2	1-8,14-20,22,36-39, 41,42
Y	US 2008/0241789 A1 (MUNDORF S.) 02 Oct 2008 (2008/10/02) paragraph [0079]; figure 2	44-47

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
01 Oct 2014	01 Oct 2014
Name and mailing address of the ISA: Israel Patent Office Technology Park, Bldg.5, Malcha, Jerusalem, 9695101, Israel Facsimile No. 972-2-5651616	Authorized officer SEGAL Liviu Telephone No. 972-2-5651782

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2011/0117522 A1 (COUNCIL OF SCIENTIFIC & IND. RESEARCH, NEW DELHI) 19 May 2011 (2011/05/19) paragraph [0145]; figures 4-6	48,49
A	US 2012/0009545 A1 (NOBEL BIOCARE SERVICES AG) 12 Jan 2012 (2012/01/12) the whole document	1-71
A	US 2003/0224328 A1 (SAPIAN L. S.) 04 Dec 2003 (2003/12/04) the whole document	1-71
A	US 6386876 B1 (LEE K.) 14 May 2002 (2002/05/14) the whole document	1-71

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2014/050511

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
US 2012/0295223 A1	22 Nov 2012	US 2012295223 A1	22 Nov 2012
		AU 2012255865 A1	12 Dec 2013
		CA 2833215 A1	22 Nov 2012
		EP 2709554 A1	26 Mar 2014
		JP 2014515960 A	07 Jul 2014
		US 2012295226 A1	22 Nov 2012
		US 2013196290 A1	01 Aug 2013
		WO 2012158769 A1	22 Nov 2012
US 2007/0275351 A1	29 Nov 2007	US 2007275351 A1	29 Nov 2007
		US 8177556 B2	15 May 2012
		CN 101081180 A	05 Dec 2007
		CN 101081180 B	22 Jun 2011
		EP 1862142 A1	05 Dec 2007
		EP 1862142 B1	14 Nov 2012
		ES 2398086 T3	13 Mar 2013
		JP 2007313287 A	06 Dec 2007
		JP 4694453 B2	08 Jun 2011
		KR 100677870 B1	26 Jan 2007
US 5816809 A	06 Oct 1998	US 5816809 A	06 Oct 1998
		US 6007336 A	28 Dec 1999
		US 6205837 B1	27 Mar 2001
US 2008/0241789 A1	02 Oct 2008	US 2008241789 A1	02 Oct 2008
		CN 101146492 A	19 Mar 2008
		DE 102005008273 A1	24 Aug 2006
		EP 1855610 A1	21 Nov 2007
		EP 1855610 B1	30 Jul 2014
		JP 2008531095 A	14 Aug 2008
		KR 20070114364 A	03 Dec 2007

Form PCT/ISA/210 (patent family annex) (July 2009)

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
		WO 2006089728 A1	31 Aug 2006
US 2011/0117522 A1	19 May 2011	US 2011117522 A1	19 May 2011
		EP 2231057 A2	29 Sep 2010
		WO 2009054005 A2	30 Apr 2009
		WO 2009054005 A3	15 Oct 2009
		WO 2009054005 A4	23 Dec 2009
US 2012/0009545 A1	12 Jan 2012	US 2012009545 A1	12 Jan 2012
		AU 2010219145 A1	08 Sep 2011
		CN 102307539 A	04 Jan 2012
		CN 102307539 B	12 Mar 2014
		EP 2400917 A1	04 Jan 2012
		EP 2400917 B1	04 Dec 2013
		EP 2712573 A2	02 Apr 2014
		ES 2450142 T3	24 Mar 2014
		JP 2012518502 A	16 Aug 2012
		KR 20110121684 A	08 Nov 2011
		US 2014124374 A1	08 May 2014
		WO 2010097214 A1	02 Sep 2010
US 2003/0224328 A1	04 Dec 2003	US 2003224328 A1	04 Dec 2003
		US 6939135 B2	06 Sep 2005
US 6386876 B1	14 May 2002	US 6386876 B1	14 May 2002
		US 2002064758 A1	30 May 2002
		AU 2041702 A	11 Jun 2002
		CA 2430278 A1	06 Jun 2002
		CA 2430278 C	07 Jun 2005
		EP 1339344 A1	03 Sep 2003
		WO 0243610 A1	06 Jun 2002

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IL2014/050511

Patent document cited search report	Publication date	Patent family member(s)	Publication Date
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190-196 Review Article

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Different Mechanical Complications of Implant Prosthodontics: Review Article

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Received October 03, 2014; Revised November 11, 2014; Accepted December 25, 2014

Abstract Nowadays implant therapy is an effective and reliable treatment with a high success rate, but various mechanical Complications can occur. Thus, the scope for prevention and management needs to be emphasized. The aim of this review article is to identify the different causes of dental implant failure due to fixture and or abutment screw fractures and to describe the management and the preventive options for these failures, so trying to assist the clinicians to plan accurately the implant-supported prosthesis treatment.

Keywords: *abutment screw fracture, implant fixture fracture, implant failure* **Cite This Article:** Mohamed Y.Abdelfattah, "Different Mechanical Complications of Implant Prosthodontics: Review Article." *International Journal of Dental Sciences and Research*, vol. 2, no. 6 (2014): 190-196.
doi: 10.12691/ijdsr-2-6-17.

1. Introduction

The longevity and success of an implant-retained or implant-supported prosthesis depend primarily on biological and mechanical factors [1]. The implant failure can be classified into early or late failures. Early failures occur shortly after surgery and characterized by the lack of osseointegration. In contrast, late failures correspond to those implants that have been regarded as successful for some time, and they occur after prosthetic restoration has been made [2,3].

There are two main causes for late implant fracture:

(a) *Mechanical problems*, the most frequent cause, including Metal fatigue, due to biomechanical overloading leading to loosening /or fracture of abutment or prosthetic screws and the wear and fracture of the prosthesis or various components in the system.

(b) *Biological problems*, loss of supporting tissue secondary to infection or peri-implantitis; the prevalence of periimplantitis is estimated to be 4-15% among the surviving implant population (i.e., implants still in the mouth) [4,5].

The present review identifies the different causes of dental implant failure due to fixture and or abutment screw fractures and also to describe the management and the preventive options for these failures. However, to solve these complications, one needs to understand the mechanics of such components.

2. Implant Fixture Fracture

2.1. Causes

a) Mechanical overloads; as a result of:

i. Metal fatigue when the resistance limit is exceeded.
ii. Patient's physiological alterations (e.g., para functional activity).
iii. Prosthetic problems, including inadequate occlusion, the presence of distal extensions or cantilevers in implant-supported prostheses, and a lack of prosthetic passive fit over the implants [6-10].

b) Peri implant vertical bone loss; as a result of:

i. Chronic peri-implant inflammation. ii. Occlusal trauma.

When vertical bone loss coincides with the apical limit of the screw, thereby joining trans-epithelial abutment to implant, the risk of implant fracture increases drastically [6-11].

c) Defects in implant design and manufacturing:

Metal fractures are related to microstructures that influence the material properties. They are related to the localized identification of chemical phases and segregations, frequently associated with failures at interfaces or components, which in turn can cause the fractures [12,13].

2.2. Incidence/Location of Implant Fracture

The incidence of dental implant fracture is between 0.16-1.5% as reported in the literature [14-19]. One study reported that the majority of fractured implants are located

in the regions of the molars and premolars [7,11,20] and that the fractures were evenly distributed between the maxilla and the mandible, [12] whereas another study reported more fractures in the maxilla than in the mandible. [20]

2.2.1. Diameter of Implant

Implants with small diameters such as 4 mm [20] and 3.75 mm [12,13] tend to fracture more easily than those with large diameters, especially when placed in a posterior location. A study has reported that an implant with a diameter of 5.0 mm is three times stronger than one with a diameter of 3.75 mm, whereas a 6.0-mm implant is six times stronger than a 3.75-mm implant [20].

2.2.2. Mechanism of Implant Fracture

Coronal bone resorption observed in most implant fracture cases has been described as a primary cause of fracture [7,21,22,23] Loss of supporting bone if extended to the level corresponding to the end of the abutment screw, the bending resistance in this region will be reduced. When such resorption extends apically beyond the third implant thread, it reaches a structurally weak zone coinciding with the end of the prosthetic screw and the border of the hybrid surface. This contributes to the fatigue at a point of low resistance to torque. The warning signs of such fatigue include loosening, torsion, or fracture of the post screws, and ceramic fractures of the prosthesis.

2.2.3. Clinical Manifestations

Patients may often report spontaneous bleeding and mobility. Exploration (manually or electronically) confirms increased mobility, increased pocket depth, and gingival indexes, and occasionally, also, plaque accumulation resulting from the patient's fear of the pain is triggered by brushing. Radiologically, separation of the fragments and bone loss may be seen. It has been reported that marginal bone reabsorption seems to be the most important risk factor indicating the start of an implant fracture, and may often extend beyond the actual fracture line [12]. Thus, an x-ray study is very useful.

For diagnostic purposes, the fracture risk factors have been grouped into three main categories [Table 1]. In the presence of more than three factors pertaining to one or more of these categories, the risk of fracture is high. [24]

Table 1. Clinical findings frequently documented in the literature and related to implant fracture, grouped by categories.

Patient factors	Implant factors	Prosthetic fractures
Pocket depth >5 mm	Diameter <4 mm	Loosening/torsion prosthesis screw
Bone loss	Crown/implant >1	Cantilevers
Overload (bruxism)	Implants design	Ceramic fracture

2.3. Management

There are three management options in the event of an implant fracture: [12,25]

a) Complete removal of the fractured implant using explanation trephines [12,25]. After the removal of the fractured implant, a new larger diameter implant can be installed at the same surgical bed or at another place to achieve primary stability [22] Their complete removal is considered to be the best solution to the problem
b) Removal of the coronal portion of the fractured implant with the purpose of placing a new prosthetic post [12,25]. It is essential to radiologically confirm the absence of radio transparency and to electronically determine the mobility of the fragment. A prosthetic post should be considered only if there is still sufficient remaining internal thread retention [12].
c) Removal of the coronal portion of the fractured implant, leaving the remaining apical part integrated in the bone [12,25] and the missing tooth/teeth can be restored using conventional prosthodontic procedures like removable partial denture, fixed partial denture etc.

A recent study described "apicoectomy" as a suitable technique for removing fractured implants and inserting new implants at the same clinical session. This technique was based on opening a hole in the bone in order to improve the visualization of the apical fragments of the fractured implants and to remove those fragments through this hole. Afterward, a new implant is placed in a conventional manner, and the hole is closed by using the same bone that is removed from the patient [26].

2.3.1. Preventive Measures

The following preventive measures have been suggested:

a) Avoid placing hybrid-type implant fixtures.
b) Carefully control occlusal forces: Eliminate all posterior contacts in mandibular eccentric movements
c) Perform staggered placement of implants: Avoid a straight-line configuration
d) Avoid or minimize posterior cantilevers and buccolingual offsets, particularly in partially edentulous patients
e) During the chronic loosening of gold or abutment screws or the fracture of components, critically reassess the prosthesis, retighten the abutment or use a gold screw, and check the fit.
f) Pronounced bruxers or clenchers who have experienced multiple implant fractures should be managed by the placement of additional implants fractures [20].
g) Ensure perfect fit: Resolder and assess passive fit [27].

2.4. Implant-Abutment Connection System

Two types of screws are used in implant dentistry: abutment screws and prosthetic screws. Abutment and prosthetic screws come in various shapes and sizes and are made from a variety of materials, including gold, commercially pure titanium, and surface-treated or coated titanium alloys. Although seemingly simple, the mechanics of abutment and prosthetic screws are complex, a phenomenon described as screw joint mechanics [28].

The misfit at the abutment-implant interface and the absence of a passive adaptation between the prosthesis and the abutment can lead to fracture and the most common technical complication is a fracture of the abutment screw.

Straumann USA Exhibit 1020

The stability of the implant abutment connection is influenced by factors such as internal connection versus external connection, screw head design, screw geometry, materials, screw diameter, preload, joint separating force, settling effect, and overall screw mechanics.

Factors affecting the implant-abutment connection system are as follows:

2.4.1. Internal Connection versus External Connection

The implant-abutment interface connection is generally described as an internal or external connection. Relative to external connections, the internal implant-abutment connections have been shown to present a higher stability and improved force distribution as a result of :

a) The internal implant-abutment connections have the ability to dissipate lateral loads deeply within the implant, there by shielding the abutment screw better from stress.
b) The longer internal wall engagement that creates a stiff, integrated body to resist joint opening (micro movement) [29,30].
c) After cyclic loading the internal abutment connection is stronger relative to external connections [31,32].

While mechanical strength is gained, the thinner lateral fixture wall at the connecting part of the internal connections may lead to a higher absolute strain value at the cervical area. Such stress shift has raised concerns regarding an increased risk of marginal bone resorption or fixture fracture [33].

Although there are studies that show that the fracture strength in implant systems with an external fixation is equal or superior to those with internal fixation [34,35].

The literature supports a gold alloy screw with a flat head, internal hex or square, and a high tightening force (torque driver) as having the greatest ability to produce the best results [36].

2.4.2. Screw Head Design

- To maximize the preload and minimize the loss of input torque to friction, the head of the screw should be wider than the thread diameter.
- An abutment head most often should be flat. A tapered head design reduces the clamping effect and reduces the tensile force in the threads of the screw. The tapered screw head distorts and aligns non passive components and gives a non passive casting the appearance of proper fit. However, the superstructure is not deformed permanently and leads to stress in the system. A flat-head screw distributes forces more evenly within the threads and the head of the screw, and is also less likely to distort a non passive casting. As such, the abutment head should also be flat on top to increase the clamping force in the screw head and the tensile force in the threads [37].

2.4.3. Screw Material

The most commonly used retaining screws are either of gold or titanium. Gold screws are designed to be the most "flexible" portion of the implant assembly. Due to their higher modulus of elasticity than titanium, they permit an adequate micro movement to distribute force to the implant body [38]. Implant posts, that are retained with gold or gold coated screws, show a reduction of screw loosening and improved clamping force in comparison with titanium screws [39,40].

Titanium alloy has four times the bending fracture resistance of grade 1 titanium. Therefore, abutment screws made of grade 1 titanium will deform and fracture more easily than the alloy. A higher torque magnitude can be used on the titanium alloy abutment screw and implant body [39]. Titanium retaining screws are stronger than gold, but have a lower modulus of elasticity; metal fatigue will produce a gold screw fracture before the titanium retaining screw is affected.[41] The major disadvantage of titanium retaining screws is their tendency to cause galling, which results in excessive friction between the two mating surfaces thereby causing a localized welding with a further roughening of the mating surfaces. [42] Galling occurs in the following manner: Titanium of the retaining screw slides in contact with the titanium of the implant body, the coefficient of friction increases whereby titanium molecules transfer from the mating surfaces. [43] This has been described as the adhesive wear mechanism [44] which causes slight damage to both the implant body and the retaining screw threads.

2.4.4. Screw Diameter

The greater the diameter, the higher the preload that may be applied and the greater the clamping force on the screw joint. As a general rule, abutment screws loosen less often and can take a higher preload than coping screws [45].

2.4.5. Preload

The screw joint has been described as two parts tightened together by a screw, such as an abutment and implant being held together by a screw. The initial clamping force, or preload, is the tensile force that develops when the screw is tightened into place. Preload depends on the torque applied, material, and design of the screw, and surface roughness [46]. Frictional forces that develop between the screw threads make the applied torque inversely proportional to the preload, so the more torque that is applied, the more preload is lost [47,48]. If the torque delivered to a screw is not optimal, screw loosening may occur, making the system susceptible to fracture under occlusal load. As a screw is tightened, it elongates, thereby producing tension. Elastic recovery of the screw pulls the two parts together, creating a clamping force [49]. Excessive forces cause slippage between the threads of the screw and the threads of the bone, resulting in the loss of the preload [50]. Fractured abutment and prosthetic screws are a challenging and time-consuming complication in implant dentistry [51]. When a screw fractures, the fragment inside the implant or abutment must be removed, or the implant must be modified. Otherwise, it may lose its original ability to retain prosthesis and could become useless [50].

2.4.6. Joint Separating Forces

Intra oral separating forces may include off-axis occlusal contacts, lateral excursive contacts, interproximal contacts between natural teeth and implant restorations, protrusive contacts, para functional forces, and non passive

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frameworks that attach to the implants. Opposing the clamping force is a joint-separating force, which attempts to separate the screw joint. Screw loosening occurs when the joint-separating forces acting on the screw joint are greater than the clamping forces holding the screw unit together [41].

2.4.7. Settling effect

Settling occurs as the rough spot interfaces flatten under load/micro movements, since they are the only contacting surfaces when the initial tightening torque is applied [51]. It has been reported that 2-10% of the initial preload is lost as a result of settling [52]. This reduction effect is known as embedment relaxation [53].

2.4.8. Process of Screw Loosening

The process of screw loosening has been described in two stages [54]. Initially, external forces such as mastication applied to the screw joint causes slippage, contributing to the release of preload of the screw. The second stage of loosening involves continual preload reduction below critical level, allowing threads to turn and the loss of intended screw joint junction [55].

2.4.9. Incidence of Screw Loosening

A literature review of clinical complications of osseointegrated implants showed that screw loosening or screw fracture varied from 2 to 45% of the implant restorations, with the highest amount in single crowns [8]. In one of the systematic reviews that evaluated the 5-year survival rates of implant-supported single crowns, it was observed that from the 26 clinical studies included, the cumulative incidence of abutment screw or abutment loosening was 7.3% after 5 years of clinical service in both external and internal connections [56].

2.4.10. Location of Screw Loosening

Posterior abutment screws loosen at a higher percentage than anterior implants. This supports the project of eliminating unnecessary occlusal and off-axial forces on implant-supported restorations [36]. One of the studies have reported a 38% loosening of single implant restorations in the posterior maxilla and mandible, but such studies do not take into account various important factors [57].

2.4.11. Preventive Management

a) It is recommended in clinical practice that in order to reduce the settling effect, the implant screws should be retightened 10 min after the initial torque application [58,59,60,61].
b) Mechanical torque gauges should be used instead of hand drivers to ensure a consistent tightening of the implant components to recommended torque values [51].
c) The use of sealers to fill in the gaps between these crews and implant threads and adhesives to increase the frictional resistance has been suggested to reduce screw loosening. (Ceka Bond, Preat, San Mateo, CA) is listed as an adhesive paste on the package insert. [62]
d) Cho et al 2004 [36] supported the following clinical recommendations:
   i. Ensure that implants are placed perpendicular to the occlusal plane.
   ii. Frameworks should have minimal cantilever lengths.
   iii. Use components with low tolerance levels for component misfit.
   iv. Use components with anti rotational features for single tooth restorations.

2.4.12. Clinical Techniques to manage Fractured Abutment Screws

Generally, treatment or intervention should always mitigate future risk and improve the prognosis [62]. In certain situations, however, the intervention itself may be the biggest risk factor. In reviewing published studies, some techniques have been found to be clearly more likely to cause irreversible damage to the implant components and should therefore be considered higher risk procedures. Because a direct relationship exists between the risk of damage and degree of difficulty, the clinician must understand not only the technique itself but also the inherent risks and difficulty associated with each technique

2.4.13. Examination and Diagnosis

The first step in managing any fractured screw is to obtain a detailed history and perform a thorough clinical examination. Every attempt should be made to determine the cause of the screw fracture to minimize the risk of subsequent complications. The next important step is to confirm that the screw is fractured and determine the location of the fracture. Generally, fractures that occur above the implant level are easier to manage than fractures occurring more apically. Screw fracture may be confirmed by direct visualization, radiographic examination, tactile sensation through the use of an instrument, comparison with an undamaged screw of the same system, or by using other undamaged components of the same system to see if an obstruction is prohibiting complete seating. If the restoration has been missing for an extended period, the peri-implant soft tissue may overgrow, making access to and visualization of the implant difficult. In this situation, a low-frequency diode laser may be used to trim the tissue and expose the implant platform. Use of an electrosurgery unit or scalpel should be avoided to avoid any heat transfer within the implant or scratching of the implant surface. Other techniques that may help to improve visualization include the use of dental loupes with a coaxial or light-emitting diode headlamp or a dental surgical microscope, especially in situations with deep screw fractures [63,64].

The application of risk-based decision-making plan, in relation to the various reported techniques for managing fractured screws may allow for a logical and structured approach in managing fractured abutment and prosthetic screws.

2.4.14. Low Risk: Basic Instrumentation and Instrument Modification

Once the appropriate examination and diagnostic steps are complete, a tentative plan should be established using the proposed decision making tree [1,65,66,67,68,69]. A

small rigid instrument such as a scaler, sickle explorer, or endodontic explorer was the initial instrument of choice for rotating the remaining apical portion counterclockwise and removing the fractured fragment. Oblique fractures may be easier to manage with this technique because a purchase point usually exists in which the instrument may be engaged. Although this is considered a low-risk choice, care should always be used in engaging the broken segment with any instrument because the instrument may fracture or damage the internal threads of the implant. Flexible instruments such as endodontic files or modified instruments should be used with caution because of the decreased strength of the instrument. If the fractured segment does not move with use of a hand instrument, an ultrasonic scaler can be used to loosen the screw [67]. This technique can be used in conjunction with standard instrumentation or in an alternating fashion, but care must always be taken not to damage the internal threads of the implant. In addition, this method should only be attempted a few times to ensure that the broken segment is not wedged further into the implant. Sometimes, even after the screw has been loosened, it is still difficult to grasp and remove. If a loose fragment is near the platform, a cotton tip applicator may be used as a driver, as the cotton threads can often grip the fragment, making removal easier [69].

2.4.15. Moderate Risk: Screw Modification

If the remaining screw fragment cannot be rotated with basic hand instruments, it may be rotated using rotary instruments [50,70-78]. This can be done by introducing a bur, a drill, or a trephine mounted on a handpiece into the internal chamber of the implant until it contacts the screw fragment. Then, as it is rotated counterclockwise, it may unwind the screw fragment [71,72]. If the screw fragment cannot be engaged with an instrument, a dimple or access point can be created using a ½ round bur mounted on a handpiece under copious irrigation; this dimple may be modified into a slot for better engagement [50,75,78,80]. Furthermore, burs and instruments may also be modified to allow for better engagement of the fragment and to prevent damage to the implant [72,75]. Aftermarket screw retrieval kits are available, including Fragment Fork (Astra Tech; Dentsply Sirona), ITI Dental Implant System (Institut Straumann AG), IMZ TwinPlus Implant System1 (Dentsply Sirona), Screw Removal Kit Replace (Nobel Biocare), and Certain-Screw Removal Kit (Biomet 3i). These kits may be helpful when low-risk techniques have been unsuccessful [74,77,80]. If all attempts at rotating the screw fragment fail, it may be drilled out completely, although this technique requires a high degree of attention and care to prevent damage. Specialized systems and drill guides are important in these situations, and a screw tap tool may become necessary [79]. An important consideration when removing a fractured screw is not to damage the internal threads of the implant, so care must always be taken whenever a rotary instrument is introduced into the internal chamber of the implant [80,81]. The use of drill guides or sleeves can help stabilize the drill and subsequently reduce the risk of damage to the internal threads [50,73,76,81]. Furthermore, there is a high risk of heat generation whenever screws are drilled, and for that reason, drilling should be performed intermittently at a reduced speed with copious irrigation [74,78].

2.4.16. High Risk: Implant Modification

In situations where removal of the screw fragments is not possible using a low- or moderate-risk technique, intentional modification of the implant may be necessary to keep the implant serviceable [82-90]. If the internal aspect of the implant is significantly damaged or the screw fragment is irretrievable, the clinician may choose to remove the implant and place a new one. However, this decision can be influenced by financial factors, patient experience, and patient willingness to undergo additional surgery. An implant in such situations may also be completely buried in soft tissue, an option that may require the fabrication of a new prosthesis, and may compromise function and/or esthetics [90,91]. If the patient is unwilling to sacrifice an irreversibly damaged implant, attempts can be made to maintain the use of this implant by retapping the internal threads once the irretrievable screw fragment is drilled out. This can be accomplished with the use of specific retapping tools and may require alternative or modified parts to successfully restore the implant in question [81,83,86].

If all attempts fail and the patient is still unwilling to sacrifice the implant, a custom cast post and core may be fabricated for the implant .These techniques generally start with the removal of remaining screw fragment, followed by removal of the internal threads of the implant by using a diamond rotary instrument or tungsten carbide bur in a high-speed handpiece under copious irrigation. An autopolymerizing acrylic resin pattern can either be made directly on the prepared implant or indirectly on a stone cast. The pattern is then cast using nickel- or cobalt-chromium alloys, although other types of metal alloys have also been reported [82,83,88,89,90]. Once the seating of the custom cast post and core has been confirmed, it can be cemented. The appropriate restoration can then be fabricated following conventional prosthodontic protocols.

3. Conclusion

In the present review, in order to present a complete picture, various clinical as well as in vitro studies on the mechanics of implant fixture fracture and abutment screw loosening/fracture of a single implant-abutment connection have been reviewed. The incidence of such complications is very small and the literature is still not conclusive concerning the choice of connection and/or crown-retaining system. However, understanding the mechanics of these failures will help the clinicians in formulating a more predictable treatment.

References

[1] Satterthwaite J, Rickman L. Retrieval of a fractured abutment screw thread from an implant: a case report. Br Dent J2008; 204: 177-80.

[2] Carlson B, Carlsson GE. Prosthodontic complications in osseointegrated dental implant treatment. Int J Oral Maxillofac Implants1994; 9: 90-4.

[3] Brägger U, Karoussis I, Persson R, Pjetursson B, Salvi G, Lang N. Technical and biological complications/failures with single crowns and fixed partial dentures on implants: a 10-year prospective cohort study. Clin Oral Implants Res2005; 16: 326-34.

[4] Adell R, Lekholm U, Rockler B, Brånemark PI. A 15-year study of osseointegrated implants in the treatment of the edentulous jaw. Int J Oral Surg1981; 10: 387-416.

[5] Balshi TJ. Preventing and resolving complications with osseointegrated implants. Dent Clin North Am 1989; 33: 821-68.

[6] Piattelli A, Scarano A, Piattelli M, Vaia E, Matarasso S. Hollow implants retrieved for fracture: A light and scanning electron microscope analysis of 4 cases. J Periodontol 1998; 69: 185-9.

[7] Rangert B, Krogh PH, Langer B, Van Roekel N. Bending overload and implant fracture: A retrospective clinical analysis. Int J Oral Maxillofac Implants 1995; 10: 326-34.

[8] Goodacre CJ, Kan JY, Rungcharassaeng K. Clinical complications of osseointegrated implants. J Prosthet Dent 1999; 81: 537-52.

[9] Kronström M, Svenson B, Hellman M, Persson GR. Early implant failures in patients treated with Brånemarksystem titanium dental implants: A retrospective study. Int J Oral Maxillofac Implants 2001; 16: 201-7.

[10] Flanagan D. External and occlusal trauma to dental implants and a case report. Dent Traumatol 2003; 19: 160-4.

[11] Uribe R, Peñarrocha M, Sanchis JM, García O. Marginal periimplantitis due to occlusal overload. A case report. Med Oral 2004; 9: 159-62.

[12] Balshi TJ. An analysis and management of fractured implants: A clinical report. Int J Oral Maxillofac Implants 1996; 11: 660-6.

[13] Eckert SE, Meraw SJ, Cal E, Ow RK. Analysis of incidence and associated factors with fractured implants: A retrospective study. Int J Oral Maxillofac Implants 2000; 15: 662-7.

[14] Jemt T, Lekholm U. Oral implant treatment in posterior partially edentulous jaws: A 5-year follow-up report. Int J Oral Maxillofac Implants 1993; 8: 635-40.

[15] Naert I, Quirynen M, van Steenberghe D, Darius P. A study of 589 consecutive implants supporting complete fixed prostheses. Part II: Prosthetic aspects. J Prosthet Dent 1992; 68: 949-56.

[16] Gunne J, Jemt T, Lindén B. Implant treatment in partially edentulous patients: A report on prostheses after 3 years. Int J Prosthodont 1994; 7: 143-8.

[17] Lekhom U, van Steenberghe D, Herrmann I, Bolender C, Folmer T, Gunne J, et al. Osseo integrated implants in the treatment of partially edentulous jaws: A prospective 5-year multicenter study. Int J Oral Maxillofac Implant 1994; 9: 627-35.

[18] Pylant T, Triplett RG, Key MC, Brunsvold MA. A retrospective evaluation of endosseous titanium implants in the partially edentulous patient. Int J Oral Maxillofac Implants 1992; 7: 195202.

[19] Piattelli A, Scarano A, Piattelli M. Histologic observations on 230 retrieved dental implants: 8 years' experience (1989-1996). J Periodontol 1998; 69: 178-84.

[20] Kwon K, Sim K, Cha J, Kim E, Lee J. Clinical and scanning electron microscopic analysis of fractured dental implants: A retrospective clinical analysis. J Korean Assoc Oral Maxillofac Surg 2012; 38: 371-8.

[21] Muroff FI. Removal and replacement of a fractured dental implant: Case report. Implant Dent 2003; 12: 206-10.

[22] Gargallo Albiol J, Satorres-Nieto M, Puyuelo Capablo JL, Sánchez Garcés MA, Pi Urgell J, Gay Escoda C. Endosseous dental implant fractures: An analysis of 21 cases. Med Oral Patol Oral Cir Bucal 2008; 13: E124-8.

[23] Morgan MJ, James DF, Pilliar RM. Fractures of the fixture component of an osseointegrated implant. Int J Oral Maxillofac Implants 1993; 8: 409-14.

[24] Sánchez-Pérez A, Moya-Villaescusa MJ, Jornet-Garcia A, Gomez S. Etiology, risk factors and management of implant fractures. Med Oral Patol Oral Cir Bucal 2010; 15: 504-8.

[25] Jemt T. Failures and complications in 391 consecutively inserted fixed prostheses supported by Branemark implants in edentulous jaws: A study of treatment from the time of prosthesis placement to the first annual checkup. Int J Oral Maxillofac Implants 1991; 6: 270-6.

[26] Gealh WC, Mazzo V, Barbi F, Camarini ET. Osseo integrated implants fracture: Causes and treatment. J Oral Implantol 2010; 37: 499-503.

[27] Santos MD, Pfeifer AB, Silva MR, Sendyk CL, Sendyk WR. Fracture of abutment screw supporting a cemented implantretained prosthesis with external hexagon connection: A case report with sem evaluation. J Appl Oral Sci 2007; 15: 148-51.

[28] Mc Glumphy EA, Mendel DA, Holloway JA. Implant screw mechanics. Dent Clin North Am 1998; 42: 71-89.

[29] Sailer I, Sailer T, Stawarczyk B, Jung RE, Hämmerle CH. In vitro study of the influence of the type of connection on the fracture load of zirconia abutments with internal and external implantabutment connections. Int J Oral Maxillofac Implants 2009; 24: 850-8.

[30] Da Silva EF, Pellizzer EP, QuinelliMazaro JV, Garcia Júnior IR. Influence of the connector and implant design on the implanttooth-connected prostheses. Clin Implant Dent Relat Res 2010; 12: 254-62.

[31] Khraisat A, Stegaroiu R, Nomura S, Miyakawa O. Fatigue resistance of two implant/abutment joint designs. J Prosthet Dent 2002; 88: 604-10.

[32] Maeda Y, Satoh T, Sogo M. In vitro differences of stress concentrations for internal and external hex implant-abutment connections: A short communication. J Oral Rehabil 2006; 33: 75-8.

[33] Steinebrunner L, Wolfart S, Ludwig K, Kern M. Implant-abutment interface design affects fatigue and fracture strength of implants. Clin Oral Implants Res 2008; 19: 1276-84.

[34] Balfour A, O'Brien GR. Comparative study of anti rotational single tooth abutments. J Prosthet Dent 1995; 73: 36-43.

[35] Möllersten L, Lockwandt D, Lindén LA. Comparison of strength and failure mode of seven implant systems: An in vitro test. J Prosthet Dent 1997; 78: 582-91.

[36] Cho SC, Small PN, Elian N, Tarnow D. Screw loosening for standard and wide diameter implants in partially edentulous cases: 3- to 7-year longitudinal data. Implant Dent 2004; 13: 245-50.

[37] Shetty M, Krishna Prasad D, Shetty NH, Jaiman R. Implant abutment connection: Biomechanical Perspectives. NUJHS 2014; 4: 47-53.

[38] Weinberg LA. The biomechanics of force distribution in implantsupported prostheses. Int J Oral Maxillofac Implants 1993; 8: 1931.

[39] Scholander S. A retrospective evaluation of 259 single-tooth replacements by the use of Branemark implants. Int J Prosthodont 1999; 12: 483-91.

[40] Jörnéus L, Jemt T, Carlsson L. Loads and designs of screw joints for single crowns supported by osseointegrated implants. Int J Oral Maxillofac Implants 1992; 7: 353-9.

[41] Mc Glumphy EA, Mendel DA, Holloway JA. Implant screw mechanics. Dent Clin North Am 1998; 42: 71-89.

[42] Al Jabbari Y, Fournelle R, Ziebert G, Toth J, Iacopino A. Mechanical behavior and failure analysis of prosthetic retaining screws after long-term use in vivo. Part 2: Metallurgical and micro hardness analysis. J Prosthodont 2008; 17: 181-91.

[43] Martin WC, Woody RD, Miller BH, Miller AW. Implant abutment screw rotations and preloads for four different screw materials and surfaces. J Prosthet Dent 2001; 86: 24-32.

[44] AlJabbari Y, Fournelle R, Ziebert G, Toth J, Iacopino AM. Mechanical behavior and failure analysis of prosthetic retaining screws after long-term use in vivo. Part 1: Characterization of adhesive wear and structure of retaining screws. J Prosthodont 2008; 17: 168-80.

[45] Misch C. Principles for abutment and prosthetic screws and screwretained components and prostheses. In: Misch CE, editor. Dental Implant Prosthetics. San Luis. Elsevier Mosby; 2014. 2nd. ed. p. 730.

[46] Khraisat A, Abu-Hammad O, Al-Kayed AM, Dar-Odeh N. Stability of the implant/abutment joint in a single-tooth externalhexagon implant system: clinical and mechanical review. Clin Implant Dent Relat Res 2004; 6: 222-9.

[47] Burguete RL, Johns RB, King T, Patterson EA. Tightening characteristics for screwed joints in osseointegrated dental implants. J Prosthet Dent 1994; 71: 592-9.

[48] Haack JE, Sakaguchi RL, Sun T, Coffey JP. Elongation and preload stress in dental implant abutment screws. Int J Oral Maxillofac Implants1995; 10: 529-36.

[49] Lang JA, May KB, Wang RF. The effect of the use of a countertorque device on the abutment-implant complex. J Prosthet Dent 1999; 81: 411-7.

[50] Satwalekar P, Chander KS, Reddy BA, Sandeep N, Sandeep N, Satwalekar T. A simple and cost effective method used for removal of a fractured implant abutment screw: a case report. J Int Oral Health 2013; 5: 120-3.

[51] Winkler S, Ring K, Ring JD, Boberick KG. Implant screw mechanics and the settling effect: An over view. J Oral Implantol 2003; 29: 242-5.

[52] Sakaguchi RL, Borgersen SE. Nonlinear contact analysis of preload in dental implant screws. Int J Oral Maxillofac Implants 1995; 10: 295-302.

[53] Shigley IE, Mischke CR. Standard Handbook of Machine Design. 1st.ed. New York: McGraw Hill; 1986. p. 23-26.

[54] Bickford JH. An Introduction to the Design and Behavior of Bolted Joints, Revised and Expanded. New York1997: 3rd Edition, Kindle Edition.Taylor& Francis Group. P: 175-286.

[55] Wiskott HW, Nicholls JI, Belser UC. Stress fatigue: Basic principles and prosthodontic implications. Int J Prosthodont 1995; 8: 105-16.

[56] Jung RE, Pjetursson BE, Glauser R, Zembic A, Zwahlen M, Lang NP. A systematic review of the 5-year survival and complication rates of implant-supported single crowns. Clin Oral Implants Res 2008; 19: 119-30.

[57] Becker W, Becker BE. Replacement of maxillary and mandibular molars with single endosseous implant restorations: A retrospective study. J Prosthet Dent 1995; 74: 51-5.

[58] Fugazzotto PA, Kirsch A, Ackermann KL, Neuendorff G. Implant/Tooth connected restorations utilizing screw -fixed attachements: A survey of 3,096 sites in function for 3 to 14 years. Int J Oral Maxillofac Implants1999; 14: 819-23.

[59] Begona Ormeachea M, Millstein P, Hirayama H. Tube angulation effect on radiographic analysis of the implant-abutment interface. Int J Oral Maxillofac Implants 1999; 14: 77-85.

[60] Bakaeen LG, Winkler S, Neff PA. The effect of implant diameter, restoration design, and occlusal table variations on screw loosening of posterior single-tooth implant restorations. J Oral Implantol 2001; 27: 63-72.

[61] Siamos G, Winkler S, Boberick KG. Relationship between implant preload and screw loosening on implant-supported prostheses. J Oral Implantol 2002; 28: 67-73.

[62] Breeding LC, Dixon DL, Nelson EW, Tietge JD. Torque required to loosen single-tooth implant abutment screws before and after simulated function. Int J Prosthodont 1993: 6: 435-9.

[63] Patel RD, Kan JY, Jonsson LB, Rungcharassaeng K. The use of a dental surgical microscope to aid retrieval of a fractured implant abutment screw: a clinical report. J Prosthodont 2010; 19: 630-3.

[64] Murat Kurt, Ahmet Umut Güler, İbrahim Duran, A Technique for Removal of a Fractured Implant Abutment Screw, Journal of Oral Implantology. 2013; 39(6): 723-725.

[65] Satwalekar P, Chander KS, Reddy BA, Sandeep N, Sandeep N, Satwalekar T. A simple and cost effective method used for removal of a fractured implant abutment screw: a case report. J Int Oral Health 2013; 5: 120-3.

[66] Fauvell SA, Gialanella G, Penna KJ. The Lumen Technique. Retrieval of broken gold screws in dental implants. NY State Dent J 2006; 72: 43.

[67] Reyhanian A, Parker S, Moshonov J, Fuhrman N. The use of Er: YAG in laser-assisted broken abutment screw treatment. Case report_Er: YAG. Lasers 2010; 3: 6-11.

[68] Bhandari S, Aggarwal N, Bakshi S. Ultrasonic oscillations for conservative retrieval of a rare fracture of implant healing abutment. J Oral Implantol 2013; 39: 475-8.

[69] Barbosa JM, Ascenso J, Hirata R, Caramês J. The cotton driver: an alternative technique for removing fractured screw fragments. J Prosthet Dent 2014; 112: 1601-2.

[70] Ow RK, Ho KH. Retrieval of the resilient element in an osseointegrated implant system. J Prosthet Dent 1992; 68: 93-5.

[71] Biller H. Removing broken abutment screws from internally threaded implants. J Prosthet Dent 1993; 69: 344.

[72] Lau YH, and Pang IC.A modified instrument for removing a fractured abutment screw. J Prosthet Dent 1994; 71: 542.

[73] Rosen H. Salvaging endosseous implants with fractured abutment screws. Implant Dent 1995; 4: 174-6.

[74] Luterbacher S, Fourmousis I, Lang NP, Brägger U. Fractured prosthetic abutments in osseointegrated implants: a technical complication to cope with. Clin Oral Implants Res 2000; 11: 163-70.

[75] Williamson RT, Robinson FG. Retrieval technique for fractured implant screws. J Prosthet Dent 2001; 86: 549-50.

[76] Nergiz I, Schmage P, Shahin R. Removal of a fractured implant abutment screw: a clinical report. J Prosthet Dent 2004 Jun; 91: 513-7.

[77] Yilmaz B, McGlumphy E. A technique to retrieve fractured implant screws. J Prosthet Dent 2011; 105: 137-8.

[78] Taira Y, Sawase T. A modified technique for removing a failed abutment screw from an implant with a custom guide tube. J Oral Implantol 2012; 38: 165-9.

[79] Gooty JR, Palakuru SK, Guntakalla VR, Nera M. Noninvasive method for retrieval of broken dental implant abutment screw. Contemp Clin Dent 2014; 5: 264-7.

[80] Walia MS, Arora S, Luthra R, Walia PK. Removal of fractured dental implant screw using a new technique: a case report. J Oral Implantol 2012; 38: 747-50.

[81] Imam AY, Moshaverinia A, Chee WW, McGlumphy EA. A technique for retrieving fractured implant screws. J Prosthet Dent 2014; 111: 81-3.

[82] Pipko DJ, Kukunas S, Ismail YH. Retrofitting a cast dowel-core on salvaged dental implants. J Prosthodont 2004; 13: 52-4.

[83] Pow EH, Wat PY. A technique for salvaging an implant-supported crown with a fractured abutment screw. J Prosthet Dent 2006; 95: 169-70.

[84] Santos MD, Pfeifer AB, Silva MR, Sendyk CL, Sendyk WR. Fracture of abutment screw supporting a cemented implantretained prosthesis with external hexagon connection: a case report with sem evaluation. J Appl Oral Sci 2007; 15: 148-51.

[85] Maalhagh-Fard A, Jacobs LC. Retrieval of a stripped abutment screw: a clinical report. J Prosthet Dent 2010; 104: 212-5.

[86] Imam AY, Yilmaz B, Özçelik TB, McGlumphy E. Salvaging an angled implant abutment with damaged internal threads: a clinical report. J Prosthet Dent 2013; 109: 287-90.

[87] Yilmaz B, McGlumphy E. A technique to salvage a single implant-supported fixed dental prosthesis having a nonretrievable implant screw fragment. J Oral Implantol 2013; 39: 81-3.

[88] Canpolat C, Ozkurt-Kayahan Z, Kazazo_glu E. Management of a fractured implant abutment screw: a clinical report. J Prosthodont 2014; 23: 402-5.

[89] Gupta V, Prithviraj DR, Muley N. A new restorative technique for the perishing implant due to abutment screw fracture. J Oral Implantol 2014; 40: 755-7.

[90] Harshakumar K, Bhatia S, Ravichandran R, Joy PT. Salvaging an implant with abutment screw fracture by a custom titanium post and core supported prosthesis-a novel technique. Int J Sci Study 2014; 2: 36-9.

[91] Mardinger O, Oubaid S, Manor Y, Nissan J, Chaushu G. Factors affecting the decision to replace failed implants: a retrospective study. J Periodontol 2008; 79: 2262-6.

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(54) **Combined dental drill and anchor pin.**

(57) A dental device which comprises a drill (30), an integrally-connected anchoring pin (20), stop means (35) positioned on the anchoring pin, and a trailing shank (15), at the other end from the drill, which can be attached to a powerful dental hand piece. The trailing shank may comprise a frangible connection (40) which breaks when, on drilling, the stop means comes into contact with the drilling tooth; the protruding portion then serves as an anchoring pin for subsequent dental work on the tooth.

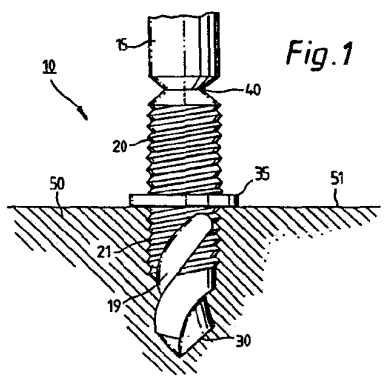


Fig.1

EP 0 104 284 A1

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COMBINED DENTAL DRILL AND ANCHOR PIN

The present invention relates to a novel dental appliance. More particularly the invention pertains to a combined dental drill and anchor pin for use in teeth restoration and orthodontic procedures.

In conventional dentistry procedures it is customary to install one or more pins into broken-down teeth or into teeth to which orthodontic appliances are being applied. The treatment of broken-down teeth is of course more prevalent, and the present invention will be discussed primarily in conjunction with restorative techniques for treating teeth where the nerve is still alive. It will be understood, however, that the invention is also applicable to orthodontic techniques or to non-vital teeth.

As is well known, the conventional procedure is to initially drill one or more relatively deep holes in the dentin portion of the tooth undergoing repair. The drilling can be carried out, for example, by utilizing a typical dental twist drill. The dentist then screws in a small, screw-threaded anchor into each of the holes, leaving a portion of the screw-threaded pin sticking out of the hole. The remainder of the screw-threaded pin is retained in the dentin as the anchor.

Illustrative U.S. patents pertaining to anchor retention pins include the following:

Baker	3,364,575
Tieche	4,142,293
Chan	4,187,611
Smith	4,189,834
Weissman	4,202,101
Carse	4,219,620

A commercially available screw pin is sold by Pulpdent Corporation of America as "Stabilok" screw-pins under U.S. Patent No. 4,189,834.

A number of commercially available dental drills have been employed for making the holes or channels in the dentin which are required for the anchor pins.

In accordance with present day practices, therefore, two instruments are needed: a drill, e.g. a twist drill; and a diameter-coordinated screw pin. After the twist drill digs its deep hole or channel, the path of insertion must again be found in order to screw in the screw-threaded anchor pin. Since the drilled hole is very tiny, in general being of the order of 0.53 mm, plus or minus a few 100 or 10 nm units, in diameter. If the screw-threaded

pin is not inserted with its long axis exactly parallel and in line with the orifice and the long axis of the hole, it is difficult, if not impossible, to successfully screw the pin into the hole. Moreover, sometimes the drilled hole or opening is in a difficult location for good accessibility or visibility. At times, the drilled hole or channel is obfuscated by debris or saliva.

According to the invention, a drill and an anchor pin are combined in one structure. In general, the overall instrument or device of this invention has at its end a short drill, e.g. a twist drill, immediately followed by an anchor pin section, a major portion of which will generally protrude above the surface of the dentin and which will serve as the retaining or reinforcing device for enhancing the attachment of an amalgam filling or other restorative material to the tooth. In order to limit the drilling depth, a stop means is positioned on the shank carrying the drill bit and the anchor pin. Furthermore, the device is provided with a weakened point, i.e. a frangible reduced portion or shearing joint positioned on the shank immediately following the desired protruding length of anchor pin.

The invention will be more fully understood by reference to the accompanying drawings in which:

Fig. 1 is a partly cut-away side-view showing a combined drill and anchor pin device according to the present invention.

Fig. 2 is a partly cut-away side-view showing several variations on the combined drill and anchor pin device according to the present invention.

Fig. 3 is an end view of the single fluted drill illustrated in Fig. 2.

Referring now to the drawings and more specifically to Fig. 1, the present invention comprises a combined drill and anchor pin structure 10, which may be a latch type or straight hand piece bur shank made of stainless steel, plated cast iron or any material harder than dentin and suitable for making a drill therefrom; has a trailing shank portion 15, an anchor pin 20, a screw-threaded portion 21, a groove 19 for debris removal and a drill 30. A stop 35, which may be a part of anchor pin 20, is positioned so that it separates the drill 30 and a portion of the screw-threaded pin from the protruding portion of the anchor pin 20. After drill 30 has pierced the dentin section 50 of the tooth to the desired depth, the stop 35 will come to rest on the top surface 51 of dentin 50 and further drilling will cease.

The drill 30 used in the instrument of this invention may be any kind of deep drilling end such as a single flute, or twist drill, suitable for drilling deep pin holes. For many purposes the drill 30 can be a conventional twist drill type. Fig. 1 shows a twist drill while a single flute drill is illustrated in Fig. 2. Portion 21 of the anchor pin secures the anchor pin to the tooth and portion 21 must have a screw thread for the present purposes.

The protruding section or portion of anchor pin 20 can be screw-threaded as shown in Fig. 1 or can be a straight shank that has been scored or provided with grooves 42 to enhance its functioning as a retention or reinforcing pin. In general, the anchor pin section of the present instrument is screw-threaded, and it will have an overall length of from about 3 to 6 mm. For most restorative dental work, the segment of the anchor pin extending above or protruding from dentin surface 51 will range from about 1.5 to 4 mm. The outside diameter or lands or anchor screw portion 21 must be slightly larger than the diameter of drill 30, while the grooves of the anchor screw pin 21 must be slightly smaller than the diameter of drill 30. Useful diameters of the anchor pin and the drill will range from about 0.43 to 0.71 mm. It will be understood, however, that for some purposes the diameter of that portion of the anchor pin protruding from the dentinal surface may be less or greater than the diameter of the drill 30.

As also shown in Fig. 1, the trailing shank 15 has a reduced diameter or shearing joint 40 positioned on the upper end of the anchor pin 20 so as to provide a fracture or shear point. When rotation continues following abutment of the stop 35 against the upper dentin surface 51, shearing joint 40 severs under continuing torsional forces leaving the drill 30 and anchor pin portion 21 securely affixed in dentin 50, and that portion of the anchor pin 20 below shearing joint 40 protruding from dentin surface 51.

In Fig. 3, the centerpoint 25 and the cutting edge 26 of the drill are shown. The drill may have single or multiple blades, as desired.

Although the use of an instrument having a shearing joint 40 is preferred under the invention, it will be understood that other arrangements are also possible. Thus, the trailing shank may be cooperatively attached to an elongated circular-cylindrical shank (not shown) which in turn is attached to a latching-type dental hand piece (not shown). In such a structure, the trailing shank, which can also function as a part of the protruding anchor pin, is detached from the dental handpiece (not shown) when stop 35 is in abutment with the upper dentinal surface 51. It will also be understood that the free end of the trailing shank may have a variety of shapes to cooperate with some locking means on a dental handpiece so that the essential structure of the present invention is locked to a powered dental handpiece.

As will be comprehended by those skilled in the art, the combined drill and pin instrument of this invention may be used in a variety of orientations at various inclinations and inverted from the position shown in the drawings, so that certain positional terms in the foregoing description are used to describe the relative portions of the combined structure without limitation to their orientation with respect to a horizontal plane.

CLAIMS

1. A dental device characterised in that it comprises a drill (30), an integrally-connected anchoring pin (20), stop means (35) positioned on the anchoring pin, and a trailing shank (15), at the other end from the drill, which can be attached to a powered dental hand piece.

2. A device according to claim 1, wherein the anchoring pin is screw-threaded.

3. A device according to claim 1 or claim 2, wherein that portion of the anchoring pin which, when drilled into a tooth, protrudes from the dentinal surface, is scored or grooved.

4. A device according to any preceding claim, wherein the drill is a twist drill.

5. A device according to any preceding claim, wherein the drill is a single or multiple-fluted end cutting drill.

6. A device according to any preceding claim, wherein the trailing shank is provided with a shearing point.

7. A device according to any preceding claim, wherein the stop means is positioned between a screw retention section on the drill and a section of the anchoring pin, which section protrudes from a tooth when the device is drilled into that tooth.

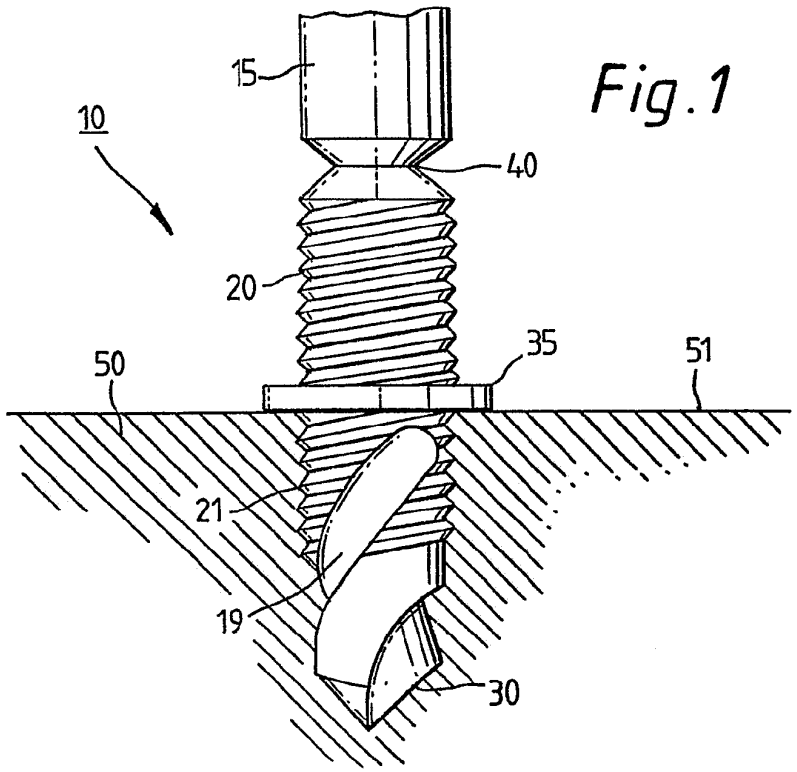


Fig.1

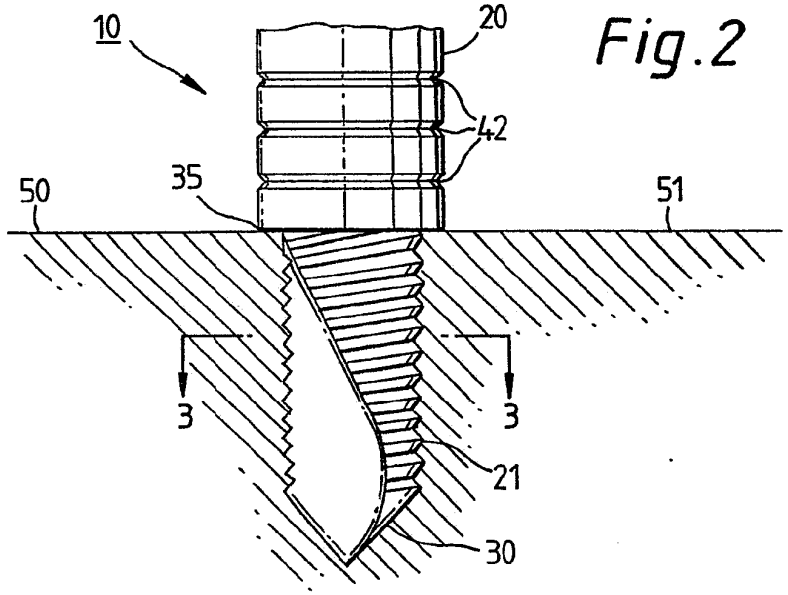


Fig.2

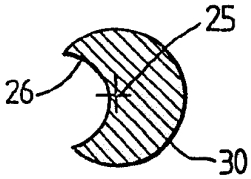


Fig.3

European Patent Office

EUROPEAN SEARCH REPORT

Application number

EP 82 30 5105

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. ³)
X	DE-C- 665 805 (SZABO) * Whole document *	1,4	A 61 C 5/08 A 61 C 3/02 F 16 B 25/00
X	US-A-1 698 951 (HOLMES) * Whole document *	1,5	
A	US-A-2 823 574 (ROSAN) * Whole document *	2,7	
A	US-A-2 740 315 (GOUVERNEUR) * Whole document *	6	
A	CH-A- 562 605 (SPANG) * Whole document *	3	

TECHNICAL FIELDS SEARCHED (Int. Cl. ³)

A 61 C
F 16 B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	23-05-1983	VAN BOGAERT J.A.M.M.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

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(54) Title: AN IMPLANT SYSTEM

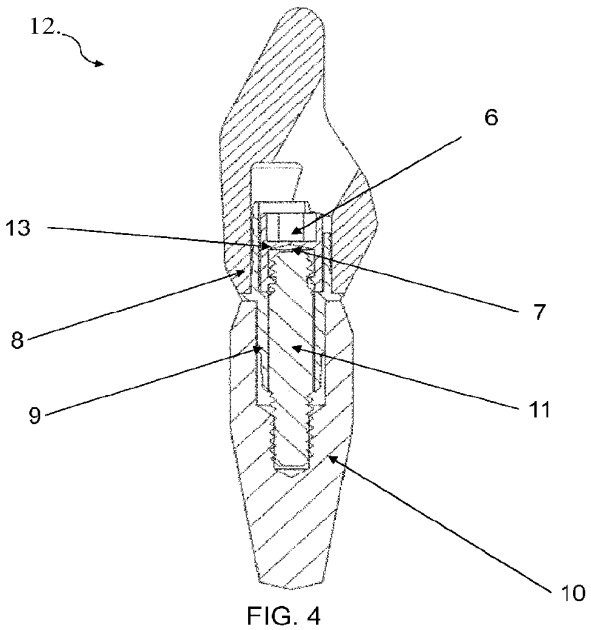


FIG. 4

(57) Abstract: The present invention relates to an implant system for fixing an abutment to an implant, such as a dental implant, comprising a threaded bolt having a top threaded portion configured to engage with a nut and an end threaded portion configured to be inserted in an implant.

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AN IMPLANT SYSTEM

FIELD OF THE INVENTION

The present invention relates to an implant system for fixing an abutment to an implant, such as a dental implant, comprising a threaded bolt having a top threaded portion configured to engage with a nut and an end threaded portion configured to be inserted in an implant.

BACKGROUND OF THE INVENTION

Existing implant solutions requires large hollow spaces above the implant to allow for removal of lengthy screw elements necessary to fasten the dental abutment to the implant.

This disadvantage may lead to damages on the tooth restoration during removal as the screw element need to be almost entirely pulled out of the implant before being titled to be removed.

Current solutions employ bridges elements between the abutment and the implant adding complexity due to the presence of several parts that need to be fasten. The use of several elements has also the drawback of increasing the risk of bacterial infections.

Hence, an improved dental assembly system would be advantageous, and in particular, a more reliable dental assembly system that is easier to unscrew and to remove and has a reduced amount of elements would be advantageous.

OBJECT OF THE INVENTION

It is an object of the present invention to wholly or partly overcome the above disadvantages and drawbacks of the prior art in removing an abutment, such as a dental abutment, from an implant, such as a dental implant. More specifically, it may be seen as an object of the invention to provide a dental assembly system providing solutions for fastening a dental abutment to a dental implant, which are easy to be unfasten for temporary removal.

A further object of the present invention is to provide an alternative to the prior art.

In particular, it may be seen as a further object of the present invention to provide a dental assembly system that solves the above mentioned problems of the prior art by employing a threaded bolt having a top portion configured to engage with a nut and an end threaded portion configured to be inserted in an implant.

SUMMARY OF THE INVENTION

Thus, the above described object and several other objects are intended to be obtained in a first aspect of the invention by providing a dental implant system comprising : a bolt having a top portion a central portion and an end portion, wherein the end portion is configured to engage with an interior bore of an implant; a nut having a hole, the hole having an area configured to engage with the top portion of the bolt, wherein the nut comprises one or more engaging surfaces opposite to the hole, the engaging surfaces adapted to mate with protuberances or recesses of a tightening tool.

The above described object and several other objects are intended to be obtained in a second aspect of the invention by providing a dental implant system comprising : a threaded bolt having a top portion a central portion and an end threaded portion, wherein the end threaded portion is configured to engage threads of an interior bore of an implant; a nut having a hole, the hole having an area configured to engage with the top portion of the threaded bolt, wherein the nut comprises one or more engaging surfaces opposite to the hole, the engaging surfaces adapted to mate with protuberances or recesses of a tightening tool.

The threaded element or bolt is an elongated element having threads in one end. In some embodiments, the central portion may be also threaded. Thus, the threaded bold may be an elongated element, such as a rod, having threads over 2/3 of its longitudinal axis.

The top and end portion of the threaded element may have different sizes, cross sections, diameters or pitches.

The nut may be any type of fastener with a hole. The nut according to the invention is used in conjunction with the mating threaded bolt to fasten an abutment to a dental implant.

Engagement or connection between the top portion of the threaded bolt and the area of the hole of the nut may occur in between the two mating part by different means.
For example, engagement or connection between the top portion of the threaded bolt and the area of the hole of the nut may occur by interference fit or press fit.

The top portion may be configured to engage with the nut via a bayonet connection.

In some embodiments, the connection between the top portion of the threaded bolt and the area of the hole of the nut may also occur via a bayonet mount or bayonet connector.
In this case the top portion of the male threaded bolt may have pins aligned with slots, such as L-shaped slots on the female nut. When pushed together the pins reaches the bottom of the slot and the nut may be rotated so as that the pins slide and are no longer free to rotate.

In some other embodiments the top portion of the threaded bolt comprises the L-shaped slots while the nut comprises pins in the internal area of the hole so that upon insertion and rotation according the pins reaches the bottom of the slot on the threaeded bolt and upon rotation slide and are no longer free to rotate.

In some other embodiments, the threaded bolt is a double threaded bolt.

The top portion may be a top threaded portion.

The area of the hole configured to engage with the top portion is at least partially threaded and is configured to engage with threads of the top threaded portion.

Thus, the above described object and several other objects are intended to be obtained in an aspect of the invention by providing a dental implant system comprising : a double threaded bolt having a top threaded portion, a central portion and an end threaded portion, wherein the end threaded portion is configured to engage threads of an interior bore of an implant; a nut having a hole having an area at least partially threaded and configured to engage threads of the top threaded portion, wherein the nut comprises one or more engaging surfaces opposite to the hole, the engaging surface adapted to mate with protuberances or recesses of a tightening tool.

The double threaded element or bolt is an elongated element having threads in both ends.

In some embodiments, the central portion may be also threaded. Thus, the double threaded bold may be an elongated element, such as a rod, having threads all along the longitudinal axis.

The top and end portion of the double threaded element may have different sizes, cross sections, diameters or pitches.

The nut may be any type of fastener with a threaded hole. The nut according to the invention is used in conjunction with the mating double threaded bolt to fasten an abutment to a dental implant. The nut and the double threaded bolt are kept together by a combination of their threads' friction, eventually with slight elastic deformation a slight stretching of the double threaded bolt and compression of the parts to be held together.

In some embodiments, the nut is a blind nut, the one or more engaging surfaces are a recess or protrusion and the hole is a cavity.

Thus the invention relates in one aspect to an implant system comprising : a double threaded bolt having a top threaded portion a central portion and an end threaded portion, wherein the end threaded portion, is configured to engage threads of an interior bore of an implant; a blind nut having a cavity internally threaded and configured to engage threads of the top threaded portion, wherein

the blind nut comprises a recess or protrusion opposite to the cavity, the recess or protrusion adapted to mate with protuberances or recesses of a tightening tool.

In some embodiments, the blind nut comprises a recess in its head, which is located in a position opposite to the cavity. The recess has a geometry, shape or structure that is adapted to mate with protuberance or recess of a tightening tool. For example, the recess may have element structures that are complementary to element structures on the tightening tool.

The blind nut may be a cap nut, an acron nut, a crown hex nut or domed cap nut, characterized by a domed top covering the threads.

The domed top or head may comprise an internal or external torque transferring interface for a tightening tool.

The domed top or head of the blind nut may present openings, such as openings having a width or diameter, smaller than the width or diameter of the threaded bolt.
The openings on the domed top or head of the blind nut may thus not be through going openings for the threaded bolt.

In some embodiments the one or more engaging surfaces are located above the area of the hole configured to engage with the top portion.

In some other embodiments, the one or more engaging surfaces are located above the at least partially threaded area of the hole.

The positioning of the one or more engaging surfaces above the area of the hole configured to engage with the top portion or the at least partially threaded area of the hole prevent the contact between the protuberances or recess of a tightening tool and the underneath areas or threads. In this way, the area of the hole configured to engage with the top portion or at least partially threaded area of the hole and the top portion or the threads of the top threaded portion are protected from unintentional rubbing while operating the tightening tool.

In some embodiments, the implant system further comprises an implant for installation in a bone, the implant having : a proximal end located near an exterior surface of a bone; an interior bore, internally threaded, extending distally from the proximal end; and an externally threaded exterior surface.

The end threaded portion of the double threaded bolt is configured to engage threads of the interior bore of the implant.

The proximal end is located near an exterior surface of the bone and can also referred to a gingival end portion.

The implant has a threaded exterior surface to be fastened to the bone.

In some embodiments, the double threaded bolt is pre-assembled with the dental implant.

In some other embodiments, the implant system further comprises an abutment for use in a dental implant comprising a prosthetic portion configured to support a prosthesis having a supragingival region protruding beyond gingiva adjacent to the dental implant, the prosthetic portion having a passageway extending therethrough; an end portion having a central opening, the end portion configured to be inserted in the dental implant; the double threaded bolt being insertable in the dental implant through the passageway in the prosthetic portion and the central opening in the end portion.

The supragingival region or supragingival end is the area carrying the prosthetic or dental restoration.

The end portion or insert extends into the passageway and engage the subgingival end of the prosthetic portion.

When the abutment has to be fasten to the dental implant, the end portion is inserted in the dental implant. The threaded bolt is then inserted in the dental implant through the passageway in the prosthetic portion and the central opening in the end portion.

The blind nut is then used to fasten the abutment to the implant by engaging the threads of the top threaded portion of the double threaded bolt.

The dental implant system when in place comprises a dental implant, an abutment, a double threaded bolt and a nut.

In some further embodiments, the central portion is externally threaded.

The central portion may also be threaded, thus the bolt may be threaded from the top to the end. Top, central and end portion may have a thread having the same or different pitch.

For example, the top threaded portion may have a first pitch and the end threaded portion may have a second pitch, the first pitch being different form the second pitch.

In some further embodiments, the top threaded portion and the end threaded portion have a same first pitch.

In some other embodiments, the implant system further comprises a hollow interface element for facilitating fixing of the abutment to the implant. The hollow interface may be a bridge structure between the abutment and the implant for improving fastening between the abutment and the implant.

The interface element may comprise a proximal section adapted to favour fastening and a distal section adapted to be inserted into the implant.

The first and other aspect and embodiments of the present invention may each be combined with any of the other aspects or embodiments. These and other aspects and embodiments of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

BRIEF DESCRIPTION OF THE FIGURES

The implant system according to the invention will now be described in more detail with regard to the accompanying figures. The figures show one way of implementing the present invention and is not to be construed as being limiting to other possible embodiments falling within the scope of the attached claim set.

Figure 1 and figure 2 show an implant system according to the prior art showing one of the problem addressed by the invention.

Figure 3 shows an implant system having an interface element between the abutment and the implant.

Figure 4 shows an implant system according to some embodiments of the invention.

Figure 5 and figure 6 show a 3D representation of a nut and a double threaded bolt, respectively, according to some embodiments of the invention.

Figure 7 and figure 8 show a cross section and a front view of a nut, according to some embodiments of the invention.

Figure 9 and figure 10 show a cross section and a front view of a nut, according to some other embodiments of the invention.

Figure 11 and figure 12 show a 3D representation and a cross section of a double threaded bolt pre-assembled in an implant, according to some embodiments of the invention.

Figure 13 shows a 3D representation of an implant having a threaded rod extending longitudinally out of a top surface of the implant.

Figure 14 and figure 15 show a 3D representation of a threaded bolt and a nut, according to some embodiments of the invention.

Figure 16 shows a technical drawing of a cross section of a threaded bolt and a nut assembled in an implant, according to some embodiments of the invention.

Figure 17 and 18 show a 3D representation and a cross section of a threaded bolt and a nut assembled in an implant, characterized by the presence of a bayonet connection according to some embodiments of the invention.

DETAILED DESCRIPTION OF AN EMBODIMENT

Figure 1 and figure 2 show an implant system according to the prior art showing one of the problem addressed by the invention.

The implant system of figure 2 comprises an abutment that is fasten to a dental implant by means of a screw. Due to the length of the screw existing implant solutions requires large hollow space above the implant, so that if removal is necessary this can be done without damaging the dental restoration.

Figure 1 shows damages to the dental restoration due to the difficulty of removal of a lengthy screw element in a limited hollow space.

Figure 3 shows an implant system having an interface element between the abutment and the implant.

The abutment is fasten to the implant via an interface element or bridge located in between the fastening screw and the implant.

In this case, the screw is shorter thus allowing for removal also in case of limited hollow space above the implant. Removal of the screw may occur via an angulated tightening tool, such as an angulated screw driver.

Figure 4 shows an implant system 12 according to some embodiments of the invention.

The dental implant system of figure 4 shows a double threaded bolt 11 inserted into a dental implant 10. The abutment having a prosthetic portion 8 supporting a dental restoration and an end portion 9 inserted into the implant 10 is fasten to the implant by means of nut 13. The nut 13 shown in figure 4 is a blind nut having a cavity 7 internally threaded and configured to engage threads of the top threaded portion of the double threaded bolt. The blind nut comprises also a recess 6 opposite to the cavity 7, which is adapted to mate with protuberances of a tightening tool, thus can be tightened or loosen by, e.g. an angulated screwdriver.

Figure 5 and figure 6 show a nut 1 and a double threaded bolt 2 according to some embodiments of the invention.

The double threaded bolt 2 has a top threaded portion 5, a central portion 3 and an end threaded portion 4. The central portion 3 may be threaded as well (not shown). The end threaded portion 4 is configured to engage threads of an interior bore of an implant, while the top threaded portion 5 is configured to engage with threads of the at least partially threaded area of the hole of nut 1.

The nut 1 as shown in figure 5 may be an open nut or blind nut.
The one or more engaging surfaces 6 adapted to mate with protuberances or recesses of a tightening tool are located above the at least partially threaded area of the hole or the cavity.

Figure 7 and figure 8 show a cross section and a front view of nut 14 having as engaging surfaces 15 adapted to mate with protuberances or recesses of a tightening tool an internal torque transferring interface.
The torques transferring interface is located above the at least partially threaded area of the hole, i.e. the threaded internal area.

Figure 9 and figure 10 show a cross section and a front view of nut 16 having as engaging surfaces 17 adapted to mate with protuberances or recesses of a tightening tool an external torque transferring interface.
The torques transferring interface is located above the at least partially threaded area of the hole, i.e. the threaded internal area.

Figure 11 and figure 12 show a 3D representation and a cross section of a double threaded bolt pre-assembled in an implant, according to some embodiments of the invention.

Figure 13 shows a 3D representation of an implant having a threaded rod extending longitudinally out of a top surface of the implant.
Thus in one aspect the invention relates to an implant comprising a rod at least partially threaded extending longitudinally out of a surface, such as a top surface of the implant.
The thread rod has the function of the top threaded portion of the double threaded bolt, i.e. it is configured to engage with threads of the at least partially threaded area of the hole on the nut.
Figure 14 and figure 15 show a 3D representation of a threaded bolt 18 and a nut 19, in the engagement or connection between the top portion of the threaded bolt and the area of the hole of the nut occur via a bayonet mount.
The threaded bolt 18 comprises L-shaped slots 21 located on opposite correspondent areas along the shaft of the bolt, which can be aligned with pins 22 located in the hole or cavity of the nut 19.

As shown in figure 16, the end portion of the threaded bolt is designed to be inserted in a dental implant 20.

The connection between the top portion of the threaded bolt and the nut is realized by aligning the pins 22 with the slots 21 and by pushing the nut until the pins reaches the bottom of the slot. Upon rotation of the nut the pins slides into the L-shaped area and are thus are no longer free to rotate.

Figure 17 and 18 show a 3D representation and a cross section of a threaded bolt and a nut assembled in an implant, characterized by the presence of a bayonet connection according to some embodiments of the invention.

The connection between the top portion of the threaded bolt and the area of the hole of the nut may occur via a bayonet mount or bayonet connector.

As shown in figure 17 and figure 18 the top portion 23 of a male threaded bolt has pins 24 aligned with slots 25, such as L-shaped slots on a female nut. When pushed together the pins reaches the bottom of the slot and the nut may be rotated so as that the pins slide into the slot and are no longer free to rotate.

Although the present invention has been described in connection with the specified embodiments, it should not be construed as being in any way limited to the presented examples. The scope of the present invention is set out by the accompanying claim set. In the context of the claims, the terms "comprising" or "comprises" do not exclude other possible elements or steps. In addition, the mentioning of references such as "a" or "an" etc. should not be construed as excluding a plurality. The use of reference signs in the claims with respect to elements indicated in the figures shall also not be construed as limiting the scope of the invention. Furthermore, individual features mentioned in different claims, may possibly be advantageously combined, and the mentioning of these features in different claims does not exclude that a combination of features is not possible and advantageous.

CLAIMS

1. A dental implant system comprising :

- a threaded bolt (2) having a top portion (5) a central portion (3) and an end threaded portion (4), wherein said end threaded portion is configured to engage threads of an interior bore of an implant;

- a nut (1) having a hole (7) said hole having an area configured to engage with said top portion of said threaded bolt, wherein said nut comprises one or more engaging surfaces (6) opposite to said hole, said engaging surfaces adapted to mate with protuberances or recesses of a tightening tool, wherein said one or more engaging surfaces are located above said area of said hole configured to engage with said top portion.

2. A dental implant system according to claim 1, wherein said threaded bolt is a double threaded bolt.

3. A dental implant system according to any of the preceding claims, wherein said top portion is a top threaded portion.

4. A dental implant system according to any of the preceding claims, wherein said area of said hole is at least partially threaded and is configured to engage with threads of said top threaded portion.

5. A dental implant system according to any of the preceding claims, wherein said nut is a blind nut, said one or more engaging surfaces are a recess or protrusion and said hole is a cavity.

6. A dental implant system according to any of the preceding claims, further comprising an implant (10) for installation in a bone, said implant having :

- a proximal end located near an exterior surface of a bone;

- an interior bore, internally threaded, extending distally from the proximal end; and

- an externally threaded exterior surface.

7. A dental implant system according any of the preceding claims, further comprising an abutment for use in a dental implant comprising :

- a prosthetic portion (8) configured to support a prosthesis having a supragingival region protruding beyond gingiva adjacent to the dental implant, said prosthetic portion having a passageway extending therethrough;
- an end portion (9) having a central opening, said end portion configured to be inserted in said dental implant;
said threaded bolt being insertable in said dental implant through said passageway in said prosthetic portion and said central opening in said end portion.

8. A dental implant system according to any of the preceding claims, wherein said central portion is externally threaded.

9. A dental implant system according to any of the preceding claims, further comprising a hollow interface element for facilitating fixing of said abutment to said implant.

10. A dental implant system according to any of the preceding claims 3-9, wherein said top threaded portion has a first pitch and said end threaded portion has a second pitch, said first pitch being different form said second pitch.

11. A dental implant system according to any of the preceding claims 3-9, wherein said top threaded portion and said end threaded portion have a same first pitch.

12. A dental implant system according to claim 1, wherein said top portion of said threaded bolt is configured to engage with said nut via a bayonet connection.

13. A dental implant system according to claim 12, wherein said area configured to engage with said top portion comprises pins aligned with slots on said top portion of said threaded bolt.

14. A dental implant system according to claim 12, wherein said top portion of said threaded bolt comprises pins aligned with slots in said area configured to engage with said top portion.

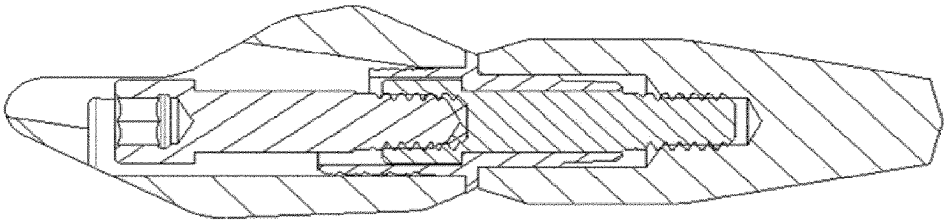


FIG. 2

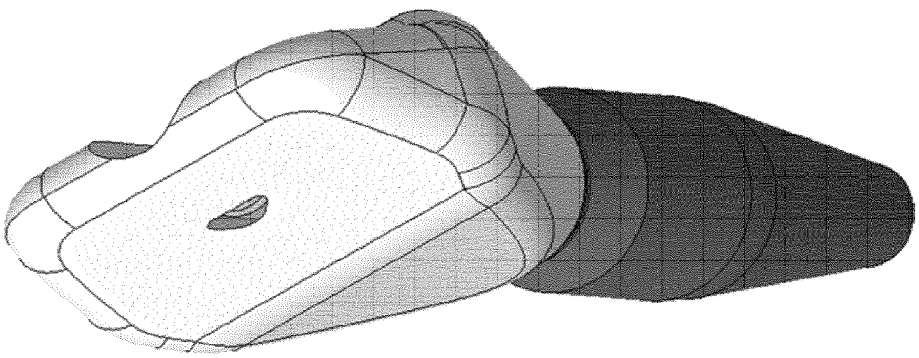


FIG. 1 (PRIOR ART)

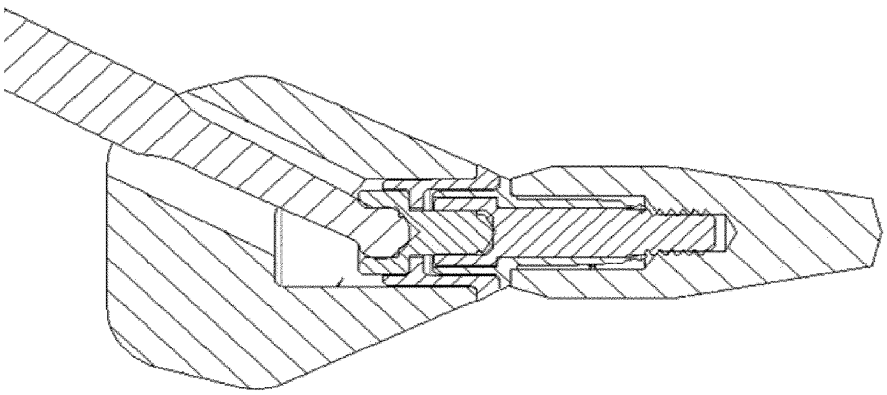


FIG. 3

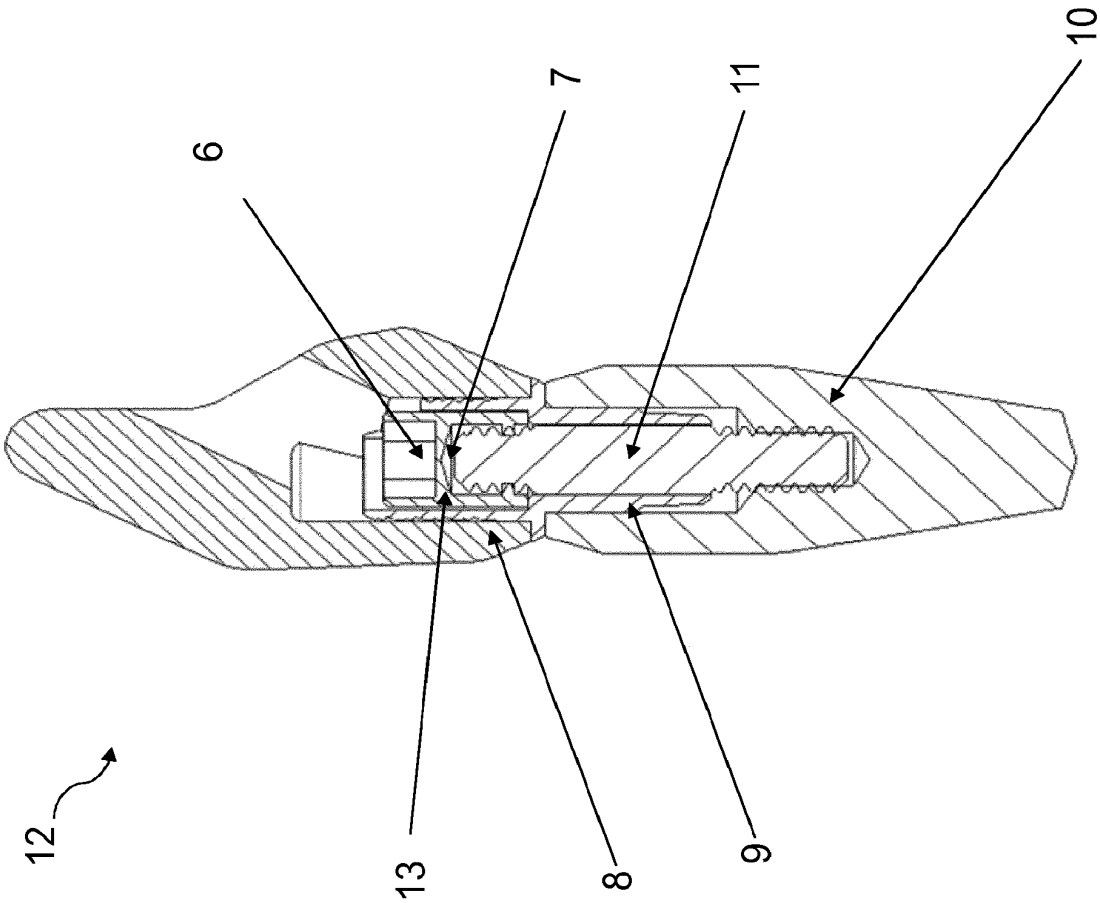


FIG. 4

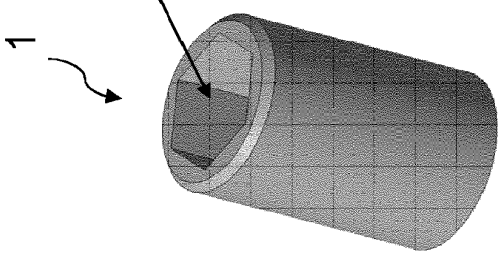


FIG. 5

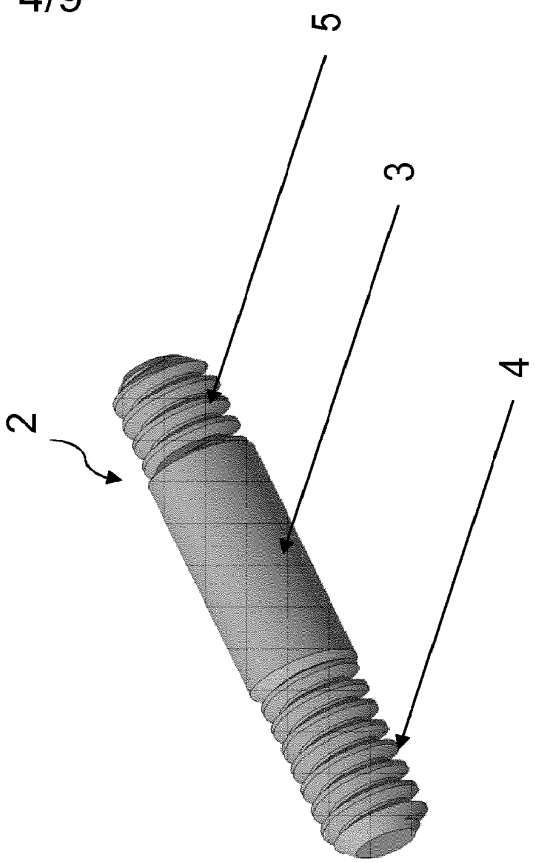


FIG. 6

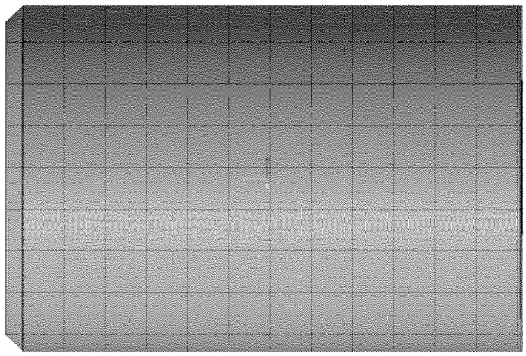


FIG. 8

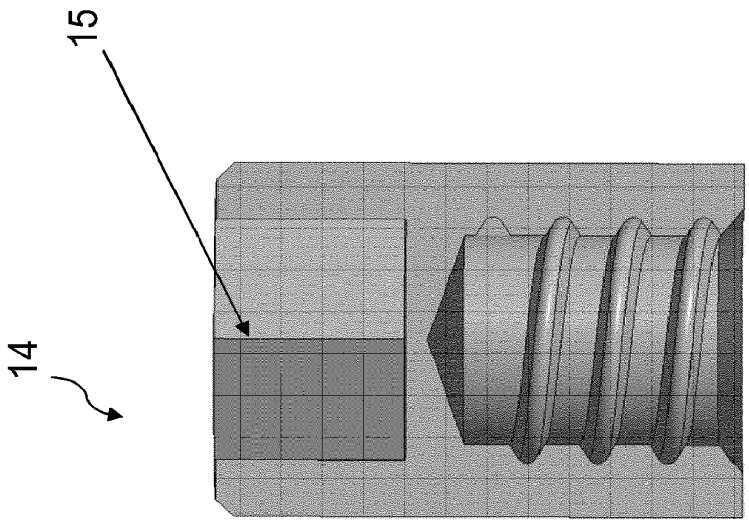


FIG. 7

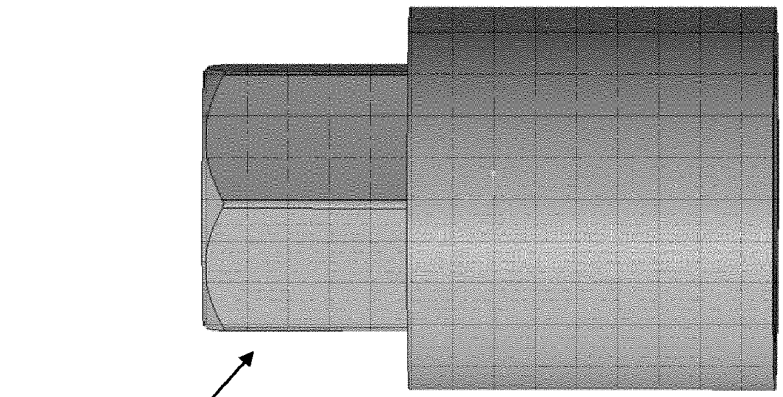


FIG. 10

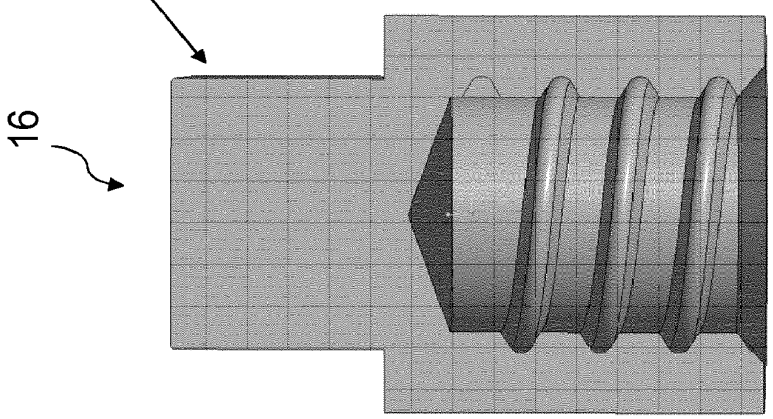


FIG. 9

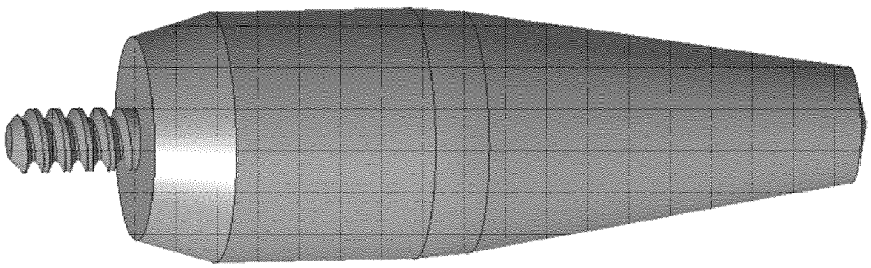


FIG. 13

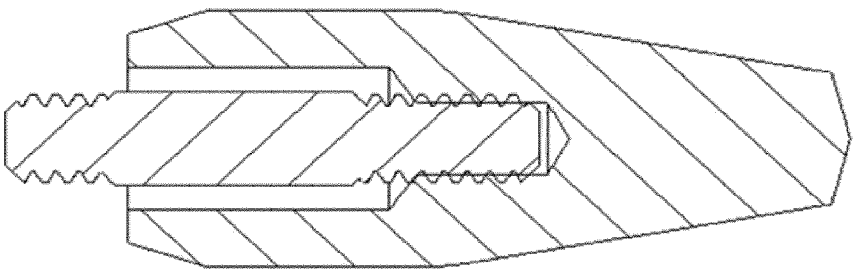


FIG. 12

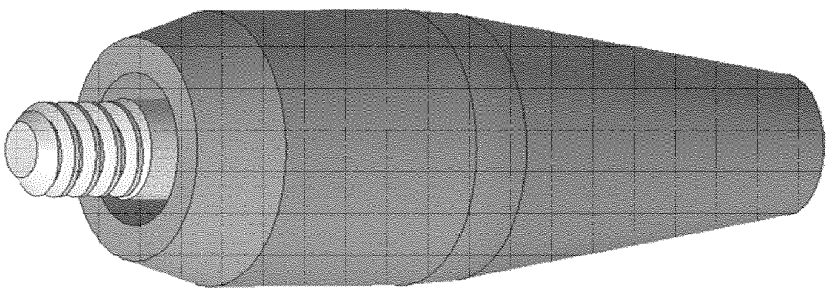


FIG. 11

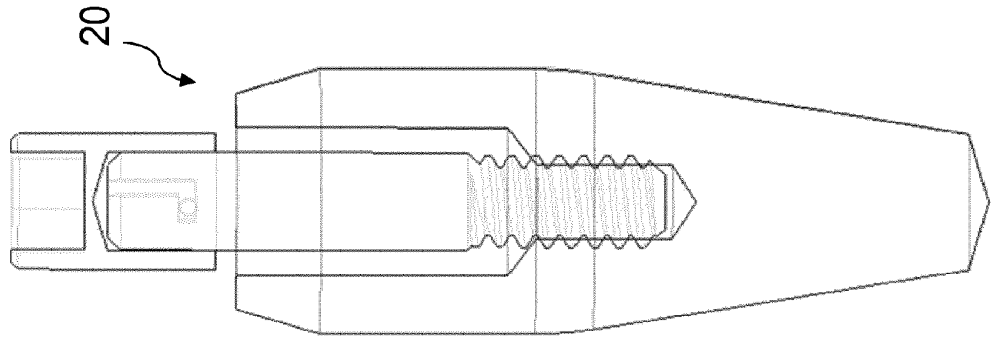


FIG. 16

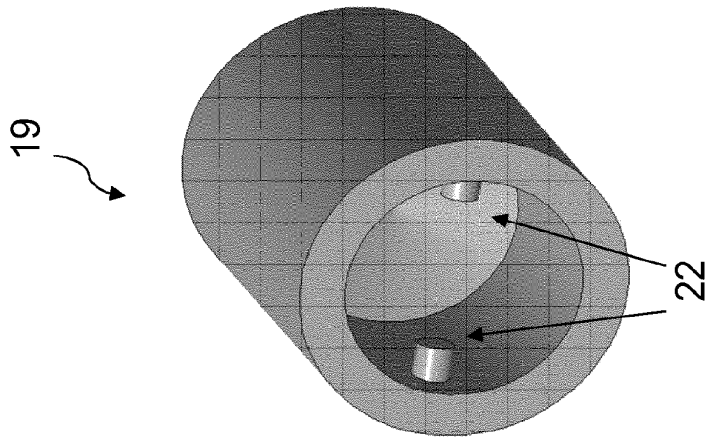


FIG. 15

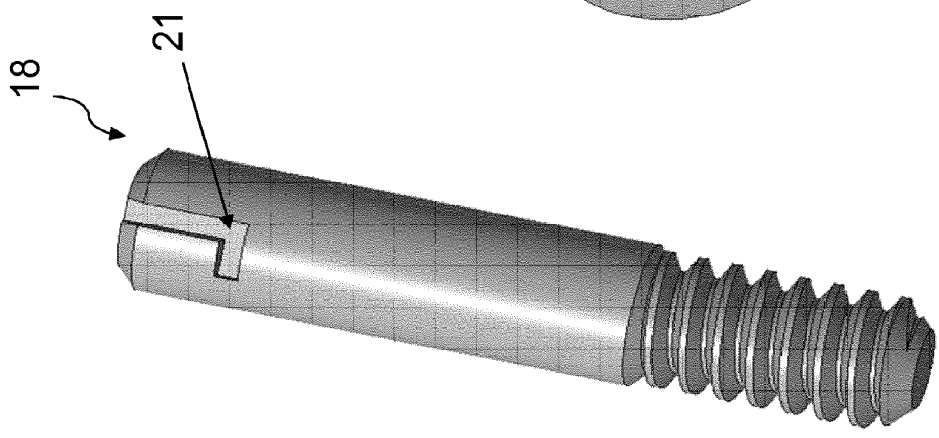


FIG. 14

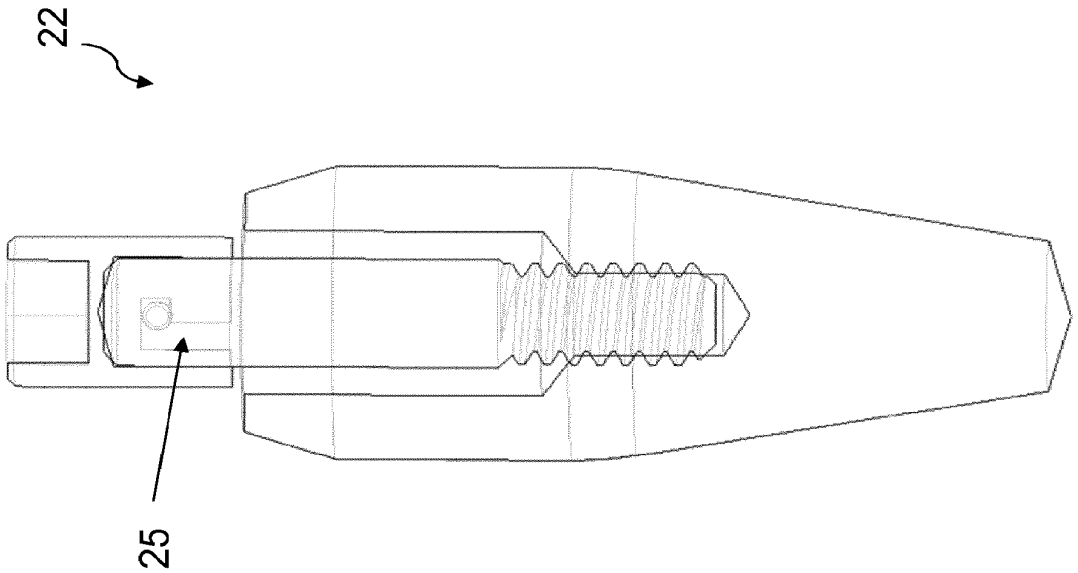


FIG. 18

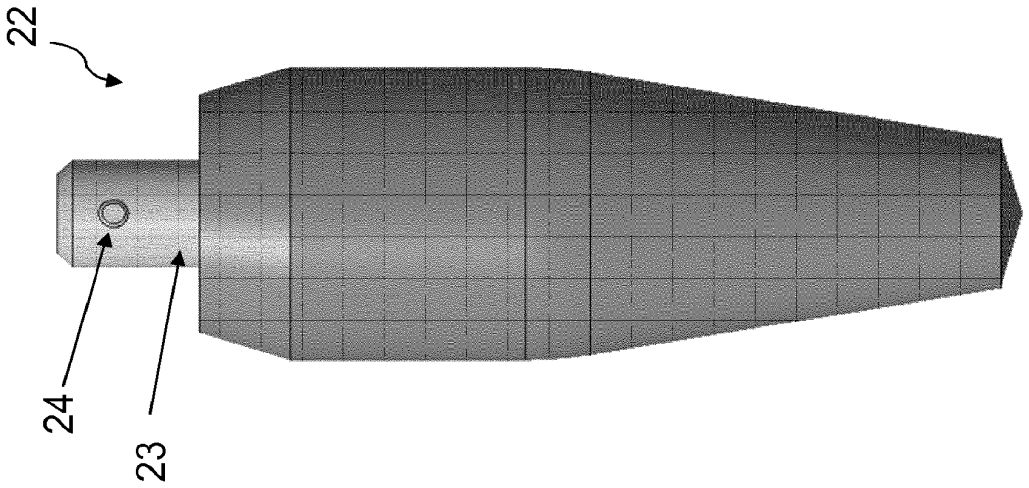


FIG. 17

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2018/067661

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61C8/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 938 693 A (BULAKI EV GEORGI K [BG]) 3 July 1990 (1990-07-03) column 1, line 54 - column 2, line 43 figure	1-4,6-14
X	EP 1 972 297 A1 (STRAUMANN HOLDING AG [CH]) 24 September 2008 (2008-09-24)	1-7 ,9-11
A	paragraph [0017] - paragraph [0020] paragraph [0021] figures 1,2 figures 3A-3D	8 , 12-14
A	US 5 733 122 A (GORDON BASIL [US]) 31 March 1998 (1998-03-31) column 9, lines 3-22 column 6, line 10 - column 6, line 67 figures 6-8 figure 17	1-4, 12-14

-/- .

[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 August 2018	12/09/2018

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Fortune, Bruce

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SDC001568

Page 365 of 1175

Straumann USA Exhibit 1020

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 687 450 A1 (REGENT LTD [KY]) 20 December 1995 (1995-12-20) column 2, line 23 - column 3, line 17 figures 1,2	1-14
A	JP 4 898950 B1 (HISAKAKAI ; HISAKA MITSUHIRO) 21 March 2012 (2012-03-21) the whole document	1-14
A	US 5 209 659 A (FRIEDMAN KURT E [US] ET AL) 11 May 1993 (1993-05-11) figures	1-14

3

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2018/067661

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 4938693 A	03-07-1990	BG 47523 A1	15-08-1990
		EP 0312935 A1	26-04-1989
		JP H01236048 A	20-09-1989
		US 4938693 A	03-07-1990
EP 1972297 A1	24-09-2008	EP 1972297 A1	24-09-2008
		ES 2557555 T3	27-01-2016
		US 2008233538 A1	25-09-2008
US 5733122 A	31-03-1998	NONE	
EP 0687450 A1	20-12-1995	DE 69420258 D1	30-09-1999
		DE 69420258 T2	31-08-2000
		EP 0687450 A1	20-12-1995
		ES 2136141 T3	16-11-1999
JP 4898950 B1	21-03-2012	JP 4898950 B1	21-03-2012
		JP 2012090676 A	17-05-2012
US 5209659 A	11-05-1993	NONE	

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Mechanical Behavior and Failure Analysis of Prosthetic Retaining Screws after Long-term Use in vivo. Part 4: Failure Analysis of 10 Fractured Retaining Screws Retrieved from Three Patients

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Part 4: Failure Analysis of 10 Fractured Retaining Screws Retrieved from Three Patients" (2008).
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Scanning electron microscopy (SEM) examination 5
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Mechanical Behavior and Failure Analysis of Prosthetic Retaining Screws after

Longterm Use in vivo. Part 4: Failure Analysis of 10 Fractured Retaining Screws Retrieved from Three Patients

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Abstract

Purpose: The aim of this study was to perform a failure analysis on fractured prosthetic retaining screws after long-term use in vivo. Additionally, the study addresses the commonly asked question regarding whether complex repeated functional occlusal forces initiate fatigue-type cracks in prosthetic retaining screws.

Materials and Methods: Ten fractured prosthetic retaining screws retrieved from three patients treated with fixed detachable hybrid prostheses were subjected to a failure analysis. In patients 1 and 2, the middle three retaining screws of the prostheses were found fractured at retrieval time after they had been in service for 20 and 19 months, respectively. In patient 3, the middle three and one of the posterior retaining screws were found to be fractured at retrieval after they had been in service for 18 months. Low power stereomicroscopy and high-power scanning electron microscopy (SEM) were performed to analyze the fractured surfaces of the retaining screws examining fatigue cracks in greater detail.

Results: Typical fatigue failure characterized by ratchet mark formation was revealed by light microscopy and SEM for all examined screws. Using low magnification light microscopy, ratchet marks were visible on the fracture surfaces of only two screws. SEM examination revealed all three classical stages of fatigue failure, and it was possible to see the ratchet marks on the fracture surfaces of all specimens, indicating a fatigue zone. The final catastrophic overload fracture appeared fibrous, indicating ductile fracture. The final overload ductile fracture surfaces showed equiaxed dimples, suggesting tensile

overload in all examined screws except in two specimens that showed an elongated dimple pattern indicating shear/tearing overload forces.

Conclusions: Fracture of prosthetic retaining screws in hybrid prostheses occurs mainly through a typical fatigue mode involving mostly the middle anterior three screws. Fatigue cracks can grow in more than one prosthetic retaining screw, leading to fracture before the patient or clinician determines that any problem exists.

Although the use of implant-retained and -supported fixed detachable hybrid prostheses has become a very successful treatment for totally edentulous patients, one of the commonly encountered complications is clamped joint instability as a result of screw loosening and/or fracture.1-3 Because prosthetic retaining screws are designed to be the weakest-link component in fixed detachable hybrid prosthesis and are used as a "break-safe" mechanism, the occurrence of screw loosening and/or fracture is expected to occur more frequently than for abutment screws.4, 5 If patients and/or clinicians fail to detect loose retaining screws early on, inevitable screw fracture will occur, leading to more complicated, time consuming, and expensive repairs.

A 31% occurrence of retaining screw loosening in edentulous patients has been reported 2 weeks after insertion.6 Other studies have reported: (1) 5% loosening of all retaining screws placed in 91 patients;7 (2) 9% implant screw loosening in 56 complete and partially edentulous patients treated with implantretained and -supported prostheses with screw failure in 25% of the patients;8 and (3) 53 prosthetic retaining screw fractures as complications of implant treatment.4 A summary of various studies indicates a 1–9% occurrence of retaining screw fracture.9 Implant screw loosening and/or loss of osseointegration (mechanical and/or biological failures) have been attributed to unfavorable biomechanical factors, such as occlusal overload and/or poor stress distribution.2, 3, 10 Two studies regarding implant screw loosening and fracture11, 12 suggested the following to minimize such problems: (1) occlusal forces should be directed to the long axis of the implant by placing the implant in a favorable position in relation to the opposing occlusion; (2) cantilevers should be as short as possible in fixed detachable hybrid prostheses; (3) application of recommended preload and use of gold screws; and (4) establishing a proper and accurate occlusion.

To date, only in vitro studies have attempted to investigate the effect of functional cyclic loading on implant system components, or to explain the mechanism of implant screw loosening and characterize the mode of failure.13-17 The aim of this study was to perform a failure analysis on fractured prosthetic retaining screws after long-term use in vivo. Additionally, the study addressed the commonly asked question regarding whether complex repeated functional occlusal forces initiate fatigue-type cracks in prosthetic retaining screws.

Materials and methods

Sample collection

Ten fractured prosthetic retaining screws retrieved from three patients treated with fixed detachable hybrid prostheses were subjected to failure analysis. All three patients came to the dental office complaining of loose prostheses. The fractured retaining screws were in Groups 16, 17, and 20 in Table 1 of Part 1 of this series. In patients 1 (Group 16) and 2 (Group 17), the middle three retaining screws of the prostheses were found to be fractured at retrieval after they had been in service for 20 and 19

months, respectively. In patient 3 (Group 20), the middle three and one of the posterior retaining screws were found to be fractured at retrieval after they had been in service for 18 months (refer to Table 1 in Part 1 of this series for more detail regarding group classification system, screw manufacturer, and inservice history). All the retaining screws were made by Sterngold (SG; Sterngold ImplaMed, Attleboro, MA) and used with the Nobel Biocare (Göteborg, Sweden) implant system. Screws were carefully handled during all stages of analysis and testing, using only plastic tweezers. Prior to testing, each screw was ultrasonically cleaned. Screws were placed individually in a glass beaker containing water/Alconox detergent powder (Alconox Inc., White Plains, NY) and ultrasonically cleaned for 10 minutes. Each screw was placed in a different glass beaker containing methanol and ultrasonically cleaned for an additional 5 minutes.

Low-power stereomicroscope examination

Low-power stereomicroscopy was used as the first-step for performing failure analysis (Meiji MZS-TR Model, Meiji Techno Co., Ltd., Saitama, Japan). A fiber optic light source was used for illumination (Lumina-I, Chiu Technical Corp., Kings Park, NY), and white paper was used to provide a neutral background. Prosthetic screws were examined and photographed within a white paper barrel that distributed the light more evenly and prevented glare. Photography was performed using an Image Analysis System comprised of a Sony CCD digital camera (DXC 151A, Sony, Tokyo, Japan) coupled to a computer with photo analysis software (Image Pro Plus 4.0 software, Media Cybernetics Inc., Bethesda, MD).

Scanning electron microscopy (SEM) examination

SEM was used to analyze the fractured surfaces of the retaining screws in more detail. A JEOL JSM 35 scanning electron microscope (JEOL USA Inc., Peabody, MA) was operated according to manufacturing instructions at 25 Kev, using secondary electron imaging.

Results

Light and scanning electron microscopy revealed typical fatigue failure on the fracture surfaces of the retrieved implant prosthetic retaining screws in Groups 16, 17, and 20. All of the middle three retaining screws from each group and one of the two posterior screws in Group 20 were fractured with moderate to severe thread wear. The remaining two posterior screws in each group were intact with mild thread wear. The fatigue fracture occurred in the shank area of all prosthetic screws, with the exception of the posterior screw in Group 20, for which fracture occurred in the threaded area (Fig 1).

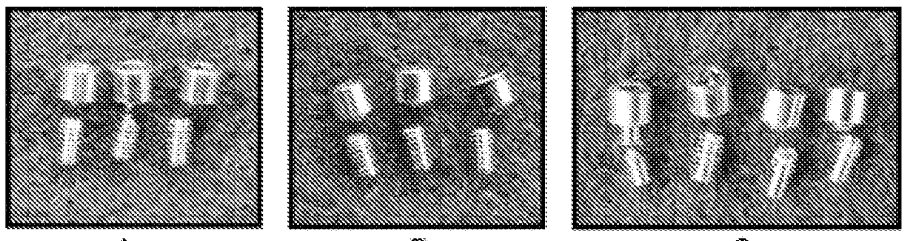
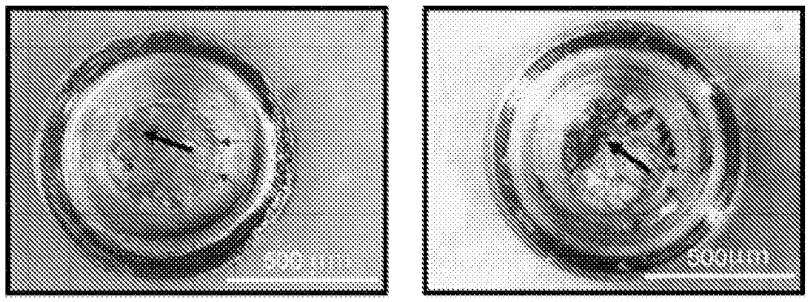


Figure 1 Fractured prosthetic retaining screws. Representative samples from groups 16 *(A)*, 17 *(B)*, and 20 *(C)*. Note that fracture occurred in the shank area for all screws except for $20B_1$, for which fracture occurrence was in the threaded segment of the screw.

Low-magnification light microscopy of the fracture surfaces of the prosthetic retaining screws suggested that fatigue failure was the primary mode of fracture (ratchet marks were observed). Ratchet marks were visible on the fracture surfaces of specimens $16A_1$ and $17A_2$ but were not visible on the fracture surfaces of other specimens (Fig 2). Additionally, light microscope examination revealed yellow fibrous (rutted) areas on the fracture surfaces representing the areas of final fracture when the fatigue crack reached its critical length and the cross-section area was reduced to the point where it could not carry the load.



A B

Figure 2 Light microscope photograph of fatigue fracture surfaces of prosthetic retaining screws. (A) 16A1(B) 17A2. Note the ratchet marks evenly dispersed along the periphery (blue arrows). Black arrows indicate fatigue crack propagation direction.

SEM revealed more detail of the fatigue fracture surfaces. At low magnification (×65), it was possible to see the ratchet marks on the fracture surfaces of all specimens. They were dispersed evenly along the periphery of the fatigue zone. The final catastrophic overload fracture appeared fibrous, indicating ductile fracture. The fatigue fracture surfaces of specimens $16A_1$, $17A_2$, and $20A_1$ are the best representative examples of the fatigue fracture surfaces for Groups 16, 17, and 20. Figure 3A is a lowmagnification (×65) SEM fractograph of the fatigue fracture surface of specimen $16A_1$. It illustrates a typical fatigue fracture surface characterized by ratchet marks parallel to the direction of crack propagation. The fibrous gray area indicates the final overload ductile fracture. The distinction between the area of fatigue crack propagation and that of final overload ductile fracture was very visible, whereas the distinction between the two areas was not clear for the fatigue fracture surfaces of specimens $16A_2$ and $16A_3$ at low magnification (×65). It was possible, however, to distinguish between the two areas under higher magnification, at which the fatigue crack propagation area was characterized by fatigue striations, and the final overload ductile fracture area was characterized by dimple formation. As can be seen in Figure 3A, the fatigue crack covered approximately 40% of the fracture surface as indicated by the outline in yellow, until final rapid overload fractured occurred (red area). For specimens $16A_1$, $16A_2$, and $16A_3$, the ratio of fatigue crack propagation area to the final overload ductile fracture area was 0.4:0.6, 0.6:0.4, and 0.8:0.2, respectively (Fig 3).

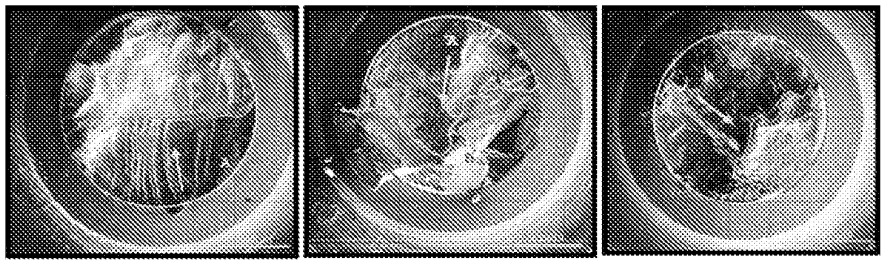


Figure 3 Scanning electron microscopy (SEM) fractograph of specimens 16A1 (A),16A2 (B), and 16A3 (C). In (A) the fracture surface shows well-formed and distinct ratchet marks (red arrow) parallel to crack propagation (yellow arrow). In both (B) and (C) fatigue fracture surfaces show fine ratchet marks on the periphery (red arrows). Region A is fatigue crack, and region B is final catastrophic overload fracture. The yellow arrow indicates the fatigue crack propagation direction.

Figure 4A is a high-magnification (×1500) SEM fractograph of one of the fatigue crack initiation sites for specimen $16A_1$. It illustrates typical fatigue striations, which are normally associated with fatigue cracks in ductile material. Figure 4B is another high-magnification (×500) SEM fractograph for specimen $16A_1$. It demonstrates the transition of the fatigue crack from the crack propagation stage (stage II) to the final overload fracture stage (stage III). Stage II shows parallel ratchet marks along the crack propagation direction and very fine fatigue striations perpendicular to the crack direction. Stage III shows dimple formation, which might be a result of a single occlusal (bite) overload force.

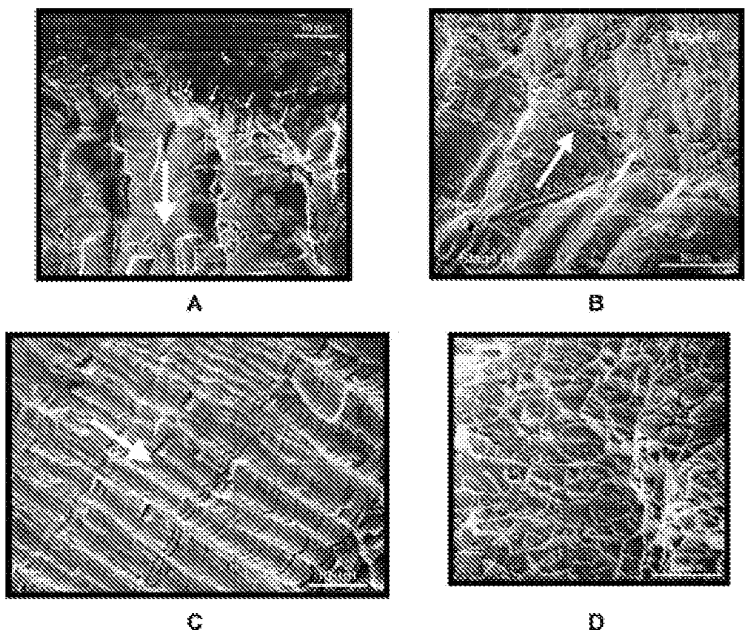


Figure 4 SEM fractograph of specimen 16A1. (A) Shows the origin of fatigue fracture as indicated by small arrows. Note fine striations within the fatigue crack propagation region. (B) Shows the transition from fatigue crack propagation stage (stage II) to final overload fracture (stage III). Stage II is characterized by ratchet marks and striations, and stage III is characterized by equiaxed dimples. Bold arrows indicate the crack propagation direction. (C) Shows the local variation of the orientation of the fatigue striations due to microstructural features. Note the variation of the striation banding or spacing (small arrows) due to varying stress

magnitudes. Large, bold arrow in (A), (B), and (C) indicates crack propagation direction. (D) Shows equiaxed dimples indicating the final ductile overload fracture (stage III).

Figure 4C is a high-magnification (×1500) SEM fractograph of stage II for specimen 16A1. It shows two common, interesting features of fatigue striations. First, there is local variation of the orientation of the fatigue striations due to differing microstructural features through which the crack was advancing. Second, there is variation of the striation spacing due to the differing magnitudes of occlusal cyclic loading. Careful examination of the striation spacing in Figure 4C may suggest occlusal loading magnitude. The wider the striation, the higher the magnitude of occlusal forces. Figure 4D is a highmagnification (×1000) SEM fractograph of stage III for specimen 16A1. It shows equiaxed dimples, which are usually caused by tensile overload.

Figure 5B is a low-magnification (×65) SEM fractograph of the fracture surface of specimen 17A2. It shows fatigue features similar to those seen in Figure 3A. The ratchet marks, however, are visible only at the periphery of the fracture surface and start to disappear as the fatigue crack propagates. Additionally, the distinction between the area of the fatigue crack growth and that of the final overload ductile fracture was not as clear as it was in Figure 3A. Distinction between the two areas was possible under higher magnification. For specimens 17A1, 17A2, and 17A3 the ratios of the fatigue crack propagation areas to the final overload ductile fracture areas were 0.8:0.2, 0.85:0.15, and 0.7:0.3, respectively (Fig 5).

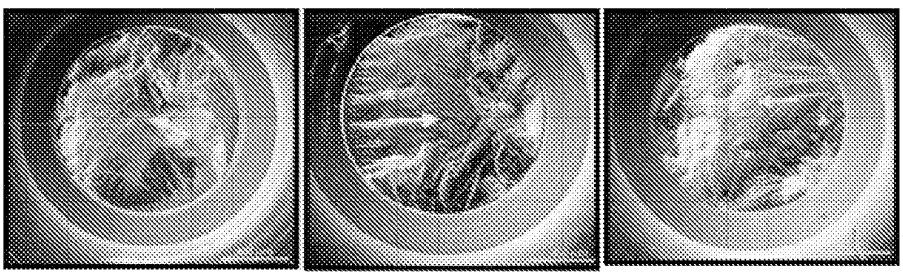


Figure 5 SEM fractograph of specimens 17A1 (A), 17A2 (B), 17A3 (C). In (A) and (B) fatigue fracture surfaces show fine ratchet marks on the periphery (red arrows), while in (C) fatigue fracture surface shows fine ratchet marks on the periphery with a very distinct band of ratchet marks in the middle (red arrows). Region A is fatigue crack propagation (stage II), and region B is final catastrophic overload fracture (stage III).Yellow arrow indicates crack propagation direction.

Figures 6A and B are high-magnification (×2000 and ×600) SEM fractographs for specimen $17A_2$. Figure 6A shows typical fatigue striations similar to those seen in Figures 4A and C, whereas Figure 6B shows an equiaxed dimple pattern of final overload ductile fracture similar to those found on the fracture surface of specimen $16A_1$ in Figures 4B and D. An elongated dimple pattern was observed on the final catastrophic overload fracture surfaces of $16A_2$ and $17A_1$, indicating shear or tearing overload forces (Figs 6C, D).

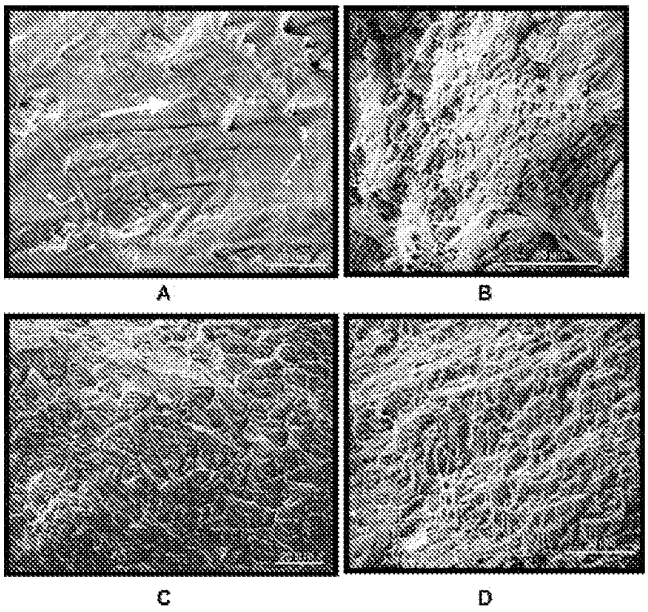


Figure 6 SEM fractograph for specimen 17A2. (A) Shows the fatigue crack propagation (stage II). Note local variation of the striation spacing (small arrows) due to repeated stress cycles. Large, bold arrow indicates crack propagation direction. (B) Demonstrates the final overload fracture (stage III), which was characterized by equiaxed dimples formation. (C) & (D) demonstrate elongated dimple pattern formation of the final overload fracture (stage III) for specimens 16A2 and 17A1, respectively.

Figure 7 shows low-magnification (×65) SEM fractographs for specimens $20A_1$, $20A_2$, $20A_3$, and $20B_1$. They show features similar to those seen in Figure 3. For specimens $20A_1$, $20A_2$, $20A_3$, and $20B_1$ the ratios of the fatigue crack propagation area to the final overload ductile fracture areas were 0.75:0.25, 0.4:0.6, 0.55:0.45, and 0.5:0.5, respectively. Figure 8A is a high-magnification (×1000) SEM fractograph of the fatigue crack initiation sites for specimen $20A_1$. It shows the first two stages (stage I and II) of fatigue crack initiation and propagation. Stage I extends inward from the surface (usually along a slip band about 45° to the tensile stress axis)[18] with no associated striations. It was the only specimen for which stage I was observed on the fracture surface. Stage II, on the other hand, shows the change of orientation of crack propagation as it becomes perpendicular to the long axis of the implant screw and the tensile loads. Stage II contains typical fatigue striations similar to those seen in Figures 4A, 4C, and 6A.

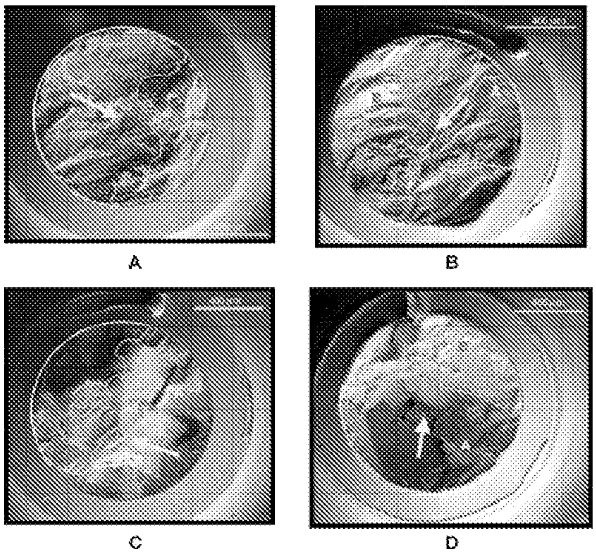


Figure 7 SEM fractograph of specimens 20A1, 20A2, 20A3, and 20A4 are shown in (A), (B), (C), and (D), respectively. Fatigue fracture surfaces show fine ratchet marks on the periphery (red arrows). Region **A** is fatigue crack propagation (stage II) and region **B** is final catastrophic overload fracture (stage III). Yellow arrow indicates crack propagation direction.

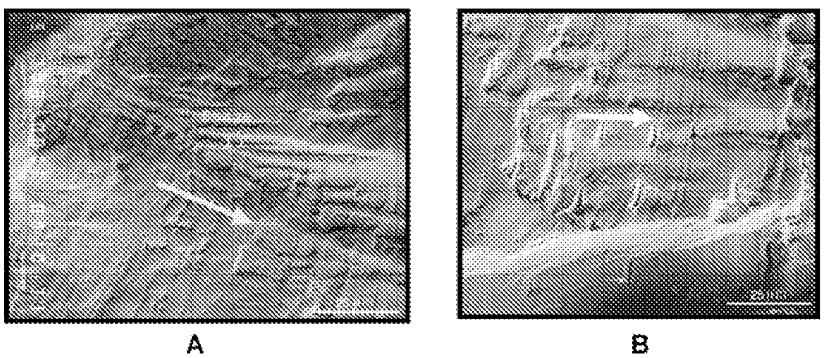


Figure 8 SEM fractograph of specimen 20A1. (A) shows the transition from stage I to stage II at the periphery of the fracture surfaces (yellow arrow indicates crack propagation direction). (B) shows stage II with secondary cracks (small arrows) associated with striations perpendicular to the fatigue crack propagation direction (large, bold arrow).

Figure 8B is another high-magnification (×1000) SEM fractograph of fatigue crack propagation from a different location for specimen $20A_1$. It illustrates typical fatigue striations with secondary crack formation.

Discussion

Metal fatigue is caused by repeated loading at stress levels above the endurance limit of a susceptible material.[18] In this study, it was possible to see features of fatigue failure at both the macroscopic and microscopic level for all fracture surfaces of prosthetic retaining screws examined. Macroscopically, the

fatigue fracture surfaces exhibited two distinct regions, a fatigue crack propagation region and a final overload ductile region. The ratio of the areas of the two regions to each other provided a better understanding of the fatigue with regard to the number of occlusal load cycles and stress level. Normally, if the stress level from occlusal (biting) forces is relatively low, it takes many cycles for the fatigue crack to propagate to a location where the remaining material would fracture catastrophically on the next (and final) occlusal load application (Fig 9).18 Thus, for lower loads, the relative amount of the fracture surface covered by fatigue crack propagation will be larger than the surface covered by final occlusal overload fracture. On the other hand, if the stress level is high, then the fatigue crack will not propagate far before final fracture occurs.18 Accordingly, in this study, failed screws with larger fatigue crack propagation areas (probably 70% or more) are most likely the ones that initiated fatigue cracking and failure. Therefore, the observed stage I propagation in Figure 8A of this study might indicate that the retaining screw was subjected to a very low stress level and was the first screw that initiated fatigue cracking and failure. Many factors can initiate or produce stage I propagation such as: (1) surface finishing micro-cracks; (2) scratches and/or deformations due to improper handling; (3) manufacturer defects; and (4) corrosion.18, 19 In this study, corrosion was not considered to be a major causative factor of fatigue failure, because the prosthetic screws were made from noble materials as determined by energy dispersive X-ray analysis in Part 2 of this series. The noble metals are resistant to corrosion.20 Retaining prosthetic screws, however, are more sensitive to the effect of surface finish and scratches/deformation due to improper handling. It was possible to see both manufacturer machining irregularities and surface damage on one of the non-fractured screws ($15B_1$; Fig 10).

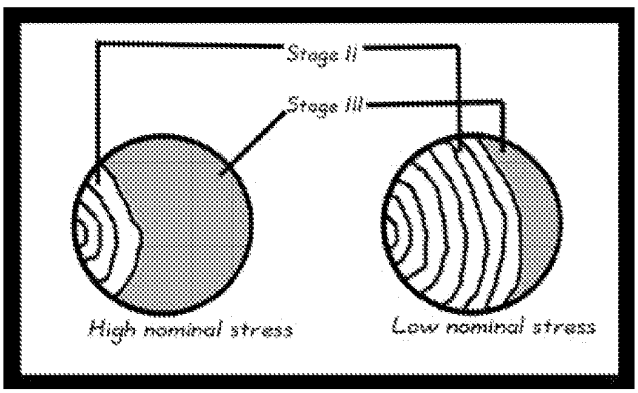


Figure 9 Schematic illustration of a fatigue fracture surface and the effect of loading conditions and stress level on the relative area covered by the fatigue crack.

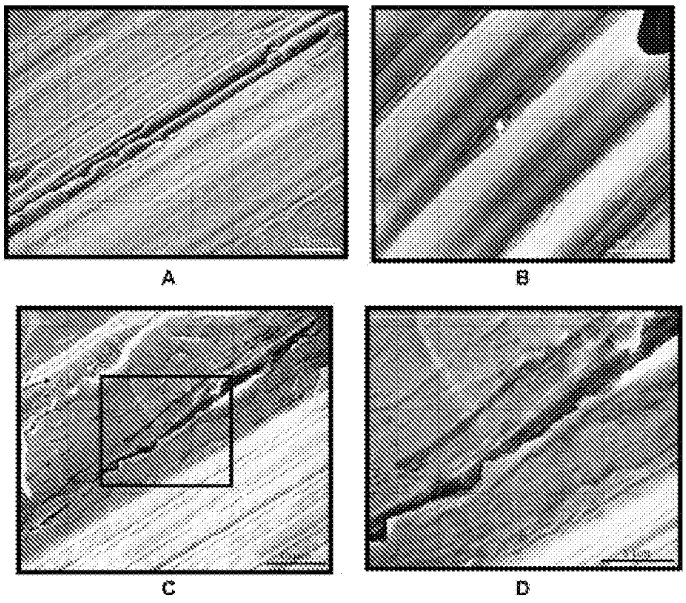


Figure 10 SEM micrograph of the15B1 prosthetic screw. Variability of machining roughness and irregularities in the head area are demonstrated in (A). (B) Localized damage to the crest of a thread (white arrow). (C) High magnification view of the area in (B) at ×2000 showing severe plastic deformation of the thread crest associated with crack/groove-like defect formation. (D) is the outlined area in (C) at ×5000.

In stage II, the fatigue propagation plane becomes normal to the maximum tensile stress, and it is usually associated with most of the fatigue crack propagation.18, 19 It has been established that each striation formed during stage II is associated with the growth of the crack during one loading cycle, but every load cycle does not necessarily produce a striation.18 Others have shown that one striation does not necessarily correspond to one load cycle; tens to thousands of load cycles may be required to obtain one striation.18 In this study, the observed fatigue striations on all fracture surfaces of prosthetic retaining screws were considered to result from single high-stress occlusal loads and/or multiple lowstress occlusal loads. An additional observation of this study was local variations of the orientation of the fatigue striations as the crack advanced (Fig 4C). This indicates that the crack propagated through various microstructural features (multiple plateaus) that were at different elevations with respect to one another.18, 19 Stage III is the final stage of fatigue failure and involves final fracture resulting from a single overload. Final fracture may be brittle, ductile, or a combination of the two.18, 19 The dimple rupture observed in this study indicates a ductile type of final fatigue fracture in all specimens.

The ductile fracture was associated with equiaxed dimple formation except for two screws (16A2 and 17A1) in which the final fracture was associated with elongated dimple formation. Equiaxed dimples are caused by tensile overload forces, and elongated dimples are caused by shear or tear overload forces. It has been suggested theoretically that the most posterior two implant screws in fixed detachable hybrid prostheses are subjected mainly to compression, while the most anterior implants are subjected mainly to tensile forces.21 This has never been proven clinically. The failure analysis in this study suggests that the most anterior prosthetic retaining screws are subjected to more occlusal overload force. This is supported from the location of the fatigue fracture and the higher thread wear on the middle three screws, observed and discussed in Part 1 of this series. Additionally, it suggests that the most anterior screws are not subjected solely to tensile force as previously proposed.21 The difference in dimple

patterns (equiaxed and elongated) indicates that the prosthetic screws were subjected to a combination of tensile and shear/tear forces. The occlusal forces acting on the implant prosthetic screw are considered complex. In addition to the vertical forces induced by mastication, lateral forces are created by: (1) horizontal motion of the mandible during function; (2) inclination of the cusps; and (3) existence of parafunctional habits for long periods of time.21-24 Furthermore, all fatigue fractures, except for one screw, occurred in the shank area of the screws, rather than below the shank area or in the threaded part. It has been suggested that for adequately preloaded and torqued screws, the maximum stress from the cyclic tensile and transverse loading will be located on the shank area.25, 26 Therefore, the finding of fatigue fracture in the threaded area in one screw (Fig 11) indicates it was loose before fatigue crack initiation and fracture occurrence. It is not yet known why a fastener will self-loosen under cyclic loading and/or thermal cycles.25 It has been suggested that a fastener subjected to both tensile and transverse cyclic loading will have a vibratory motion along a circular path rather than a straight one. The vibration motion may loosen, tighten, or have no effect on the fastener.26 Therefore, the observation of fatigue fracture locations suggests that the fatigue cracks initiated and propagated in the middle anterior three screws first, and then the posterior screw started to self-loosen after experiencing higher cyclic occlusal loading before it fractured in the threaded area.

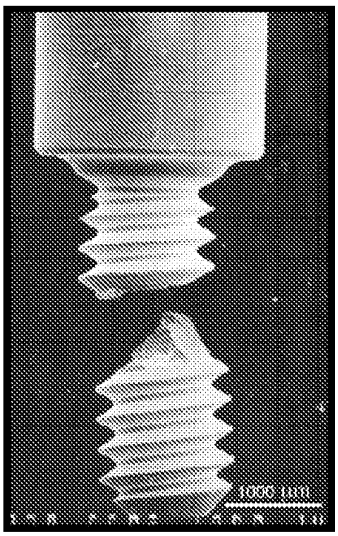


Figure 11 SEM micrograph for specimen 20B1 showing screw fracture at threaded area.

The finding of this study that the failure occurred only in retaining screws from SG after a short inservice time may be significant. The failure may be related to design incompatibility of the retaining screws from SG with the NB implant system. In Part 1 of this series, the observed unique design of the junction between the shank area and the head revealed by low-magnification SEM as wide and inclined with no head-shank fillet raised a significant concern because these screws had been considered compatible and interchangeable with the NB implant system. A retrospective assembly of one of the retrieved retaining screws from SG ($15B_1$) with NB implant components using a 3 mm gold cylinder (DCA 073–0 lot 0728A-03) and a standard abutment replica (DCB 175–0 Lot 123246) compared with a similar assembly using an NB hexed retaining screw and a standard abutment revealed an unexpected finding (Fig 12). The junction area between the head and shank of the retaining screw from SG formed a "point contact" with the gold cylinder. Such a point contact will lead to rapid and total relaxation. As the compression from the tightening torque increases, it will concentrate at a very small area, creating permanent (plastic) deformation and subsequent screw loosening. This problem can be exaggerated if a screw has lower

hardness and higher preload. As mentioned in Part 3 of this series, SG screws had the highest preload and the lowest hardness. This observation might explain why fatigue failure occurred only in retaining screws from SG in Groups 16, 17, and 20 after a short period of in-service time. The manufacturer might argue that the retaining screw was not assembled with the SG implant system. The NB implant components were used based on claims of interchangeability and compatibility with the NB implant system.

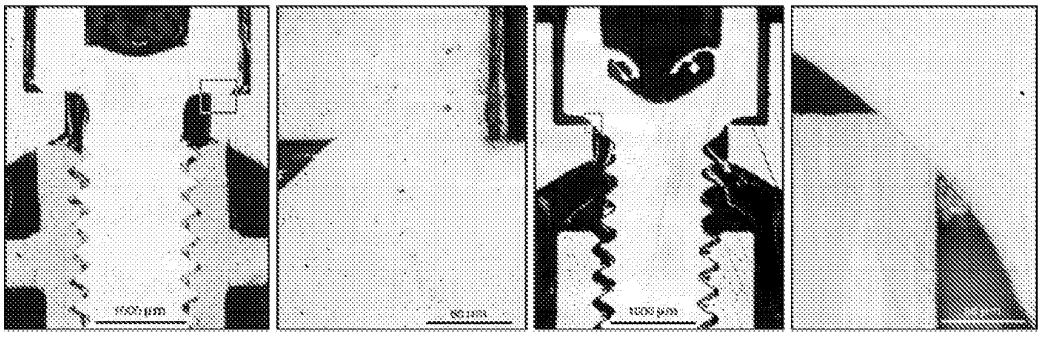


Figure 12 Light micrograph of assembled implant complex illustrating the assembly difference between the gold alloy retaining screws from NB and SG. NB is shown in (A) and (B), while SG is shown in (C) and (D). The outlined two areas in (A) and (C) at ×25 are shown in (B) and (D) at ×500. Compared to (B), the assembly in (D) formed a point contact area with the gold cylinder, which gradually will yield and deform plastically under torque preload and functional bite forces.

Clinical significance

The findings of this study and those presented in Part 1 of this series demonstrate that retaining screws from the same manufacturer and/or different manufacturers have different geometrical designs. Catastrophic failure and fatigue fracture of prosthetic retaining screws from SG may be related to design incompatibility when used with the NB gold cylinder designed for flat-headed screws. These findings support previous concerns raised by consensus of the "JOMI Current Issues Forum" in 1993[11] and a study in 1995[26] regarding interchangeable implant hardware. These emphasized that "to provide scientific proof regarding long-term survival of interchanging implant hardware between different implant system components, there is a need for long-term clinical trials." Additionally, this study reinforces previous concerns regarding the lack of written specifications for prosthetic implant components.[26] Therefore, based on the findings of this study, avoiding interchanging implant components between different implant systems is highly recommended until an accurate written specification regarding geometrical design, alloy composition, and mechanical properties of implant components becomes available. This may be the only way to ensure long-term clinical performance of the prostheses. Additionally, maintaining retaining screws within their own implant system facilitates the most accurate information and best service from the manufacturer when problems arise.

Conclusions

1) The fracture of prosthetic retaining screws in fixed detachable hybrid prostheses observed in this study suggests that failure of these types of screws occurs mainly by fatigue and involves mostly the middle anterior three screws (the screws farthest from the fulcrum).

2) Fatigue cracks can grow in more than one prosthetic retaining screw, leading to catastrophic fracture before the patient or clinician determines that any problem exists. Annual evaluation of retaining screws using stereo-light microscopy (as a suggested maintenance protocol in Part 1 of this series) may allow early detection of fatigue cracks before catastrophic failure occurs.

3) When possible, clinicians should avoid interchanging prosthetic implant components between different implant systems.

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References

1 Adell R, Erickson B, Lekholm U, et al: Long-term follow-up of osseointegrated implants in the treatment of totally edentulous jaws. *Int J Oral Maxillofac Implants* 1990;5:347-359

2 Rangert B, Krogh PH, Langer BM, et al: Bending overload and implant fracture: a retrospective clinical analysis. *Int J Oral Maxillofac Implants* 1995;10:326-334

3 Kallus T, Bessing C: Loose gold screws frequently occur in full-arch fixed prostheses supported by osseointegrated implants. *Int J Oral Maxillofac Implants* 1994;9:169-178

4 Zarb GA, Schmitt A: The longitudinal clinical effectiveness of osseointegrated dental implants: the Toronto study. Part III: problems and complications encountered. *J Prosthet Dent* 1990;64:185194

5 Rangert B, Jemt T, Joreous L: Forces and moments on Branemark implants. *Int J Oral Maxillofac Implants* 1989;4:241-247

6 Jemt T: Failure and complications in 391 consecutively inserted fixed prostheses supported by Branemark implants in edentulous jaws. A study of treatment from the time of prosthesis placement to the first annual checkup. *Int J Oral Maxillofac Implants* 1991;6:270-276

7 Naert I: A study of 589 consecutive implants supporting complete fixed prostheses. Part II: prosthetic aspects. *J Prosthet Dent* 1992;68:949-956

8 Wie H: Registration of localization, occlusion and occluding materials for failing screw joints in the Branemark implant system. *Clin Oral Implants* Res 1995;6:47-53

9 Goodacre CJ, Kan JY, Rungcharassaeng K: Clinical complications of osseointegrated implants. *J Prosthet Dent* 1999;81:537-552

10 McGlumphy EA, Robinson DM, Mendel DA: Implant superstructures: a comparison of ultimate failure force. *Int J Oral Maxillofac Implants* 1992;7:35-39

11 Taylor TD: Prosthodontic problems and limitations associated with osseointegration. *J Prosthet Dent 1998;79:74-78*

12 Sakaguchi RL, Sun T, Haack JE: External strain distribution on implant prosthetic components. *J Dent Res* 1994;73:232. Abstract 1045

13 Khraisat A, Stegaroiu R, Nomura S, et al: Fatigue resistance of two implant/abutment joint designs. *J Prosthet Dent* 2002;88:604-610

14 Gratton DG, Aquilino SA, Stanford CM: Micromotion and dynamic fatigue properties of the dental implant-abutment interface. *J Prosthet Dent* 2001;85:47-52

15 Lee J, Kim Y, Kim C, et al: Wave analysis of implant screw loosening using an air cylindrical cyclic loading device. *J Prosthet Dent* 2002;88:402-408

16 Hoyer SA, Stanford CM, Buranadham S, et al: Dynamic fatigue properties of the dental implantabutment interface joint opening in wide-diameter versus standard-diameter hex-type implants. *J Prosthet Dent* 2001;85:599-607

17 Cibirka RM, Nelson SK, Lang B, et al: Examination of the implant-abutment interface after fatigue testing. *J Prosthet Dent* 2001;85:268-275

18 Failure analysis and prevention. *ASM Handbook*, volume 11, 4th printing, 1992

19 Brooks C, Choudhury A: *Metallurgical Failure Analysis*. Columbus , OH , McGraw Hill, 1993

20 Bickford J, Nassar S: *Handbook of Bolts and Bolted Joints*. New York , NY , Marcel Dekker, 1998

21 Rangert B, Gunne J, Glantz PO, et al: Vertical load distribution on a three-unit prosthesis supported by a natural tooth and single Branemark implant. *Clin Oral Implants Res* 1995;6:40-46

22 Brunski J, Puleo D, Nanci A: Biomaterials and biomechanics of oral and maxillofacial implants: current status and future developments. *Int J Oral Maxillofac Implants* 2000;15:15-38

23 Falk H, Laurell L, Lundgren D: Occlusal force pattern in dentition with mandibular implant supported fixed cantilever prostheses occluded with complete dentures. *Int J Oral Maxillofac Implants* 1989;4:55-61

24 Lundgren D, Falk H, Laurell L: The influence of number and distribution of occlusal cantilever contacts on closing and chewing forces in dentitions with implant-supported fixed prostheses occluding with complete dentures. *Int J Oral Maxillofac Implants* 1989;4:277=283

25 Bickford J: *An Introduction to the Design and Behavior of Bolted Joints* (ed 3). New York , NY , Marcel Dekker, 1995

26 Jaarda M, Razzoog M, Gratton D: Ultimate tensile strength of five interchangeable prosthetic retaining screws. *Implant Dent* 1996;5:16-19

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(54) Title: DENTAL IMPLANT SYSTEM COMPRISING MEANS FOR PREVENTING ROTATION OF THE SUPERSTRUCTURES AND METHODS OF FORMING AND INSTALLING

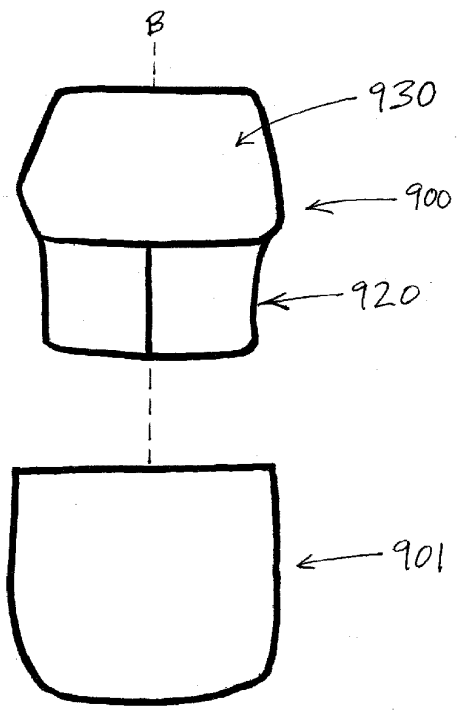


FIG. 9

(57) Abstract: Dental implants for fixed and removable prosthetic devices, having application to single tooth replacement, e.g., caps and crowns, and multiple tooth replacement using one or more implants, e.g., bridges, and multiple implants for full and partial prosthetic devices. Dental implants comprise a non-cylindrical implant and an abutment configured to mate with the implant in a non-rotatable fashion. Further, dental reconstruction and abutment installation methods utilizing the dental implant systems and instruments are disclosed. Also provided are impression taking procedures, and impression copings that produce an accurate fit between the dental prosthesis and the dental implant.

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DENTAL IMPLANT SYSTEM COMPRISING MEANS FOR PREVENTING ROTATION OF THE SUPERSTRUCTURES AND METHODS OF FORMING AND INSTALLING

CROSS REFERENCE TO RELATED APPLICATION

This application claims the benefit of priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 61/804,159, filed March 21, 2013, which is incorporated herein by reference.

TECHNICAL FIELD

This disclosure describes a dental implant system having improved structural features for ensuring proper alignment and orientation with improved implant stability and fixation and which prevents the rotation of the superstructures, such as a post or abutment, on the implant body of an abutment assembled on an implant. This disclosure also provides methods and materials for preparing an accurate dental impression and mold representing the implantation site and its relationship to adjacent teeth structure. The disclosure further describes a multi-component kit containing the dental implant system components and related devices and instructions for proper use and implantation.

BACKGROUND

Natural teeth in the human mouth are supported in bone by periodontal fibers that function as shock absorbers when a compressive force is applied, such as during chewing. Through disease, accidental injury, anatomical abnormalities, age, and the like, a natural tooth may be removed or missing, such that a dental appliance or prosthetic device (e.g. a crown) is implanted in the patient's bone structure to improve the patient's physical appearance and/or quality of mastication. However, conventional implants are often too rigid to function like natural teeth. Problems such as crown breakage, crown rotation, screw loosening and screw breakage are inherent problems with a rigid crown implant. Failure is also known to occur when an implant is used in a bridge abutment with a natural tooth or when improper occlusion is created by the implant crown.

As shown in Figure 1, most conventional dental implants include an implant 1 having a screw part, and an abutment 3 integrally formed with the upper end of the implant, such that the implant and the abutment 3 are fixedly secured to each other by means of a screw 4. The abutment is secured to a dental prosthesis (such as a crown) 2 whereby combined 5, the dental prosthesis 4 covers the abutment 3, leaving the implant

imbedded in the patient's jawbone. Figure 2 shows such conventional dental implant 1 supporting a crown 2 between adjacent teeth 6. Embrasures, or periodontal gaps 12 between the bottom portion of the crown 2 and adjacent teeth 6 may become irritated or infected following food impaction and collection.

Screws associated with conventional crowns sometimes break because of over tightening and due to tension and lateral stress to which the crown is subjected during use. Besides the time and inconvenience associated with conventional procedures for implanting, it is also difficult in some cases to properly orient the implant and maintain it in a stable orientation after the prosthesis has been fitted. This can contribute to longer healing periods before the implant and the bony tissue integrate because of the lack of substantial close bone contact. Screw-type implants also are difficult to orient and stabilize. Typically, the thread pattern of screw-type implants require multiple turns to set the implant. The hardness of the bony tissue in and around the implant cavity varies. With a multiple-turn implant, the threads tend to draw the implant towards and through softer bony tissue. This can result in the entire implant misaligning within the alveolar bone structure of the patient. Such implants are typically designed such that they conform to a generally cylindrical configuration. In addition, typical implants are of a single piece construction and do not include additional or auxiliary means for interlocking the implant to the alveolar bone structure. Once the prosthesis has been attached to the top portion of the implant and the patient starts to use the implant to chew food, the stress, vertical and lateral forces, as well as frequent temperature changes of over 100 °F from hot versus cold foods and liquids, and rotational torques placed on the prosthesis, are transferred downwardly to the implant. In cases where the implant is not stable and tightly secured within the implant cavity, the implant tends to rotate and turn under these stresses and torque. This results in the implant becoming loose within the implant cavity and that often results in the implant becoming dislodged from the cavity or being so loose and unstable within the cavity that the implant has to be removed from the patient's alveolar bone. Imperfections in the manufacture of dental implant systems also contribute to screw loosening.

It is expensive and time consuming to retrieve and/or repair such loose or broken screws. In addition, special purpose torque drivers are required to install the screws. Once the crown is implanted, it may take several months to achieve suitable bone integration of the root portion with the surrounding bone structure thereby resulting in increased loading time before the root portion can be reliably anchored. Improperly anchored implants or

crowns loosened by rotation may be susceptible to damage or reduced life and may be unable to provide the function of a natural tooth, including the quality of mastication.

Accordingly, it is desirable to overcome the problems associated with conventional crowns by avoiding dental implant system screws which can break or loosen due to rotation of the crown. It would also be desirable to decrease integration time by increasing stabilization between the root portion of the implant and the bone structure of the patient. With such system, patient comfort will be enhanced, the life of the crown will be increased, and the need to make repairs, and corresponding costs, can be reduced.

Each of the foregoing disadvantages are overcome by the implant system and methods provided in this disclosure. Additionally, the implant system and methods provided in this disclosure achieve other advantages described more fully below.

SUMMARY

In one aspect, this disclosure provides a dental implant adapted to be embedded within a patient's jawbone comprising a non-cylindrical apical end adapted to engage the jaw bone, and a top end, opposite the apical end, the top end having an abutment or prosthesis receiving portion. In some embodiments, the apical end of the dental implant has a shape substantially consistent with a square, an oval, a rectangle, a pentagon, or a hexagon. In one embodiment, the dental implant has an apical end shaped substantially consistent with a rectangle. In another embodiment, the dental implant has an apical end shaped substantially consistent with an hourglass in the mesial-distal plane, having two wider lobes, and a narrower center portion between the two lobes.

The dental implants of this disclosure may be made of at least one material selected from titanium or titanium alloys, gold alloys, zirconium, and a ceramic.

The dental implants of this disclosure may have a smooth surface texture or a rough surface texture. Additionally, these dental implants may have one surface portion with a rough surface texture, and one surface portion with a smooth surface texture.

Dental implants of this disclosure may have a surface coating with materials selected from an artificial hydroxyapatite, a bisphosphonate, a platelet-rich plasma (PRP), a PRP-bone matrix mix, and combinations thereof. Such surface coatings may be uniformly applied over the external surface of the implant, or the surface coating may be applied to only a portion of an external surface of the implant. For example, such surface coatings may be applied to a portion of an external surface of the implant that resides below the gum line in the surrounding tissues within the patient's mouth following implantation of the implant. Alternatively, such coating may be absent in a portion of the

external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth following implantation of the implant. In certain embodiments, the external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth is smooth and free of surface coatings.

In certain embodiments, the dental implant of this disclosure may include a top end that is adapted to receive a prosthesis without the use of an abutment.

In some embodiments, the dental implants of this disclosure may be formed such that the top end comprises a dental fixture integrally formed with the implant. In other embodiments, the dental implant has a top end adapted to receive an abutment. Such abutment-receiving portion of the implant may be a cavity formed within the top end of the implant to receive an abutment, or other dental prosthetic structure. The abutment-receiving portion of the implant may include a plurality of projections formed on an interior wall of the cavity comprising the abutment-receiving portion of the implant. Such projections may extend from the interior wall into the cavity comprising the abutment-receiving portion of the implant. Such projections are of a size and/or shape to engage with an abutment in a manner that will prevent rotation of an abutment disposed in the abutment-receiving portion of the implant. Such projections may be located in the cavity comprising the abutment receiving portion of the implant in a non-symmetrical pattern that will prevent rotation of an abutment disposed in the abutment-receiving portion of the implant. The projections may have a shape that prevents the rotation of an abutment disposed in the abutment-receiving portion of the implant. In a specific embodiment, the dental implant has an abutment-receiving portion that has a substantially pentagonal shape. In other embodiments, the dental implant may have an abutment receiving portion which has a substantially non-cylindrical shape selected from a square, an oval, a rectangle, a hexagon, and an hourglass shape.

In one embodiment, the dental implant has an abutment-receiving portion which comprises a cavity formed within the implant to receive an abutment, or other dental prosthetic structure, and the cavity further comprises a hole configured for receiving a fixation implant screw that will secure the implant into a jawbone. Such hole may comprise a circular opening in the apical end adapted for receiving a fixation screw that will pass through the circular opening in the abutment-receiving portion and extend below the apical end of the implant, and into a jawbone. Such hole in the apical end of the implant may have a countersunk central opening adapted to fit a countersink head on the fixation screw.

Another aspect provided by this disclosure is a dental implant abutment adapted to receive a dental prosthesis surmounted with a crown, or other dental fixture, comprising an implant insertion portion and prosthesis receiving portion opposite the implant insertion portion.

Such abutment may comprise a material including titanium, zirconium, or a combination thereof. In one embodiment, the abutment has an implant insertion portion that has a substantially pentagonal shape. In other embodiments, the abutment has an implant insertion portion that has a shape substantially consistent with a square, an oval, a rectangle, a pentagon, a hexagon, or an hourglass shape. In specific embodiments, the dental implant abutment has an implant insertion portion having a substantially cylindrical shape comprising a plurality of indentations configured to mate with projections on an abutment-receiving portion of a dental implant.

Another aspect provided by the present disclosure is a surgical drill guide adapted to guide the formation of drill holes in a jawbone comprising a guide comprising a plurality of holes of varying sizes and spatial arrangements that will guide a dental drill into the jawbone to form patterns of drill holes.

Another aspect provided by the present disclosure is a method for securing a dental prosthesis to a patient's jawbone, including drilling at least one pilot hole in the jawbone to form an extraction cavity, expanding the extraction cavity to accept a non-cylindrical implant, setting a non-cylindrical implant into the extraction cavity, affixing a dental prosthesis on the non-cylindrical implant. The drilling may be conducted using a surgical drill guide secured about an extraction site to guide the formation of pilot holes. The surgical drill guide may include a plurality of holes of various sizes and spatial arrangements configured to guide a dental drill into the jawbone to form patterns of drill holes. The expanding step may include using an osteotome to expand the extraction cavity to fit the chosen implant. The expanding step may also include reaming to shape and contour the extraction cavity to accept the selected implant. The affixing step may include anchoring the non-cylindrical implant to the jawbone with a fixation screw extending from an apical end of the non-cylindrical implant. The method may include closing the implant site after setting the non-cylindrical implant into the extraction cavity prior to affixing a dental prosthesis on the non-cylindrical implant. The method may include attaching a temporary cap to the non-cylindrical implant after setting the non-cylindrical implant into the extraction site. The method may include closing the implant site by placing a gingival flap across the non-cylindrical implant. The affixing step may be conducted about 3

months to about 12 months after setting a non-cylindrical implant into the extraction cavity. The affixing step may include securing a false tooth to the implant. The affixing step may include securing an abutment to the implant. The method may include forming an impression of the non-cylindrical implant in the extraction cavity including surrounding dentitia.

Another aspect of the present disclosure provides an impression coping comprising an implant mating portion and an impression material contact portion, and a top. The impression coping may include an impression material contact portion that is substantially cylindrical. The impression material contact portion may include at least one of surface projections, surface texturing, roughening, and other surface features, to enhance contact and retention in an impression material. The implant mating portion may be configured to be received by and mate with an interior portion of a dental implant with an indented feature configured to permit a mating fit with a cooperating protrusion. The implant mating portion may include a plurality of flanges situated around the impression material contact portion, opposite the top of the impression coping. The flanges may be spaced regularly around the generally cylindrical impression material contact portion.

Another aspect of the present disclosure provides an impression coping securing screw for securing an impression coping to an implant comprising at least one material selected from a heat labile plastic and silicone. In certain embodiments, the impression coping securing screw comprises threads made of metal or plastic and coated with a heat labile plastic or silicone. In use, the impression coping securing screw is threaded into the internal threading in a dental implant by exerting a rotational force on the impression coping securing screw. At the time of removal, the heat labile plastic, or silicone threads (or heat labile plastic, or silicone-coated threads) are activated to allow the impression coping, secured by the impression coping securing screw, to be disengaged from the implant and removed with the impression of the patient's dentitia.

Another aspect of the present disclosure provides a dental implant system comprising a dental implant and an impression coping member and an impression coping securing screw comprising a heat-labile plastic or silicone material configured to cooperatively engage the dental implant and the impression coping member, thereby ensuring proper alignment and orientation of a dental prosthesis assembled on the implant.

Another aspect of the present disclosure provides a method of making an impression and dental reconstruction, which method includes providing an impression coping including a screw access channel in the impression coping configured to receive an

impression coping securing screw, securing the impression coping on a dental implant set in a jawbone by passing an impression coping securing screw through the screw access channel and mating an end of the impression coping securing screw with the dental implant, activating a heat liable plastic or silicone on the impression coping securing screw to dissolve or soften the plastic or silicone sufficiently to allow removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw, and removing the impression coping securing screw from the implant. In this method, an impression material may be used to form an impression of the implant and surrounding dentitia before the step of removing the impression coping securing screw from the implant.

Another aspect of the present disclosure provides a method for obtaining an accurate translation of an orientation and position of an implant, including securing a dental implant in a jawbone, wherein the dental implant has a plurality of protrusions internal to an interior cavity of the implant, which protrusions are configured to matingly-engage flanges on an impression coping in a snap-fit engagement when the flanges extend beneath the protrusions, and seating an impression coping comprising flanges that engage two or more of the protrusions internal to the interior cavity of the implant by deflecting and springing back to an un-deflected state upon seating of the impression coping in the implant, and applying a dental impression material to at least an area adjacent the impression coping seated in the implant to cover the impression coping to obtain a negative impression of the area, and releasing the impression coping from the implant, and removing the impression material from the area adjacent the impression coping with the impression coping embedded in the impression material. In this method, engaging flanges of the impression coping with the protrusions on the implant may produce an audible sound, indicating that the impression coping has been properly seated in the implant. In a specific embodiment, a bore extends through the impression coping, the bore configured to allow the passage of an impression coping securing screw through the impression coping. In an embodiment, seating the impression coping in the implant may include passing an impression coping securing screw through the bore in the impression coping and engaging the screw in an internal cavity of the implant in a closely fitted engagement. In an embodiment, the impression coping securing screw may be a heat labile plastic, or silicone configured to cooperatively engage the implant. In an embodiment, releasing the impression coping from the implant may include activating the heat labile plastic or silicone portion of the impression coping securing screw to dissolve or soften sufficiently

the plastic or silicone material to allow removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw. These methods may also include sending the impression material and impression coping to a dental lab to form a dental cast model.

Another aspect of the present disclosure provides a multi-component dental implant system including at least one non-cylindrical dental implant, at least one implant abutment configured to detachably join at least one non-cylindrical dental implant. The multi-component dental implant system may also include a set of standard surgical tools prepared for the dental professional to choose from. The at least one non-cylindrical dental implant may include a set of standard shaped implants of varying size. The at least one implant abutment may include a set of standard shaped abutments of varying size. The non-cylindrical implant may be configured to replace a tooth selected from a bicuspid, a molar, a canine, and an incisor. The multi-component dental implant system may also include at least one dental surgical instrument selected from a drill guide, a reamer, a drill bit, a surgical fixation screw, and a bone screw insertion tool. The multi-component dental implant system may also include a healing abutment. Such healing abutment need not be removed during an impression taking procedure. The multi-component dental implant system may also include an implant coding system that facilitates selection or identification of a non-cylindrical dental implant by the dental professional.

The present disclosure provides a dental implant adapted to be embedded within a patient's jawbone, wherein the dental implant has an apical end adapted to engage the jaw bone, and a top end, opposite the apical end. The top end has an abutment or prosthesis receiving portion comprising a cavity formed within the implant to receive an abutment, or other dental prosthetic structure. The abutment or prosthesis receiving portion has a substantially pentagonal shape, and at least the apical end of the dental implant has a non-cylindrical shape. In one embodiment, the abutment-receiving portion of the dental implant further comprises a circular opening in the apical end adapted for receiving a fixation screw that will pass through the circular opening in the abutment-receiving portion and extend below the apical end of the implant, and into a jawbone.

This Summary of the Disclosure is neither intended nor should it be construed as being representative of the full extent and scope of the present disclosure. Moreover, references made herein to "the present disclosure," or aspects thereof, should be understood to mean certain embodiments of the present disclosure and should not necessarily be construed as limiting all embodiments to a particular description. The

present disclosure is set forth in various levels of detail in this Summary of the Disclosure as well as in the attached drawings and the Description of Embodiments, and no limitation as to the scope of the present disclosure is intended by either the inclusion or non-inclusion of elements, components, etc. in this Summary of the Disclosure. Additional aspects of the present disclosure will become more readily apparent from the Description of Embodiments, particularly when taken together with the drawings.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 depicts parts of a standard dental implant of the prior art, including an implant, an abutment, and a crown, both separate and assembled.

Figure 2 depicts the assembled dental implant of figure 1 implanted in the jaw of a patient, between two natural teeth.

Figure 3 is a mesial-distal view of an implant of the present disclosure.

Figure 4 is a top view of the implant of Figure 3.

Figure 5 is an apical view of one implant of the present disclosure, having a substantially hourglass shape.

Figure 6 is a top view of an implant of the present disclosure.

Figure 7 is a mesial-distal view of an implant of the present disclosure.

Figure 8 is a top view of the implant of Figure 7.

Figure 9 is a side view of an abutment of the present disclosure positioned above an implant of the present disclosure.

Figure 10 depicts a surgical guide disposed on a patient's gum line between two natural teeth.

Figure 11 is a side view of an impression coping according to one embodiment of the present disclosure.

Figure 12 is a partial cross-sectional view of an impression coping engaged with an implant according to an embodiment of the present disclosure.

Figure 13 is a side view of an impression coping securing screw, according to an embodiment of the present disclosure.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

Non-Cylindrical Dental Implant

This disclosure provides dental implants for fixed and removable prosthetic devices and certain fixed and removable prosthetic devices, including implants suitable for single tooth replacement (e.g., caps and crowns), multiple tooth replacements using one or more implants (e.g., bridges), and multiple implants for full and partial prosthetic devices.

Embodiments of dental implants of the present disclosure may be installed in single or multiple root tooth locations.

Implants according to the present disclosure are non-cylindrical, which better facilitates the restoration by providing a more anatomically correct emergence profile, thereby improving form, function and aesthetics of the restoration. This also facilitates immediate restoration when an abutment is mated with an implant of the present disclosure, because the abutment can be tightened to the implant without any danger that the implant will rotate within the implantation site in the patient's jawbone. These non-cylindrical implants of the present disclosure will have an increased size and increased surface area compared to conventional dental implants. This increased size and surface area will improve case selection and lower the need for sinus lifts and the number of areas in which nerve proximity would be a consideration in the placement of a dental implant.

Implants according to the present disclosure can be constructed from any non-corrosive material compatible with the abutment and prosthesis and the surrounding tissues within the patient's mouth without producing immunologic reactions effecting rejection by the body. Suitable materials include titanium or titanium alloys, gold alloys, zirconium, ceramic and the like, which are machined and milled to the requisite shape.

Implants of the present disclosure may have a smooth or rough surface texture. Mechanical surface treatments may be used to significantly alter the topography, while the surface chemistry remains substantially unchanged. Thus, the implants of the present disclosure may be treated to create a suitable roughness of the implant surface giving a mechanical interlocking between bone and implant. Alternatively, or additionally, coating the surface of the implant with certain materials may improve the healing process around the bone-implant (referred to as "osseointegration"). Thus, the implants of the present disclosure may be treated to include a surface coating with materials such as, but not limited to, an artificial hydroxyapatite, bisphosphonate(s), platelet rich plasma ("PRP") and/or a PRP-bone matrix mix (PRP may be formed by taking a blood sample from the patient, and then centrifuging the blood to create the PRP), or the like. The surface treatment and/or the coating(s) of the implants of the present disclosure may be uniform throughout the external surfaces of the implants, or may be applied to only a portion of the external surfaces of the implants. In specific embodiments of this disclosure, the surface treatment and/or coatings are applied to any portion of the external surface of the implant that will reside below the gum line in the surrounding tissues within the patient's mouth. In specific embodiments of this disclosure, the surface treatment and/or coatings are absent in

a portion of the external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth. In specific embodiments of this disclosure, the external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth is smooth and free of surface coatings to form a smooth, hygienic transition area or connection with a dental prosthetic formed on the implant, in an embrasure space in the patient's mouth.

As shown in Figures 3 and 4, a dental implant 100 of the present disclosure comprises an apical end 110 adapted to engage a patient's jaw bone, a top end 120 opposite the apical end 110, the top end 120 having an abutment or prosthesis receiving portion 130, accessible from the top end 120 of the dental implant 100. The abutment-receiving portion 130 can be adapted to receive a prosthesis, such as a crown or a bridge or other dental fixture, with or without the use of an abutment. Also, an abutment or other device for receiving a crown or other dental fixture may be formed integrally with the implant 100, in which case no abutment receiving-portion 130 is present. The apical end 110 of the implant 100 has a non-cylindrical shape such that, following implantation in the jaw of a patient, the implant will not rotate within the implantation site. In specific embodiments, the apical end of the implant may have a shape substantially consistent with a square, an oval, a rectangle, a pentagon, a hexagon, or the like. In a specific embodiment, the implant as a pentagonal shape.

In a specific embodiment shown in the apical view of the implant depicted in Figure 5, the implant 500 has an hourglass shape in the mesial-distal plane, having two wider portions 510, or lobes, and a narrower center portion 520.

In specific embodiments of the implants of the present disclosure, as depicted in Figure 4, the abutment-receiving portion of the implant may comprise a cavity 130 formed within the implant 100 to receive an abutment, or other dental prosthetic structure. The abutment-receiving portion 130 of the implant 100 comprises a plurality of projections 140 formed on the interior wall 150 of the cavity comprising the abutment-receiving portion 130 of the implant 100. The projections 140 extend from the interior wall 150 into the cavity comprising the abutment-receiving portion 130 of the implant 100. In specific embodiments, the projections 140 are of a size and/or shape to engage with an abutment in a manner that will prevent rotation of the abutment disposed in the abutment-receiving portion 130 of the implant 100. In specific embodiments, the projections 140 are located about the cavity comprising the abutment receiving portion 130 of the implant 100 in a non-symmetrical pattern that will prevent rotation of an abutment disposed in the

abutment-receiving portion 130 of the implant 100. In specific embodiments, the projections 140 comprise both a shape, and a location about the cavity comprising the abutment receiving portion 130 of the implant 100 to prevent the rotation of an abutment disposed in the abutment-receiving portion 130 of the implant 100.

A preferred embodiment is the implant of the present disclosure depicted in Figure 6. Figure 6 depicts the top end of an implant, comprising an abutment-receiving portion 630, having a substantially pentagonal shape, which will mate with a corresponding pentagonal abutment, thereby preventing rotation of the abutment disposed in the pentagonally-shaped abutment receiving portion 630 of the implant 600, without the need for specific projections residing on the interior wall 650 of the cavity comprising the abutment receiving portion 630. In related embodiments, the abutment receiving portion of the implant may have a substantially non-cylindrical shape, such as a square, an oval, a rectangle, a hexagon, an hourglass shape, or the like.

In specific embodiments of the implants of the present disclosure, the abutment-receiving portion of the implant comprises a cavity formed within the implant to receive an abutment, or other dental prosthetic structure, and the cavity further comprises a hole configured for receiving a fixation implant screw that will secure the non-cylindrical implant of the present disclosure into a jawbone of the patient. In one preferred embodiment depicted in Figure 7, the implant 700 of the present disclosure comprises an apical end 710 adapted to engage the jaw bone of a patient, a top end 720 opposite the apical end 710, the top end 720 having an abutment-receiving portion accessible from the top end 720 of the dental implant 700. The implant 700 has a circular opening in the apical end 710 adapted for receiving a fixation screw 725 that will pass through the abutment-receiving portion 720 and extend below the apical end of the implant 700, along dashed line A, and into the jawbone of the patient to further secure the implant 700 within the jawbone of a patient, while retaining the non-cylindrical, non-rotatable characteristics of the implant 700. Thus, the implant 700 retains the non-cylindrical shape of the implants of the present disclosure such that, following implantation in the jawbone of a patient, including the placement of the fixation screw 725, the implant will not rotate within the implantation site. In one embodiment, the circular hole in the apical end 710 of the implant 700 is a countersunk central opening adapted to fit a countersink head on the fixation screw 725.

Figure 8 depicts the view of the top end 720 of the implant 700 of Figure 7. The circular fixation hole 730 can be seen at the bottom of the cavity comprising the abutment-

receiving portion 730 in the top end 720 of the implant 700. In this embodiment depicted in Figure 8, the abutment-receiving portion 730 in the top end 720 of the implant 700 has a substantially circular shape. In one preferred embodiment, the abutment-receiving portion in the top end of the implant 700 has a substantially pentagonal shape.

Anatomical Abutment

The present disclosure also provides implant abutments intended to take a dental prosthesis surmounted with a crown, or other dental fixture, cemented, glued, screwed, or otherwise affixed to the abutment, adapted for use with a dental implant of the present disclosure. The abutments of the present disclosure may be made of titanium, zirconium, or the like.

As shown in Figure 9, an abutment 900 of the present disclosure, which secures a prosthesis to an implant 901 of the present disclosure, includes an implant insertion portion 920 and a prosthesis receiving portion 930. The implant insertion portion 920 of abutment 900 is configured to mate with an abutment-receiving portion of implant 901 of the present disclosure. In one embodiment, the implant insertion portion 920 has a pentagonal shape that will mate with a corresponding pentagonal-shaped abutment-receiving portion of implant 901, when the abutment-receiving portion of the implant 901 is mated with implant insertion portion 920 of abutment 900 along line B.

In specific embodiments, the implant insertion portion may have a shape substantially consistent with a square, an oval, a rectangle, a pentagon, a hexagon, or the like. In a specific embodiment, the implant insertion portion as an hourglass shape. In these embodiments, the abutment-receiving portion of the implant 901 is shaped to receive and mate with an abutment 900 having an implant insertion portion 920 having any one of the shapes described above.

In a specific embodiment of the implant of the present disclosure depicted in Figure 4, the abutment-receiving portion 130 of the implant 100 comprises a plurality of projections 140 formed on the interior wall 150 of the cavity comprising the abutment-receiving portion 130 of the implant 100. The projections 140 extend from the interior wall 150 into the cavity comprising the abutment-receiving portion 130 of the implant 100. Similarly, in a specific embodiment of the abutment of the present disclosure, the implant insertion portion has a substantially cylindrical shape comprising a plurality of indentations having a size, shape and location configured to mate with the projections 140

formed on the interior wall 150 of the cavity comprising the abutment-receiving portion 130 of the implant 100.

In these embodiments of the abutment of the present disclosure, engaging the abutment receiving portion of the implant with the correspondingly shaped implant insertion portion of the abutment prevents rotation of the abutment disposed in the implant. This also increases the ease of placing the abutment into the implant during the restoration procedure and simplifies the implantation of the dental system for the dental surgeon. Additionally, this configuration, which prevents rotation of the abutment on top of the implant, facilitates immediate restoration of a missing tooth when the abutment is mated with the implant, because the non-cylindrical implant will not rotate in the socket, such that full osseointegration is not necessary and the time to osseointegration is greatly reduced.

In these embodiments of the implants and the abutments of the present disclosure, after the abutment is mated with the implant, the abutment may be secured to the implant by any of the methods well known to those of skill in the art including, for example, cementation, or one or more screws disposed within the interior portion of the abutment and received and secured within the interior portion of the implant. Locking engagement between the complementary shaped surfaces of the implant and the abutment can be achieved through a tapping or threading operation. Some patients find the use of tapping action to seat the abutment onto the implant uncomfortable, and as an alternative, a dental implant system of the present disclosure which utilizes a threaded fastener to seat the abutment onto the implant may be used.

The interlocking non-cylindrical implant and abutment of the present disclosure are designed to overcome an aesthetic limitation of the prior art wherein, in many cases, it is possible to see some of the implant between the crown and the gum line. In the use of such prior art devices, patients and dentists often complain about food impacting and accumulating around and beneath the prosthesis portion of the implant in the enlarged periodontal gap between the implant and the adjacent teeth.

Using the non-cylindrical implants of the present disclosure (which are generally wider and provide better anatomical fit than implants and abutments of the prior art) allows for a more anatomical emergence profile than is often available with prior art reconstruction systems. The broader top of the dental implants of the present disclosure allows for a more anatomical emergence profile than is often available with prior art reconstructions systems, and this enhances the aesthetic appearance of the reconstruction,

and avoids many hygienic problems, as well as the accumulation of food in the periodontal gap, as described above. The wider implant and matching abutment of the present disclosure better distributes load on the jawbone, thereby allowing the prosthesis to have more upright peripheral sidewalls, so that embrasures, or periodontal gaps, between the bottom portion of the crown and adjacent teeth are substantially reduced, and so that both food impaction and collection are also substantially reduced. The matching abutment of the present disclosure also provides a smooth transition between the prosthesis and the implant fixture, which results in good soft tissue adaptation.

Dental Implant Procedure

This disclosure also provides a dental implant process that reduces surgical time and the cost of an implant operation, resulting in the formation of a restoration with a wider, anatomical implant shape having a more ideal emergence profile, providing better support for crowns, especially ceramic crowns, and improved hygienic embrasure spaces. The dental implant processes of the present disclosure reduce the time period that is customarily required between tooth extraction and the placement of a false tooth or prosthesis on the implants of the present disclosure. Additionally, these dental implant processes of the present disclosure may allow the implant to be inserted or set within the tooth cavity immediately after extraction.

The dental implant procedures of the present disclosure generally include the following steps. Initially, the restoration site is identified and cleaned and sufficient gum is removed from the jawbone to allow an implant of the present disclosure to seat directly on the exposed jawbone. In one embodiment, placing the implant in the jawbone includes first drilling one or more pilot holes in the jawbone, removing additional gum from the jawbone, as needed. A surgical drill guide can be secured about the extraction site to guide the formation of drill holes. Figure 10 depicts a surgical drill guide 1000 of the present disclosure located at the apical surface of a patient's gum 1020 at an extraction site, between two natural teeth 1010. The surgical drill guide 1000 includes a plurality of holes 1050 of various sizes and spatial arrangements that will guide a dental drill into the jawbone to form patterns of drill holes, which may be positioned and enlarged to accept an implant of the present disclosure. Once the pilot holes have been created using the surgical drill guide, the dental surgeon prepares an eccentric site for accepting the implant using an osteotome to expand the extraction cavity to fit the chosen implant. The implant cavity is reamed to shape and contour the extraction cavity to accept the selected implant.

After reaming and forming a clean and open implant cavity, a non-cylindrical implant of the present disclosure is firmly set into the reamed extraction cavity. Optionally, the non-cylindrical implant of the present disclosure may be anchored within the alveolar bone using a fixation screw extending from the apical end of the non-cylindrical implant, as described above.

After the implant has been set, the implant site may be closed in order to heal the site for a period of time. A temporary cap can be used, but in most cases it is preferred that the gingival flap be returned across the top of the implant so as to close the implant site. Thereafter, a process of osseointegration occurs, wherein the bone structure remodels and heals in intimate contact with the implant. The time for healing can vary from approximately 3 to 12 months depending on the age of the patient and other factors. After integration has been achieved, the dental professional can then secure a false tooth or other dental prosthesis to the top of the implant.

After osseointegration occurs, the gum around the implant disposed in the jawbone is positioned and maintained. A dental prosthesis is modeled in a form sized to fit on the implant or an abutment attached to the implant. The prosthesis is sized and formed to appropriately fill the open space between the adjacent teeth. Finally, the molded prosthesis is affixed to the implant of the present disclosure, which is anchored in the jawbone of the patient.

In some instances, an impression can be taken and the prosthetic device made prior to installation of the dental implant. In such cases, a non-cylindrical implant of the present disclosure and the appropriate prosthetic device can be installed in the same visit. In cases where the prosthetic device is to be installed in a visit subsequent to installation of the implant, a temporary prosthetic device (e.g., a conventional temporary cap) may be installed using a cement to temporarily secure the temporary cap to the dental implant. It is postulated that in the instance where implanting takes place immediately after extraction, there is quicker healing and osseointegration because the alveolar bone has not been subjected to the trauma of drilling that takes place in cases where the implanted site has healed and closed.

Although the steps described above are presented in a specific order, the technology presented herein can be performed in any variation of this order. Furthermore, additional steps may be executed between the steps described above.

Impression Coping and Related Materials and Kits and Methods of Using the Same

In dental implant procedures, an impression coping (also referred to as a transfer coping) is attached to the implant, or an abutment attached to the implant, to transfer the position of the implant in the patient to a working model, which is used in a dental laboratory where the permanent dental prosthesis is prepared.

During the surgical procedure, the impression coping is attached to the implant or abutment while the impression is made. This attachment is typically made with a separate securing screw, which attaches to internal threading on the implant to hold the impression coping in place on the implant. An impression of the patient's dental structure surrounding the site of the implant is then made using an impression material, such as a polymeric material. The impression material is then removed and sent to a dental laboratory, where the permanent dental prosthesis is fabricated. In this way, the ultimate position of the implant in the patient's mouth is identified and set by the position of the impression coping within the impression material.

Conventional open and closed tray techniques both use screws to secure the impression coping to the implant. In the closed tray technique of making dental impressions, the impression coping is engaged with the implant or abutment using the securing screw and an impression material is injected around the coping. The impression is then removed, leaving the impression coping in place. This limits the accuracy of the model of the patient's dentitia based on the impression as the impression coping must be reassembled, and the impression sent to the dental laboratory, such that the impression coping may not be properly re-oriented into the impression after removal from the patient's mouth.

Conversely, in open tray techniques, the securing screw is loosened and the impression coping is picked up with the impression material as the material is removed. This technique may also lead to inaccuracies in the model of the patient's dentitia because the angle and height of the impression coping may be altered when the screw is loosened/removed prior to removal of the impression material from the patient's mouth.

Accuracy in the location of the impression coping (particularly height and angle) within the impression is important to ensure that the prepared prosthesis fits properly in the implant and relative to the patient's existing teeth and gumline. Failure to accurately position the prosthesis could result in patient discomfort and/or failure of the restoration or implant. Thus, there is a need for an impression coping that may accurately and reliably identify the position of dental implants in patients. Moreover, there is a need for an impression coping that facilitates the impression process, requiring less manipulation by a

dentist or dental technician, and that reduces the chances of having to retro-fit the impression coping back into the impression material after removal from the implant.

The present disclosure provides an impression coping that can be used to identify the position of an implant in a patient. The impression coping according to various embodiments of the present disclosure may attach to an implant or abutment, such as a dental implant, without the use of a screw. In other embodiments, the impression coping according to various embodiments of the present disclosure may be secured to an implant or abutment using a screw. In at least one embodiment, the impression coping may be an implant level impression coping, which may allow the impression coping to be used without an abutment.

Impression copings in accordance with various embodiments of the present disclosure also may comprise an impression material contact portion. Once the impression coping is attached to the dental implant, an impression can be taken, for example with a closed dental tray, well known to those of skill in the art. The impression material surrounds the impression material contact portion of the impression coping and securely attaches the impression to the impression coping once the impression material has cured.

The impression coping according to embodiments of the present disclosure may comprise a material chosen from metal, ceramic, plastic (which may be disposable), and/or combinations thereof. In at least one exemplary embodiment, the impression coping comprises a material chosen from stainless steel, titanium, and titanium alloys. In at least one embodiment of the present disclosure, the impression coping comprises a material that is radiopaque. A radiopaque impression coping may be observable using an X-ray, which may aid in locating the implant in the patient's mouth and the position of the impression coping in the impression, and/or aid in the confirmation of the engagement between the dental implant and the impression coping.

After the impression material has cured, the impression material, with the impression coping attached or embedded therein, is removed. The impression material and the impression coping may be removed by pulling the impression coping off the dental implant, by moving the impression coping in a direction generally along the longitudinal axis of the dental implant and away from the dental implant. The impression may then be sent to a dental laboratory where the permanent tooth is fabricated.

An impression coping according to one embodiment of the present disclosure is illustrated in Figure 11. In Figure 11 the impression coping 1100 comprises an implant mating portion 1110 and an impression material contact portion 1150, and a top 1160. The

impression material contact portion 1150 is generally cylindrical. In some embodiments, impression material contact portion 1150 further comprises projections or surface texturing, roughening and/or other surface features, and/or other configurations to enhance contact and retention in an impression material. Those having ordinary skill in the art will readily understand that the configuration of such projections or surface treatments may be utilized without departing from the scope of the present disclosure.

As shown in Figure 11, the impression coping 1100 is configured with an implant mating portion 1110 configured to be received by, and mate with, an implant. In accordance with various embodiments, the implant mating portion 1110 may be configured to engage with the interior portion of a variety of implants, including, for example, the various implants of the present disclosure described above, including any dental implant with an indented feature, such as a groove or ledge, configured to permit a mating fit (e.g., snap-fit) with a cooperating protrusion, such as the implant mating portion 1110 of the impression coping of Figure 11.

As depicted in Figure 11, the implant mating portion 1110 comprises a plurality of flanges 1110 situated around the base of impression material contact portion 1150, opposite the top 1160. Flanges 1110 may be spaced regularly around the generally cylindrical impression material contact portion 1150. Flanges 1110 are configured to engage with implants having openings that hook or retain the flanges to provide an anti-rotational engagement of the impression coping with the implant. For example, Figure 12 shows a partial cross-section of the impression coping 1100 of Figure 11 engaged with a dental implant 1220 set in the jawbone 1230 of a patient. As noted above, impression coping 1100 comprises a plurality of flanges 1110 situated around the base of impression material contact portion 1150. Implant 1220 includes a plurality of protrusions 1216. As shown in Figure 12, the protrusions 1216 matingly-engage flanges 1110 on the impression coping 1100. In at least one embodiment, a snap-fit engagement may be possible by positioning and sizing the protrusions 1216 in a way that they contact flanges 1110 on the impression coping 1100 and elastically deflect the flanges 1110. Once the flanges 1110 extend beneath protrusions 1216 as the impression coping 1100 is seated in the implant 1220, the fianges 1116 spring back to their undeflected state. An audible sound may be produced when the flanges 1116 spring back to their undeflected state, which may provide an indication that the impression coping 1100 has been properly seated in the implant 1220. The impression coping 1100 is held properly seated in the implant 1220.

Conventional dental implants generally comprise a threaded exterior portion that attaches to the jawbone of a patient and interior threads designed to receive restorations or other fixtures, such as an impression coping. Those of skill in the art would be familiar with the various conventional dental implant configurations and features useful with the transfer copings of the present teachings. Similar to a conventional implant with internal threading, in at least one embodiment of the present disclosure, the implant 1220 may contain internal threading that allows a securing screw to pass through impression coping top 1160 and engage threads near the base 1240 of implant 1220. Thus, a related embodiment of the disclosure is an impression coping securing screw for securing an impression coping to an implant. The impression coping securing screw may be made of metal or other suitable hard material, while the threads of the impression coping securing screw are made of a heat labile plastic, or silicone.

One such impression coping securing screw 1300 of this disclosure is depicted in Figure 13. Threads 1310 may be composed of a heat labile plastic, or silicone. In related embodiments, threads 1310 may be made of metal or other suitable hard material, and coated with a heat labile plastic, or silicone. In use, the impression coping securing screw 1300 is threaded into the internal threading in a dental implant by exerting a rotational force on the impression coping securing screw. At the time of removal, the heat labile plastic, or silicone (or heat labile plastic, or silicone-coated threads) are activated to allow the impression coping secured by the impression coping securing screw 1300 to be disengaged from the implant and removed with the impression of the patient's dentitia.

Another embodiment of the present disclosure is a dental implant system comprising an implant member, and an impression coping member and an impression coping securing screw comprising a heat labile plastic, or silicone (or heat labile plastic, or silicone-coated threads) configured to cooperatively engage the implant and the impression coping structures for ensuring proper alignment and orientation of an abutment or other dental prosthesis assembled on the implant and for preparing an accurate dental impression and mold which represents the implantation site and its relationship to adjacent teeth structures.

Another embodiment of the present disclosure is a method of impression making and dental reconstruction utilizing the components of the dental implant system of the present disclosure. In at least one such embodiment, an impression coping includes a screw access channel in the impression coping to allow a dental professional to use an impression coping securing screw to secure the impression coping onto a dental implant,

followed by removal of the impression coping securing screw at the time of removing the impression. In a specific embodiment, the impression coping securing screw is removed immediately after the threaded portion of the impression coping securing screw comprising a heat liable plastic or silicone is activated to dissolve or soften sufficiently to allow the removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw.

Another embodiment of the present disclosure provides a method for obtaining an accurate translation of an orientation and position of an implant. With reference to Figure 12, one embodiment of this method comprises providing a dental implant of this disclosure, having a plurality of protrusions 1216 internal to an interior cavity of the implant, which protrusions 1216 matingly engage flanges 1110 on an impression coping 1100 in a snap-fit engagement when the flanges 1110 extend beneath protrusions 1216 as the impression coping 1100 is seated in the implant 1220, the flanges 1116 spring back to their undeflected state, which may produce an audible sound indicating that the impression coping 1100 has been properly seated in the implant 1220. In a preferred embodiment, a bore extends through the impression coping 1100, allowing the passage of an impression coping securing screw through the impression coping 1100, seating the impression coping onto the implant, and engaging corresponding threading in the internal cavity of the implant in a closely fitted engagement. The impression coping securing screw comprises heat labile plastic, or silicone (or heat labile plastic, or silicone-coated threads) configured to cooperatively engage the implant. A dental impression material is then applied to at least an area adjacent the impression coping so as to cover the impression coping to obtain a negative impression of the area. After the impression material has set, the heat labile plastic or silicone portion of the impression coping securing screw is then activated to dissolve or soften sufficiently to allow the removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw, and then the impression material is removed from the patient's mouth with the impression coping embedded in the impression material. The impression material, including the impression coping, may be sent to a dental lab, where a molding material is poured into the negative impression formed in the impression material to form a dental cast model, and a dental prosthetic is fabricated on an implant analog to match the surrounding dentitia of the patient. This method accurately positions the dental implant installed in the patient's mouth, based on the model created in the method described above, however, it will be apparent to one of ordinary skill in the art that other embodiments, or variations on this

methodology are also possible in which various steps are added, combined, modified, substituted, automated or omitted.

To simplify impressions for both dentist and patient, a special impression coping screw would be utilized. This impression method is used instead of currently-available impression coping methods wherein the impression coping is screwed in and must either be unscrewed prior to removing the impression (open-tray method, which is considered more accurate), or after removing the impression, the impression coping is re-inserted into the impression (closed-tray method).

This new impression coping method of this disclosure is easier for the dentist and more comfortable for the patient. The impression coping is shorter in height which creates a more stable platform when taking impressions. It is further stabilized by screwing it into the internal part of the implant. By using a screw that is metal with flexible or heat labile plastic threads that are large enough to be screwed into the implant, but are able to be pulled out without much force, the impression coping is then used in a closed tray method, which is easier for the dentist and more comfortable for the patient. But the dentist would have the benefit of accuracy of the traditional open-tray method in which the implant coping is unscrewed prior to impression removal. The threading and/or sleeve coating of the impression coping securing screw is preferably a plastic or silicone material with enough flexibility to be pulled out of the implant with low resistance such that it is not difficult for the dental professional and does not cause pain or stress to the patient. The head and body of the screw may be made of titanium or a rigid but less expensive material. In one embodiment, the impression coping securing screw having a heat labile or pliable material is configured as a single-use product, which is more hygienic and safer for the patient. In this embodiment, the metal or hard plastic portions of the impression coping securing screw could be re-sterilized and reused after association with the heat labile or pliable material.

Dental Implant System Kit

Another aspect of the present disclosure provides a multi-component dental implant system comprising at least one non-cylindrical dental implant and an implant abutment of the present disclosure, with at least one implant and the abutment being configured to detachably join to one another with an improved assembly designed to prevent rotation of the abutment about the implant.

In one embodiment, the multi-component dental implant systems of the present disclosure may include an implant comprising an abutment-receiving portion having a

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substantially pentagonal shape, which will mate with a corresponding pentagonal abutment, thereby preventing rotation of the abutment disposed in the pentagonally-shaped abutment receiving portion of the implant. In related embodiments, the abutment receiving portion of the implant(s) in the multi-component dental implant systems of the present disclosure may have a substantially non-cylindrical shape, such as a square, an oval, a rectangle, a hexagon, an hourglass shape, or the like.

The multi-component dental implant system of the present disclosure may further include a set of standard shaped devices and standard surgical tools prepared for the dental professional to choose from. For example, the dental implant system may have variously shaped non-cylindrical implants configured to replace bicuspids, molars, canines, and incisors, and different sizes for each shape. From this dental implant system, the dental professional chooses the parts that are appropriate for the particular restoration.

As an alternative, the dental professional may have the prostheses portions custom made, after analyzing the patient. In this alternative embodiment, the professional may have the prostheses prepared with the aid of a CAD milling machine or powder metallurgy, among other known methods of forming parts. As examples of how to select the proper parts, the parts may be matched to the shape of an extracted tooth, if one is available, or to an impression of the teeth and gums surrounding the site of the implant. In one embodiment of the multi-component dental implant system of the present disclosure, it is contemplated that a series of differently sized, standard implants would be available. Such a kit of standard, non-cylindrical implants may vary in length and shape. Once the appropriate implant has been selected from the group of standard implants, the dental professional selects corresponding or matching surgical tools, including, for example, a surgical drill guide, a reamer from a reamer set, conventional drill bits from a set of drill bits used in dentistry for the installation of dental implants, a surgical fixation screw(s), bone screw insertion tool(s), a healing abutment that need not be removed during an impression taking procedure, and an implant coding system that facilitates selection and identification of a non-cylindrical dental implant of the present disclosure. Thus, the multi-component dental implant system of the present disclosure may include any one or all of these additional restoration components and/or surgical tools or subsets or combinations thereof, that useful in practicing the methods of the present disclosure.

The foregoing description of the present disclosure has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the disclosure to the form disclosed herein. Consequently, variations and modifications

commensurate with the above teachings, and the skill or knowledge of the relevant art, are within the scope of the present disclosure. The embodiments described hereinabove are further intended to explain the best mode known for practicing the disclosure and to enable others skilled in the art to utilize the disclosure in such, or other, embodiments and with various modifications required by the particular applications or uses of the present disclosure. It is intended that the appended claims be construed to include alternative embodiments to the extent permitted by the prior art.

What is claimed is:

1. A dental implant adapted to be embedded within a patient's jawbone comprising:

an apical end adapted to engage the jaw bone,

a top end, opposite the apical end, the top end having an abutment or prosthesis receiving portion;

wherein at least the apical end of the dental implant has a non-cylindrical shape.

2. The dental implant of claim 1, wherein at least the apical end of the dental implant has a shape substantially consistent with a shape selected from a square, an oval, a rectangle, a pentagon, and a hexagon.

3. The dental implant of claim 1, wherein at least the apical end of the dental implant has a shape substantially consistent with a rectangle.

4. The dental implant of claim 1, wherein at least the apical end of the dental implant has a shape substantially consistent with an hourglass in the mesial-distal plane, having two wider lobes, and a narrower, center portion between the two lobes.

5. The dental implant of any one of claims 1 to 4, wherein the dental implant comprises at least one material selected from the group consisting of titanium or titanium alloys, gold alloys, zirconium, and a ceramic.

6. The dental implant of any one of claims 1 to 4, wherein the dental implant has a smooth surface texture.

7. The dental implant of any one of claims 1 to 4, wherein the dental implant has a rough surface texture.

8. The dental implant of any one of claims 1 to 4, wherein the dental implant has at least one surface portion having a rough surface texture, and at least one surface portion having a smooth surface texture.

9. The dental implant of any one of claims 1 to 8, wherein the dental implant comprises a surface coating with materials selected from the group consisting of an artificial hydroxyapatite, a bisphosphonate, a platelet rich plasma (PRP), a PRP-bone matrix mix, and combinations thereof.

10. The dental implant of claim 9, wherein the surface coating is uniformly applied throughout the external surface of the implant.

11. The dental implant of claim 9, wherein the surface coating is applied to only a portion of an external surface of the implant.

12. The dental implant of claim 9, wherein the surface coating is applied to a portion of an external surface of the implant that resides below the gum line in the surrounding tissues within the patient's mouth following implantation of the implant.

13. The dental implant of claim 9, wherein the surface coating is absent in a portion of the external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth following implantation of the implant.

14. The dental implant of claim 9, wherein an external surface of the implant that will reside above the gum line in the surrounding tissues within the patient's mouth is smooth and free of surface coatings.

15. The dental implant of any one of claims 1-8, wherein the top end is adapted to receive a prosthesis without the use of an abutment.

16. The dental implant of any one of claims 1-8, wherein the top end comprises a dental fixture integrally formed with the implant.

17. The dental implant of any one of claims 1-8, wherein the top end is adapted to receive an abutment.

18. The dental implant of Claim 17, wherein the abutment-receiving portion of the implant comprises a cavity formed within the implant to receive an abutment, or other dental prosthetic structure.

19. The dental implant of Claim 18, wherein the abutment-receiving portion of the implant comprises a plurality of projections formed on an interior wall of the cavity comprising the abutment-receiving portion of the implant.

20. The dental implant of Claim 19, wherein the projections extend from the interior wall into the cavity comprising the abutment-receiving portion of the implant.

21. The dental implant of Claim 20, wherein the projections are of a size and/or shape to engage with an abutment in a manner that will prevent rotation of an abutment disposed in the abutment-receiving portion of the implant.

22. The dental implant of Claim 21, wherein the projections are located in the cavity comprising the abutment receiving portion of the implant in a non-symmetrical pattern that will prevent rotation of an abutment disposed in the abutment-receiving portion of the implant.

23. The dental implant of Claim 21, wherein the projections have a shape to prevent the rotation of an abutment disposed in the abutment-receiving portion of the implant.

24. The dental implant of claim 17, wherein the abutment-receiving portion has a substantially pentagonal shape.

25. The dental implant of claim 17, wherein the abutment receiving portion of the implant has a substantially non-cylindrical shape selected from the group consisting of a square, an oval, a rectangle, a hexagon, and an hourglass shape.

26. The dental implant of claim 17, wherein the abutment-receiving portion of the implant comprises a cavity formed within the implant to receive an abutment, or other dental prosthetic structure, the cavity further comprising a hole configured for receiving a fixation implant screw that will secure the implant into a jawbone.

27. The dental implant of Claim 26, comprising a circular opening in the apical end adapted for receiving a fixation screw that will pass through the circular opening in the abutment-receiving portion and extend below the apical end of the implant, and into a jawbone.

28. The dental implant of Claim 26, wherein the circular hole in the apical end of the implant has a countersunk central opening adapted to fit a countersink head on the fixation screw.

29. A dental implant abutment adapted to receive a dental prosthesis surmounted with a crown, or other dental fixture, comprising an implant insertion portion and prosthesis receiving portion opposite the implant insertion portion.

30. The dental implant abutment of Claim 29, comprising a material including titanium, zirconium, or a combination thereof.

31. The dental implant abutment of Claim 29, wherein the implant insertion portion has a substantially pentagonal shape.

32. The dental implant abutment of Claim 29, wherein the implant insertion portion has a shape substantially consistent with a square, an oval, a rectangle, a pentagon, a hexagon, or an hourglass shape.

33. The dental implant abutment of Claim 29, wherein the implant insertion portion has a substantially cylindrical shape comprising a plurality of indentations configured to mate with projections on an abutment-receiving portion of a dental implant.

34. A surgical drill guide adapted to guide the formation of drill holes in a jawbone comprising a metal guide comprising a plurality of holes of varying sizes and spatial arrangements that will guide a dental drill into the jawbone to form patterns of drill holes.

35. A method for securing a dental prosthesis to a patient's jawbone, comprising:

drilling at least one pilot hole in the jawbone to form an extraction cavity,

expanding the extraction cavity to accept a non-cylindrical implant,

setting a non-cylindrical implant into the extraction cavity,

affixing a dental prosthesis on the non-cylindrical implant.

36. The method of claim 35, wherein the drilling is conducted using a surgical drill guide secured about an extraction site to guide the formation of pilot holes.

37. The method of claim 36, wherein the surgical drill guide includes a plurality of holes of various sizes and spatial arrangements configured to guide a dental drill into the jawbone to form patterns of drill holes.

38. The method of claim 35, wherein the expanding step comprises using an osteotome to expand the extraction cavity to fit the chosen implant.

39. The method of claim 35, wherein the expanding step comprises reaming to shape and contour the extraction cavity to accept the selected implant.

40. The method of claim 35, wherein the affixing step comprises anchoring the non-cylindrical implant to the jawbone with a fixation screw extending from an apical end of the non-cylindrical implant.

41. The method of claim 35, further comprising closing the implant site after setting the non-cylindrical implant into the extraction cavity prior to affixing a dental prosthesis on the non-cylindrical implant.

42. The method of claim 41, further comprising attaching a temporary cap to the non-cylindrical implant after setting the non-cylindrical implant into the extraction site.

43. The method of claim 41, wherein the implant site is closed by placing a gingival flap across the non-cylindrical implant.

44. The methods of any one of claims 41-43, wherein the affixing step is conducted about 3 months to about 12 months after setting a non-cylindrical implant into the extraction cavity.

45. The method of claim 35, wherein the affixing step comprises securing a false tooth to the implant.

46. The method of claim 35, wherein the affixing step comprises securing an abutment to the implant.

47. The method of claim 35, further comprising forming an impression of the non-cylindrical implant in the extraction cavity including surrounding dentitia.

48. An impression coping comprising an implant mating portion and an impression material contact portion, and a top.

49. The impression coping of claim 48, wherein the impression material contact portion is substantially cylindrical.

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50. The impression coping of claim 48, wherein the impression material contact portion comprises at least one of surface projections, surface texturing, roughening, to enhance contact and retention in an impression material.

51. The impression coping of claim 48, wherein the implant mating portion is configured to be received by and mate with an interior portion of a dental implant with an indented feature configured to permit a mating fit with a cooperating protrusion.

52. The impression coping of claim 51, wherein the implant mating portion comprises a plurality of flanges situated around the impression material contact portion, opposite the top of the impression coping.

53. The impression coping of claim 52, wherein flanges may be spaced regularly around the generally cylindrical impression material contact portion.

54. An impression coping securing screw for securing an impression coping to an implant comprising at least one material selected from a heat labile plastic and silicone.

55. The impression coping securing screw of claim 54, wherein the impression coping securing screw comprises threads made of metal or plastic and coated with a heat labile plastic or silicone.

56. A method of removing an impression coping securing screw threaded into the internal threading in a dental implant comprising activating heat-labile plastic, or silicone threads, or heat labile plastic-coated or silicone-coated threads, to allow the impression coping secured by the impression coping securing screw to be disengaged from the implant and removed with the impression of the patient's dentitia.

57. A dental implant system comprising a dental implant and an impression coping member and an impression coping securing screw comprising a heat labile plastic or silicone material configured to cooperatively engage the dental implant and the impression coping member for ensuring proper alignment and orientation of a dental prosthesis assembled on the implant.

58. A method of impression making and dental reconstruction comprising:

providing an impression coping including a screw access channel in the impression coping configured to receive an impression coping securing screw

securing the impression coping on a dental implant set in a jawbone by passing an impression coping securing screw through the screw access channel and mating an end of the impression coping securing screw with the dental implant,

activating a heat liable plastic or silicone on the impression coping securing screw to dissolve or soften sufficiently to allow removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw, and

removing the impression coping securing screw from the implant.

59. The method of claim 58, wherein an impression material is used to form an impression of the implant and surrounding dentitia before the step of removing the impression coping securing screw from the implant.

60. A method for obtaining an accurate translation of an orientation and position of an implant, comprising:

securing a dental implant in a jawbone, wherein the dental implant has a plurality of protrusions internal to an interior cavity of the implant, which protrusions are configured to matingly engage flanges on an impression coping in a snap-fit engagement when the flanges extend beneath the protrusions;

seating an impression coping comprising flanges that engage two or more of the protrusions internal to the interior cavity of the implant by deflecting and springing back to an un-deflected state upon seating of the impression coping in the implant;

applying a dental impression material to at least an area adjacent the impression coping seated in the implant to cover the impression coping to obtain a negative impression of the area;

releasing the impression coping from the implant;

removing the impression material from the area adjacent the impression coping with the impression coping embedded in the impression material.

61. The method of claim 60, wherein engaging flanges of the impression coping with the protrusions on the implant produces an audible sound indicating that the impression coping has been properly seated in the implant.

62. The method of claim 60, wherein a bore extends through the impression coping, the bore configured to allow the passage of an impression coping securing screw through the impression coping.

63. The method of claim 62, wherein seating the impression coping in the implant comprises passing an impression coping securing screw through the bore in the impression coping and engaging the screw in an internal cavity of the implant in a closely fitted engagement.

64. The method of claim 63, wherein the impression coping securing screw comprises a heat labile plastic or silicone configured to cooperatively engage the implant.

65. The method of claim 64, wherein releasing the impression coping from the implant comprises activating the heat labile plastic or silicone portion of the impression coping securing screw to dissolve or soften sufficiently to allow removal of the impression coping securing screw from the implant without unscrewing the impression coping securing screw.

66. The method of claim 60, further comprising sending the impression material and impression coping to a dental lab to form a dental cast model.

67. A multi-component dental implant system comprising:

at least one non-cylindrical dental implant;

at least one implant abutment configured to detachably join at least one non-cylindrical dental implant.

68. The multi-component dental implant system of claim 67, further comprising: a set of standard surgical tools prepared for the dental professional to choose from.

69. The multi-component dental implant system of claim 67, wherein the at least one non-cylindrical dental implant comprises a set of standard shaped implants of varying size.

70. The multi-component dental implant system of claim 67, wherein the at least one implant abutment comprises a set of standard shaped abutments of varying size.

71. The multi-component dental implant system of claim 67, wherein the at least one non-cylindrical dental implant comprises at least one non-cylindrical implant configured to replace a tooth selected from a bicuspid, a molar, a canine, and an incisor.

72. The multi-component dental implant system of claim 67, further comprising: at least one dental surgical instrument selected from a drill guide, a reamer, a drill bit, a surgical fixation screw, and a bone screw insertion tool.

73. The multi-component dental implant system of claim 67, further comprising: a healing abutment.

74. The multi-component dental implant system of claim 73, wherein the healing abutment need not be removed during an impression taking procedure.

75. The multi-component dental implant system of claim 67, further comprising: an implant coding system that facilitates selection or identification of a non-cylindrical dental implant by the dental professional.

76. A dental implant adapted to be embedded within a patient's jawbone comprising:

an apical end adapted to engage the jaw bone,

a top end, opposite the apical end, the top end having an abutment or prosthesis receiving portion,

the abutment or prosthesis receiving portion comprising a cavity formed within the implant to receive an abutment, or other dental prosthetic structure,

wherein the abutment or prosthesis receiving portion has a substantially pentagonal shape, and

wherein at least the apical end of the dental implant has a non-cylindrical shape.

77. The dental implant of claim 76, wherein the abutment-receiving portion of the implant further comprises a circular opening in the apical end adapted for receiving a fixation screw that will pass through the circular opening in the abutment-receiving portion and extend below the apical end of the implant, and into a jawbone.

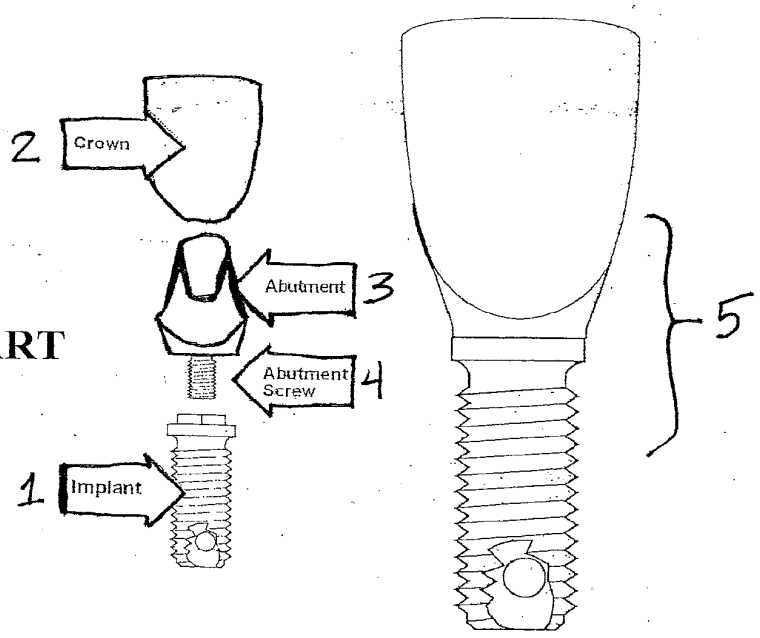


FIG. 1
PRIOR ART

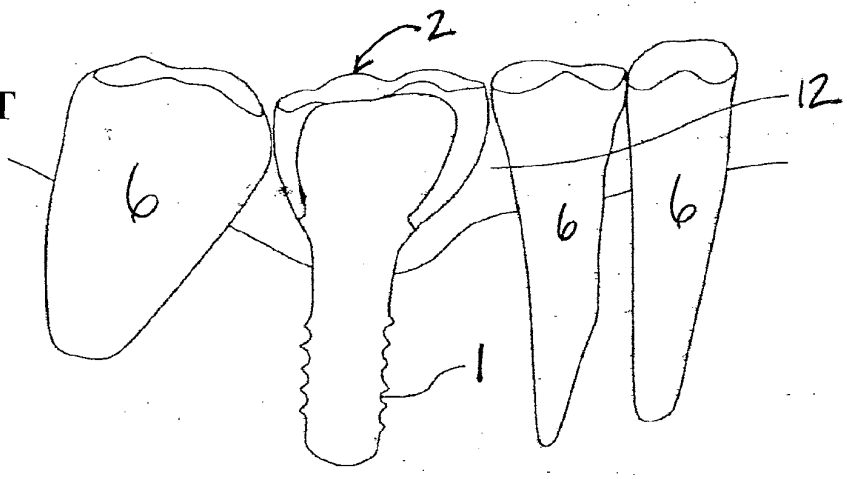


FIG 2.
PRIOR ART

FIG. 3

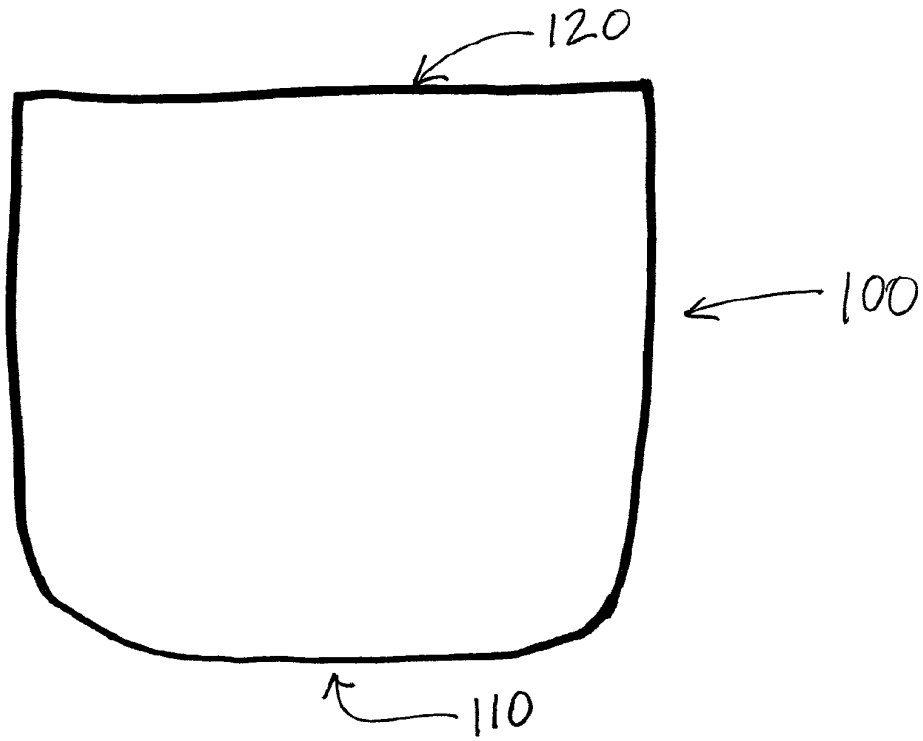


FIG. 4

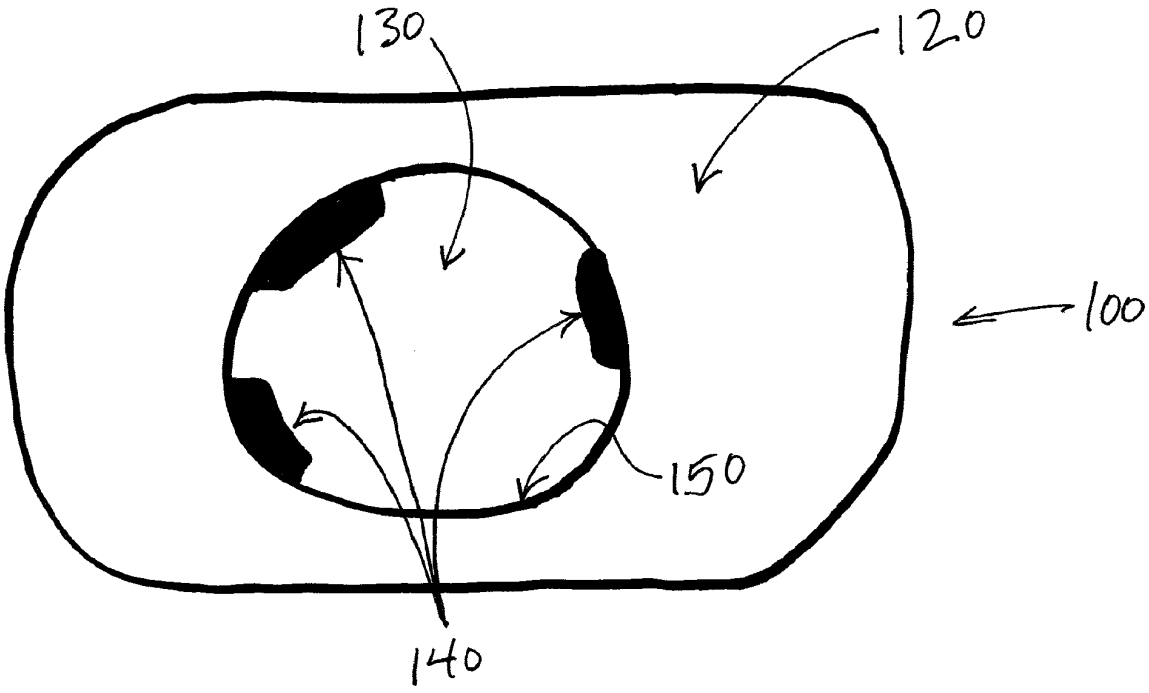


FIG. 5

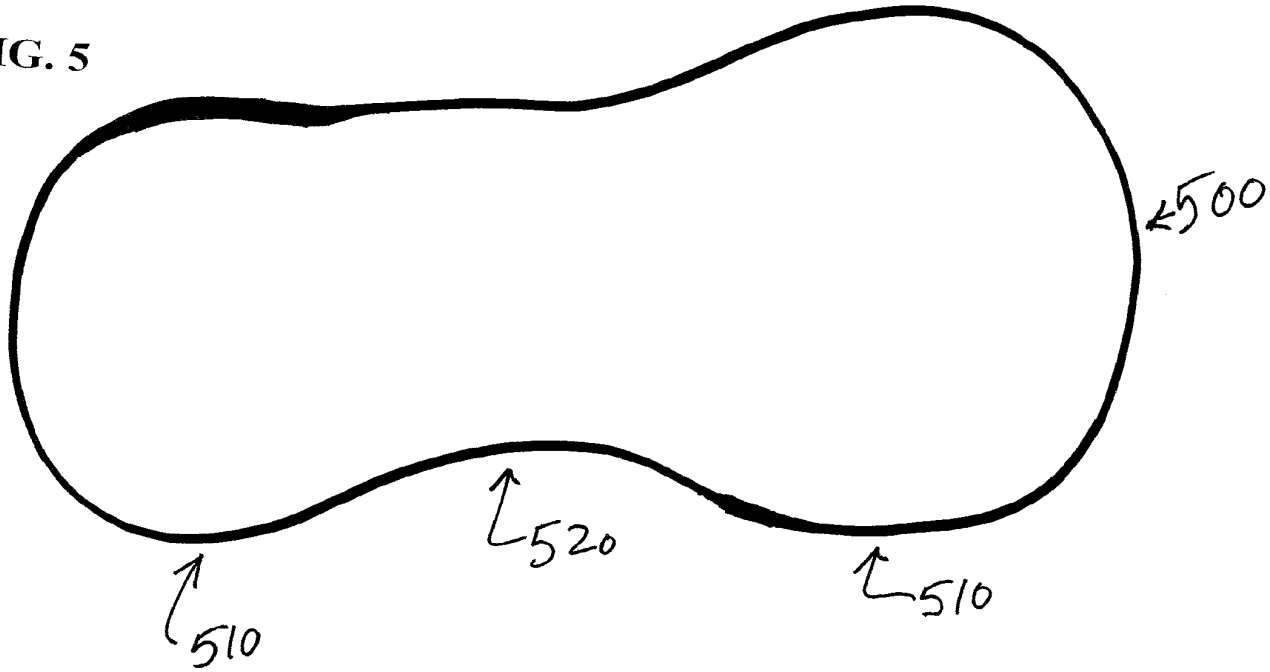


FIG. 6

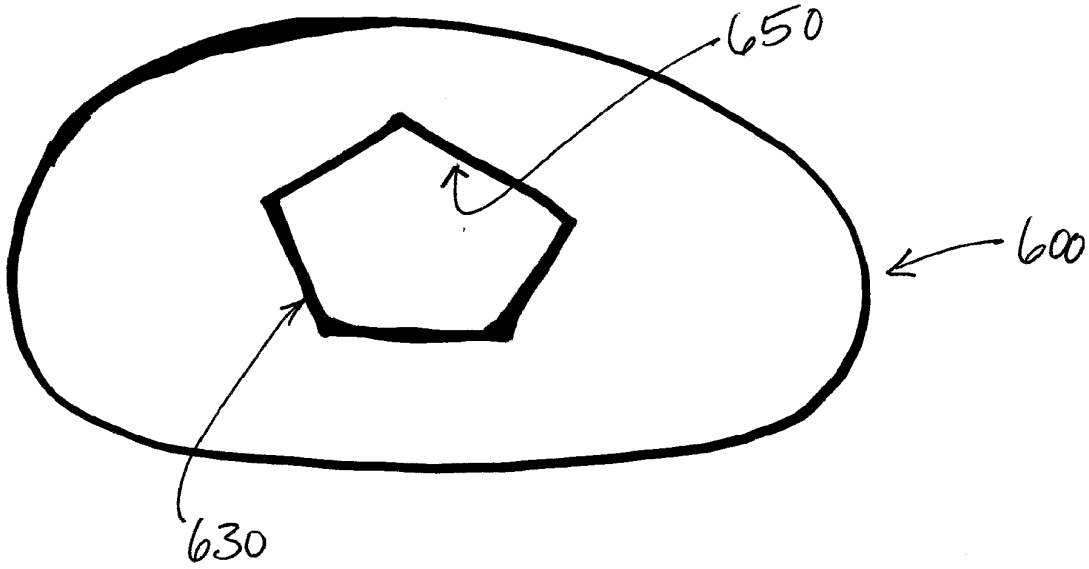


FIG. 7

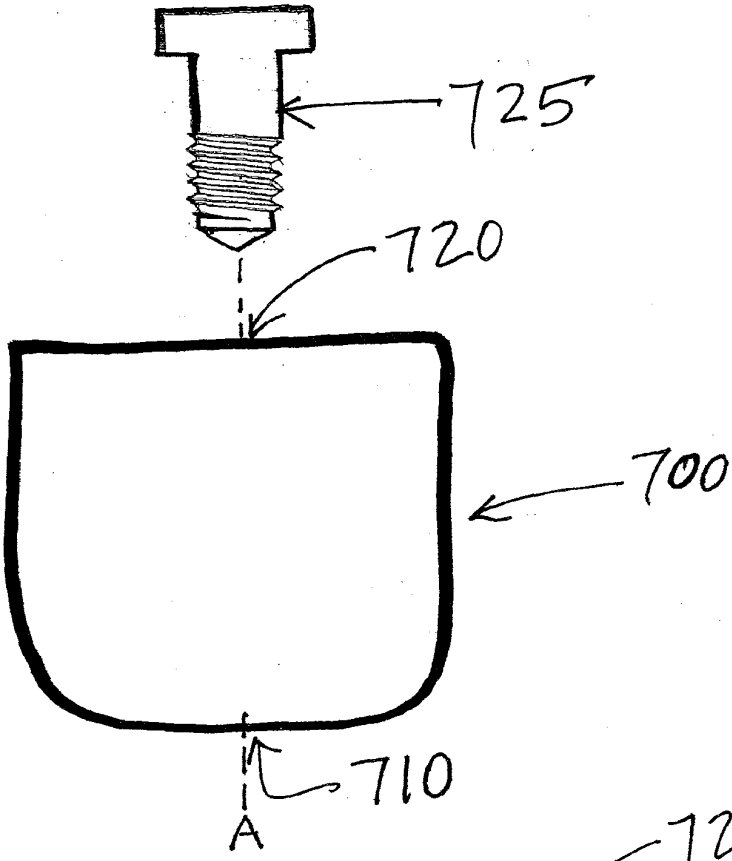
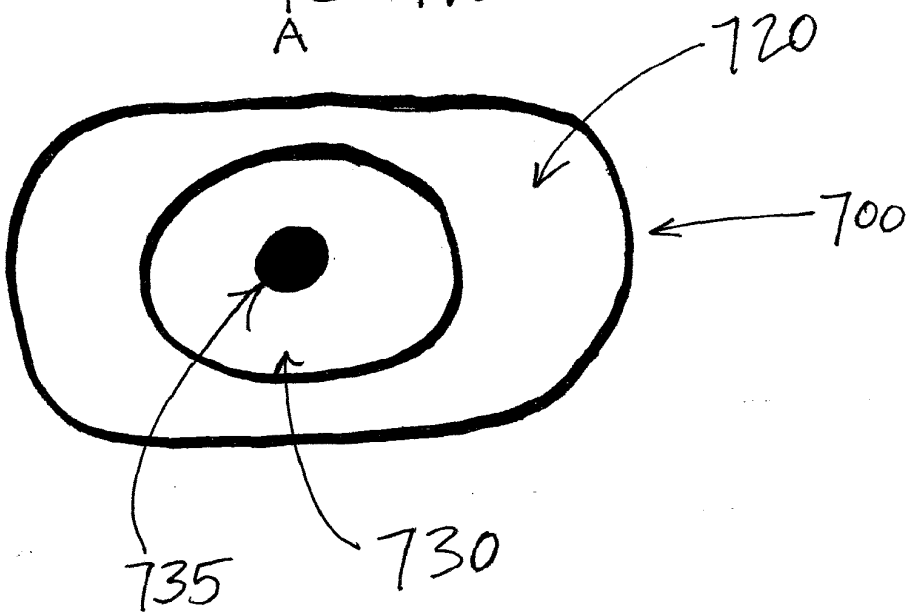


FIG. 8



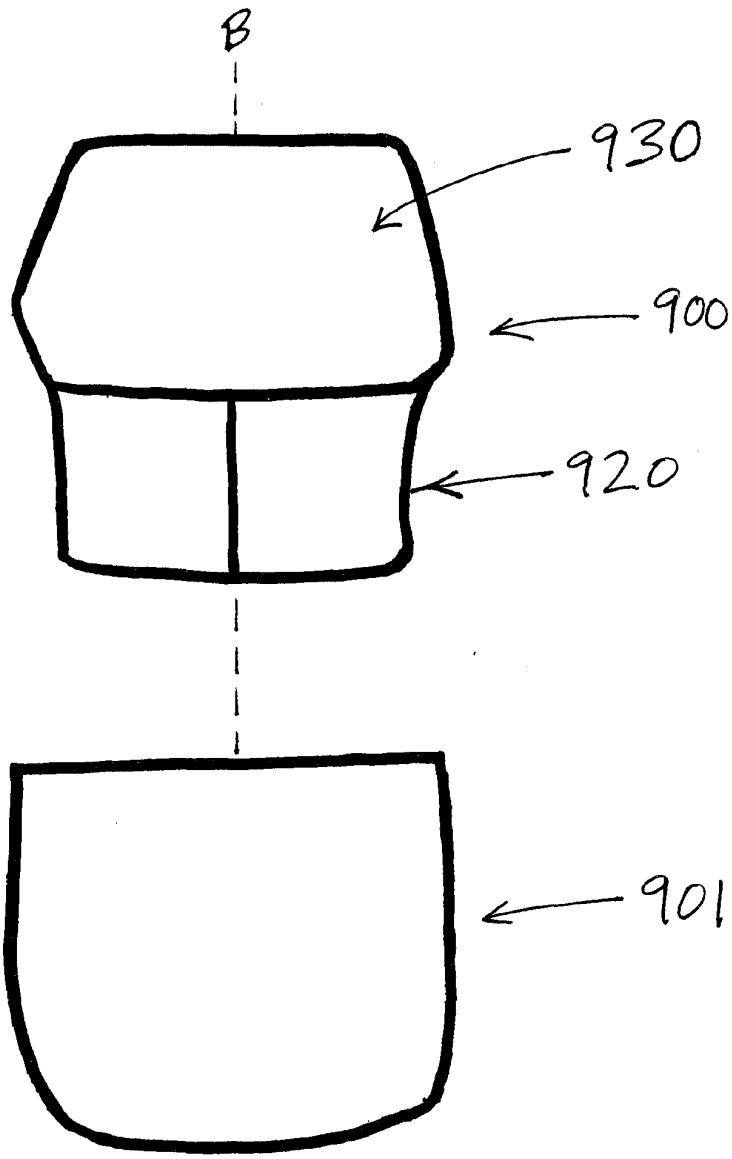
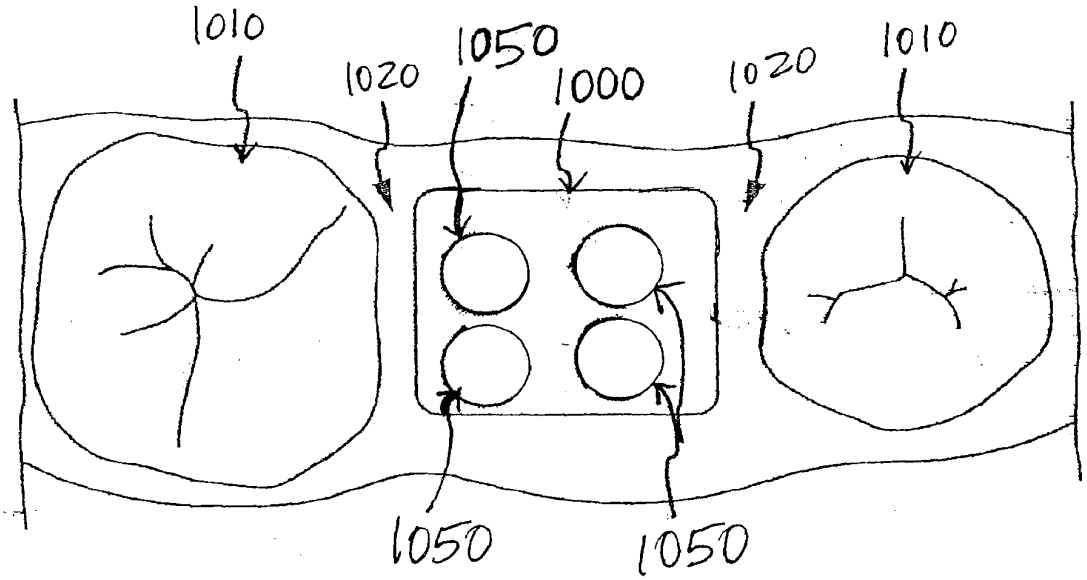


FIG. 9

FIG. 10



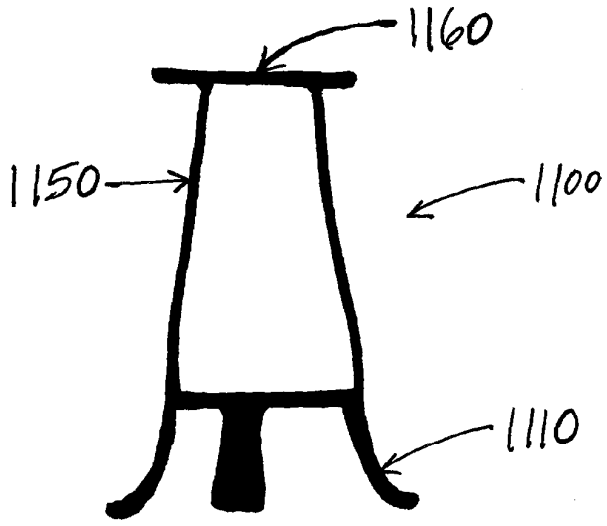

1160
1150
1100
1110

FIG. 11

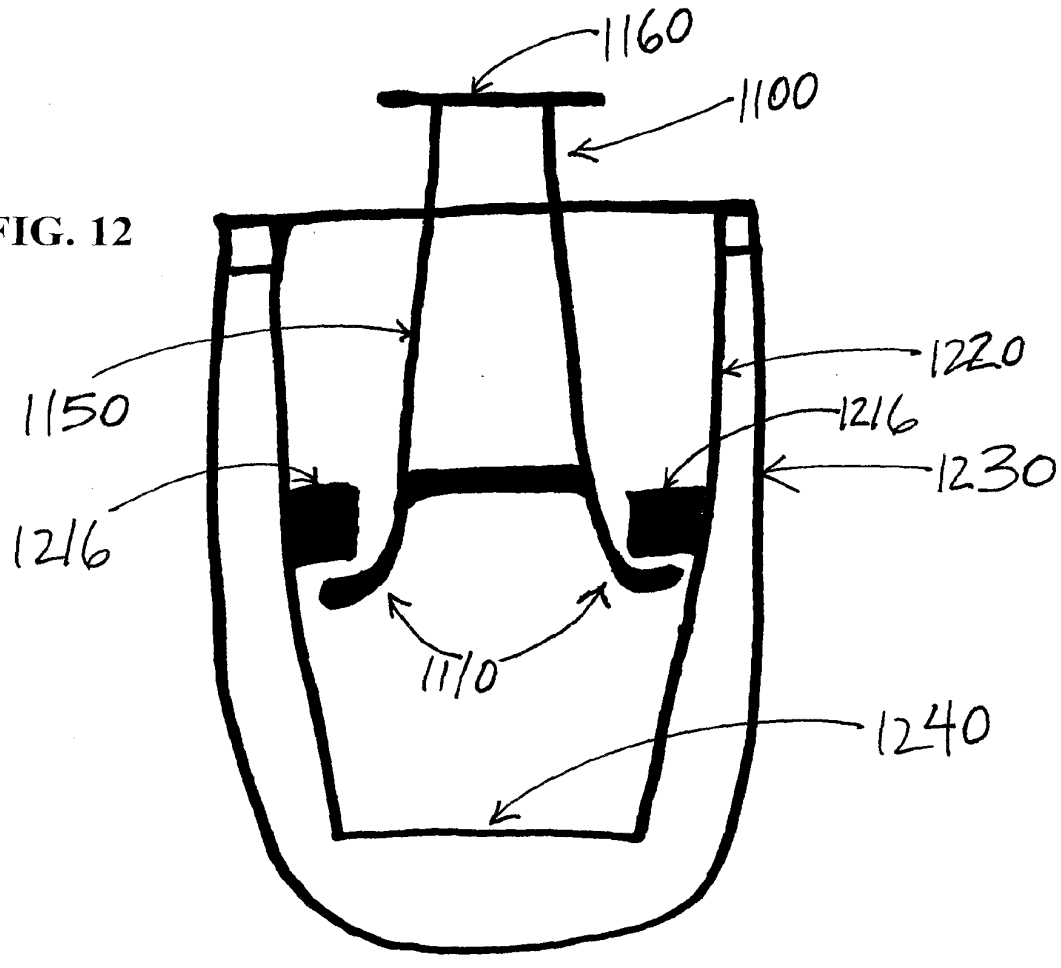
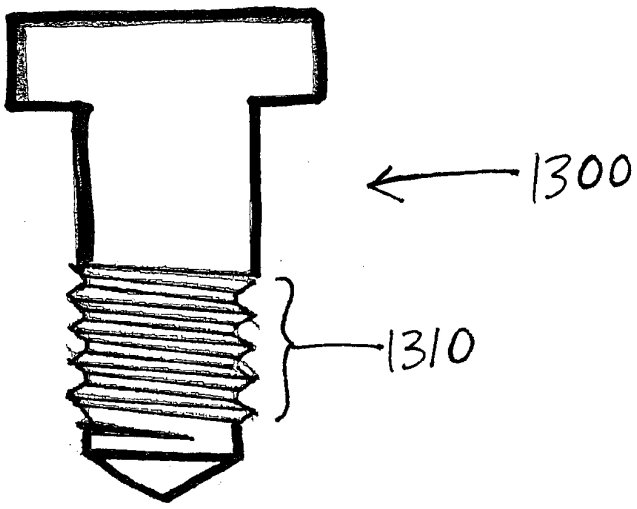

1160
1100
1150
1220
1216
1230
1216
1110
1240

FIG. 12

FIG. 13



(19) 대한민국특허청(KR)
(12) 공개특허공보(A)

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전체 청구항 수 : 총 15 항

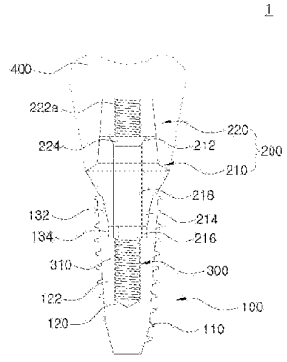
(54) 발명의 명칭 **치과용 임플란트**

(57) 요 약

본 발명은 치과용 임플란트에 관한 것으로, 보다 상세하게는 별도의 나사기둥을 이용하여 픽스쳐와 어버트먼트를 결합시킴으로써 임플란트 나사결합부의 파절을 방지한과 동시에 접촉면 전체에 골고루 힘이 전달되도록 하여 응력이 부분적으로 집중되는 현상을 방지할 수 있고, 픽스쳐와 어버트먼트 사이의 나사결합 방향을 달리하여 픽스쳐와 어버트먼트 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있는 치과용 임플란트에 관한 것이다.

본 발명은 픽스쳐와 어버드민드를 포함하여 구성되는 치과용 임플란트에 있어서, 상기 어버드민드는 픽스쳐에 끼움 결합되는 하부 어버트먼트와, 상기 하부 어버트먼트의 상부에 연결 설치되는 상부 어버트먼트로 분리 구성되고, 상기 상부 어버트먼트와 픽스쳐는 나사기둥에 의해 체결 고정되는 것을 특징으로 한다.

대 표 도 - 도3



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특허청구의 범위

청구항 1

외주면에 나사산이 형성된 픽스쳐와, 픽스쳐의 내측으로 삽입 결합되는 어버트먼트를 포함하여 구성되는 치과용 임플란트에 있어서,

상기 어버트먼트는 픽스쳐에 끼움 결합되는 하부 어버트먼트와, 상기 하부 어버트먼트의 상부에 연결 설치되는 상부 어버트먼트로 분리 구성되고,

상기 상부 어버트먼트와 픽스쳐는 나사기둥에 의해 체결 고정되는 것을 특징으로 하는 치과용 임플란트.

청구항 2

제 1항에 있어서,

상기 픽스쳐와 상부 어버트먼트에는 나사기둥이 결합되는 제1 및 제2암나사가 각각 형성되고, 상기 제1 및 제2 암나사에 대응되는 위치의 나사기둥에는 제1 및 제2수나사가 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 3

제 2항에 있어서,

상기 제1암나사 및 제1수나사와, 제2암나사 및 제2수나사는 서로 반대방향의 나사산을 갖도록 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 4

제 2항에 있어서,

상기 상부 어버트먼트의 하단에는 돌출부가 형성되고, 상기 하부 어버트먼트의 상단에는 상기 돌출부가 끼움 결합되는 안착홈이 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 5

제 2항에 있어서,

상기 상부 어버트먼트의 하단에는 내주면에 제2암나사가 형성된 연장부가 돌출 형성되고, 상기 하부 어버트먼트의 상단에는 상기 연장부가 삽입 결합되는 삽입홈이 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 6

제 2항에 있어서,

상기 하부 어버트먼트의 하부에는 결합홈이 형성되고, 상기 픽스쳐의 상단부에는 결합홈에 끼움 결합되는 고정부가 돌출 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 7

제 1항에 있어서,

상기 상부 어버트먼트의 외주면에는 시딩 그루브(seating groove)가 형성되고, 하부 어버트먼트의 외주면에는 시딩 릿지(seating ridge)가 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 8

제 2항에 있어서,

상기 나사기둥은 그 하단부와 상단부에 각각 형성되는 제1 및 제2수나사와, 상기 제1 및 제2수나사의 사이에 형성되는 다각 형상의 포스트로 구성된 것을 특징으로 하는 치과용 임플란트.

청구항 9

제 8항에 있어서,

상기 나사기둥의 제2수나사 외주면에는,

내주면에 제2암나사가 형성되고, 외주면에 제3수나사가 형성된 나사링이 결합되고, 상기 상부 어버트먼트에는 제3수나사가 체결되는 제3암나사가 형성된 제1체결홈이 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 10

제 9항에 있어서,

상기 나사기둥의 포스트에는 외주면에 제4수나사가 형성된 체결구가 끼움 결합되고, 상기 하부 어버트먼트에는 제4수나사가 체결되는 제4암나사가 형성된 제2체결홈이 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 11

제 10항에 있어서,

상기 체결구의 하단부에는 다각형상으로 이루어지는 회전방지부가 형성되고,

상기 픽스처의 상부에는 상기 회전방지부가 끼움 결합되는 회전방지홈이 형성된 것을 특징으로 하는 치과용 임플란트.

청구항 12

제 10항에 있어서,

상기 체결구의 상단에는 픽스처의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 톱니 형상의 제1스텝부가 형성되고, 상기 나사링과 체결구의 사이에는 하단부에 제1스텝부와 대응되는 형상의 제2스텝부가 형성된 제1스텝링이 설치되는 것을 특징으로 하는 치과용 임플란트.

청구항 13

제 10항에 있어서,

상기 제1암나사와 제1수나사의 나사 방향은,

픽스처에 형성된 나사산과, 제2 내지 제4암나사 및 제2 내지 제4수나사의 나사 방향과 반대로 형성된 것을 특징으로 하는 치과용 임플란트.

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청구항 14

제 8항에 있어서,

상기 하부 어버트먼트의 내측에는 상단부에 픽스처의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 톱니 형상의 제1스텝부가 형성되고,

상기 제1스텝부의 상부에는 하단부에 제1스텝부와 대응되는 형상의 제2스텝부가 형성된 제1스텝링이 하부 어버트먼트의 내측으로 삽입 결합된 것을 특징으로 하는 치과용 임플란트.

청구항 15

제 1항에 있어서,

상기 하부 어버트먼트의 상단부에는 픽스처의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 경사면을 포함하는 계단 형상의 제3스텝부가 형성되고, 상기 하부 어버트먼트와 상부 어버트먼트의 사이에는 하단부에 제3스텝부와 대응되는 형상의 제4스텝부가 형성된 제2스텝링이 설치되는 것을 특징으로 하는 치과용 임플란트.

명 세 서

기 술 분 야

[0001] 본 발명은 치과용 임플란트에 관한 것으로, 보다 상세하게는 별도의 나사기둥을 이용하여 픽스처와 어버트먼트를 결합시킴으로써 임플란트 나사결합부의 파절을 방지함과 동시에 접촉면 전체에 골고루 힘이 전달되도록 하여 응력이 부분적으로 집중되는 현상을 방지할 수 있고, 픽스처와 어버트먼트 사이의 나사결합 방향을 달리하여 픽스처와 어버트먼트 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있는 치과용 임플란트에 관한 것이다.

배 경 기 술

[0002] 일반적으로, 임플란트(implant)란 자연치아와 동일한 형태와 기능을 재현할 수 있도록 구성되는 인공 대체물을 의미하는 것으로, 그 구성은 도 1에 나타낸 바와 같이, 외주면에 나사산(11)이 형성되어 치조골(A)에 설치되도록 자연치아의 치근 형태를 본뜬 티타늄 재질의 픽스처(fixture)(10)와, 상기 픽스처(10)의 상부에 연결 설치되고 그 상부에 인공치아(B)가 결합되는 어버트먼트(abutment)(20)와, 상기 픽스처(10)와 어버트먼트(20)를 서로 고정시키는 고정나사(30)를 포함하여 이루어진다.

[0003] 즉, 종래의 일반적인 임플란트 구조는 내부에 나사공이 형성된 픽스처(10)의 상부에 어버트먼트(20)를 위치시킨 후, 어버트먼트(20)를 통해 픽스처(10)의 나사공 내측으로 고정나사(30)를 삽입 결합시켜 고정나사(30)의 회전에 의해 픽스처(10)와 어버트먼트(20)가 서로 고정 결합되도록 구성된 것이다.

[0004] 하지만, 상기와 같은 구성이 고정나사(30)의 헤드부분이 어버트먼트(20)의 내측으로 삽입되어 픽스처(10)와 어버트먼트(20)의 결합부에 지지되도록 구성되어 있어, 고정나사(30)의 길이가 짧아 픽스처(10)와 어버트먼트(20)의 결합력이 약하고, 음식물을 씹는 경우 등의 저작작용시 받는 하중이 고정나사(30)의 좁은 표면적에 집중되어 픽스처(10)와 어버트먼트(20)의 결합부에서 고정나사(30)가 파절되거나 풀릴 수 있는 문제점이 있다.

[0005] 이러한 문제점을 해결하기 위한 종래 기술로 미국 공개특허공보 US2003/0224328호에는 생물학적 기능을 갖는 치아 임플란트(1)가 게재되어 있는데, 그 주요 기술적 구성은 도 2에 나타낸 바와 같이, 환자의 입 안 잇몸뼈(64)에 크라운부(50)를 부착시키기 위한 생물학적 기능을 갖는 치과 임플란트(1)에 있어서, 환자의 잇몸뼈(64)에 형성되는 소켓(움푹 들어간 곳) 안쪽의 검라인(62)(치아와 잇몸이 만나 이루는 선) 아래에 심어지는 뿌리부(3)와, 환자의 잇몸뼈(64)에 형성되는 소켓의 안쪽에 상기 뿌리부(3)를 고정시키기 위한 수단과, 크라운부(50)와, 상기 뿌리부(3)에 크라운부(50)를 연결시키기 위한 플렉시블한 어버트먼트 포스트(18)를 포함하여 구성되되, 상기 플렉시블한 어버트먼트 포스트(18)는 상기 크라운부(50)가 환자의 잇몸뼈(64)에 형성되는 소켓 안쪽에 고정

되는 뿌리부(3)에 대해 이동이 가능하도록 하기 위하여 구부러질 수 있도록 형성된 것에 그 특징이 있다.

[0006] 상기 구성은 치근부를 둘러싸는 뼈 구조에 인간의 성장인자를 분배할 수 있도록 하는 공급 통로를 제공할 수 있도록 구성된 것에 특징이 있으나, 그 구성이 복잡하여 고, 크라우부(50)와 뿌리부(3) 사이의 결합력이 약하며, 어버트먼트 포스트(18)에 의한 크라운부(50)와 뿌리부(3)의 나사 결합이 풀릴 위험이 존재한다는 문제점이 있다.

[0007] 하지만, 상기 구성은 나사부(5)가 상부설치대(2)에 일체로 형성되어 있어, 나사부(5)가 형성된 상부설치대(2)가 파절될 위험이 여전히 존재하고, 상부설치대(2)가 파절될 경우 파절된 나사부(5)를 제거하는 것이 어렵다는 단점이 있다.

[0008] 또한, 상기 나사부(5)가 인공치아고정체(11)의 내측에서만 나사결합되므로, 나사 결합되는 부분의 표면적이 작아 인공치아고정체(11)와 상부설치대(2) 및 하부설치대(6) 사이의 결합력이 약하고, 나사결합이 풀릴 위험이 존재한다는 문제점이 있다.

[0009] 또한, 상기 종래 구성은 어버트먼트가 잇몸부분과 맞닿는 면이 없이 크라운부(50)가 통채로 뿌리부(3)에 연결된 구조이므로, 완벽하게 잇몸뼈가 존재하는 경우에만 적용이 가능하고, 검라인(62) 부근에 치태와 치석이 많이 침착하게 되는 문제점도 있다.

발명의 내용

해결하려는 과제

[0010] 본 발명은 상기와 같은 종래 기술의 문제점들을 해결하기 위하여 안출된 것으로, 본 발명의 목적은 픽스쳐와 어버트먼트의 결합을 위해 별도의 나사기둥을 사용함으로써 픽스쳐와 어버트먼트가 나사 결합되는 면적을 증가시킴으로써 픽스쳐와 어버트먼트 사이의 결합력을 증가시키고, 나사기둥의 파절 위험을 최소화할 수 있을 뿐만 아니라, 나사기둥의 파절시에도 파절된 나사기둥을 용이하게 제거할 수 있는 치과용 임플란트를 제공함에 있다.

[0011] 또한, 본 발명은 픽스쳐에 나사기둥을 먼지 결합시킨 후 그 상부에 어버트먼트를 체결 고정시킬 수 있도록 하여 픽스쳐와 어버트먼트의 결합을 보다 용이하고 정확하게 할 수 있도록 하는 치과용 임플란트를 제공함에 다른 목적이 있다.

[0012] 또한, 본 발명은 어버트먼트를 상부 어버트먼트와 하부 어버트먼트로 분리 구성함으로써 상,하부 어버트먼트의 높이, 기울기, 굵기 등의 형상을 다양하게 선택하여 조립할 수 있도록 하는 치과용 임플란트를 제공함에 또 다른 목적이 있다.

[0013] 또한, 본 발명은 나사기둥을 이용하여 상부 어버트먼트와 나사기둥의 사이, 픽스쳐와 나사기둥의 사이로 나사 결합부를 두 군데로 분리하여 구성함과 동시에 분리 구성되는 나사 결합부의 결합 방향을 서로 반대가 되도록 함으로써 픽스쳐와 어버트먼트 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있는 치과용 인플란트를 제공함에 또 다른 목적이 있다.

[0014] 또한, 본 발명은 나사기둥과 상,하부 어버트먼트의 사이에 나사링 및 체결구를 삽입 결합시킴으로써 상,하부 어버트먼트 사이의 결합력 및 상,하부 어버트먼트와 픽스쳐 사이의 결합력을 향상시킬 수 있는 치과용 임플란트를 제공함에 또 다른 목적이 있다.

[0015] 또한, 본 발명은 픽스쳐의 매식 방향 및 나사기둥과 상,하부 어버트먼트 사이의 결합방향과, 나사기둥과 픽스쳐 사이의 결합방향을 반대로 함으로써 나사기둥의 풀림방지 효과를 극대화시킬 수 있도록 하는 치과용 임플란트를 제공함에 또 다른 목적이 있다.

[0016] 또한, 본 발명은 하부 어버트먼트의 내측 또는 상부 어버트먼트와 하부 어버트먼트의 사이에 스텝링을 삽입 설치하여 하부 어버트먼트가 다각 형상으로 이루어지는 나사기둥의 포스트에 밀착되도록 함으로써 임플란트의 제조 과정에서 발생되는 공차에도 불구하고 흔들림 없이 견고한 고정 상태를 유지할 수 있도록 하는 치과용 임플란트를 제공함에 또 다른 목적이 있다.

[0017] 또한, 본 발명은 상부 어버트먼트와 하부 어버트먼트의 외주면에 시팅 그루브 또는 시팅 릿지를 각각 형성시켜 인공치아의 내측면에 시팅 그루브와 시팅 릿지의 형상에 대응되는 돌출부와 홈이 형성되도록 함으로써 상부 어

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버트먼트와 하부 어버트먼트를 고정시킬 수 있도록 하는 치과용 임플란트를 제공함에 또 다른 목적이 있다.

발명의 해결 수단

[0018] 상기와 같은 목적들을 달성하기 위한 본 발명은,

[0019] 픽스쳐와 어버트먼트를 포함하여 구성되는 치과용 임플란트에 있어서, 상기 어버트먼트는 픽스쳐에 끼움 결합되는 하부 어버트먼트와, 상기 하부 어버트먼트의 상부에 연결 설치되는 상부 어버트먼트로 분리 구성되고, 상기 상부 어버트먼트와 픽스쳐는 나사기둥에 의해 체결 고정되는 것을 특징으로 한다.

[0020] 이때, 상기 픽스쳐와 상부 어버트먼트에는 나사기둥이 결합되는 제1 및 제2암나사가 각각 형성되고, 상기 제1 및 제2암나사에 대응되는 위치의 나사기둥에는 제1 및 제2수나사가 형성된 것을 특징으로 한다.

[0021] 또한, 상기 제1암나사 및 제1수나사와 제2암나사 및 제2수나사는 서로 반대방향의 나사산을 갖도록 형성된 것을 특징으로 한다.

[0022] 그리고, 상기 상부 어버트먼트의 하단에는 돌출부가 형성되고, 상기 하부 어버트먼트의 상단에는 상기 돌출부가 끼움 결합되는 안착홈이 형성된 것을 특징으로 한다.

[0023] 또한, 상기 상부 어버트먼트의 하단에는 내주면에 제2암나사가 형성된 연장부가 돌출 형성되고, 상기 하부 어버트먼트의 상단에는 상기 연장부가 삽입 결합되는 삽입홈이 형성된 것을 특징으로 한다.

[0024] 또한, 상기 하부 어버트먼트의 하부에는 결합홈이 형성되고, 상기 픽스쳐의 상단부에는 결합홈에 끼움 결합되는 고정부가 돌출 형성된 것을 특징으로 한다.

[0025] 그리고, 상기 상부 어버트먼트의 외주면에는 시팅 그루브(seating groove)가 형성되고, 하부 어버트먼트의 외주면에는 시팅 릿지(seating ridge)가 형성된 것을 특징으로 한다.

[0026] 한편, 상기 나사기둥은 그 하단부와 상단부에 각각 형성되는 제1 및 제2수나사와, 상기 제1 및 제2수나사의 사이에 형성되는 다각 형상의 포스트로 구성된 것을 특징으로 한다.

[0027] 이때, 상기 나사기둥의 제2수나사 외주면에는, 내주면에 제2암나사가 형성되고, 외주면에 제3수나사가 형성된 나사링이 결합되고, 상기 상부 어버트먼트에는 제3수나사가 체결되는 제3암나사가 형성된 제1체결홀이 형성된 것을 특징으로 한다.

[0028] 또한, 상기 나사기둥의 포스트에는 외주면에 제4수나사가 형성된 체결구가 끼움 결합되고, 상기 하부 어버트먼트에는 제4수나사가 체결되는 제4암나사가 형성된 제2체결홀이 형성된 것을 특징으로 한다.

[0029] 그리고, 상기 체결구의 하단부에는 다각형상으로 이루어지는 회전방지부가 형성되고, 상기 픽스쳐의 상부에는 상기 회전방지부가 끼움 결합되는 회전방지홈이 형성된 것을 특징으로 한다.

[0030] 또한, 상기 체결구의 상단에는 픽스쳐의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 톱니 형상의 제1스텝부가 형성되고, 상기 나사링과 체결구의 사이에는 하단부에 제1스텝부와 대응되는 형상의 제2스텝부가 형성된 제1스텝링이 설치되는 것을 특징으로 한다.

[0031] 또한, 상기 제1암나사와 제1수나사의 나사 방향은, 픽스쳐에 형성된 나사산과, 제2 내지 제4암나사 및 제2 내지 제4수나사의 나사 방향과 반대로 형성된 것을 특징으로 한다.

[0032] 그리고, 상기 하부 어버트먼트의 내측에는 상단부에 픽스쳐의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 톱니 형상의 제1스텝부가 형성되고, 상기 제1스텝부의 상부에는 하단부에 제1스텝부와 대응되는 형상의 제2스텝부가 형성된 제1스텝링이 하부 어버트먼트의 내측으로 삽입 결합된 것을 특징으로 한다.

[0033] 또한, 상기 하부 어버트먼트의 상단부에는 픽스쳐의 내측에 결합된 나사기둥이 풀리는 방향을 향해 상향으로 경사진 경사면을 포함하는 계단 형상의 제3스텝부가 형성되고, 상기 하부 어버트먼트와 상부 어버트먼트의 사이에는 하단부에 제3스텝부와 대응되는 형상의 제4스텝부가 형성된 제2스텝링이 설치되는 것을 특징으로 한다.

발명의 효과

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[0034] 본 발명에 따르면, 픽스쳐와 어버트먼트의 결합을 위해 별도의 나사기둥을 사용함으로써 픽스쳐와 어버트먼트가 나사 결합되는 면적을 증가시킴으로써 픽스쳐와 어버트먼트 사이의 결합력을 증가시키고, 나사결합되는 부분에 전체적으로 하중이 분산되어 전달되어 응력집중에 의한 나사기둥의 파절 위험을 최소화할 수 있을 뿐만 아니라, 나사기둥의 파절시에도 파절된 나사기둥을 용이하게 제거할 수 있는 효과를 갖는다.

[0035] 또한, 본 발명은 픽스쳐에 나사기둥을 결합시킨 후 그 상부에 어버트먼트를 체결 고정시킬 수 있도록 하여 픽스쳐와 어버트먼트의 결합을 보다 용이하고 정확하게 할 수 있는 효과를 추가로 갖는다.

[0036] 또한, 본 발명은 어버트먼트를 상부 어버트먼트와 하부 어버트먼트로 분리 구성함으로써 상,하부 어버트먼트의 높이, 기울기, 굵기 등의 형상을 다양하게 선택하여 조립할 수 있는 효과를 추가로 갖는다.

[0037] 또한, 본 발명은 나사기둥을 이용하여 상부 어버트먼트와 나사기둥의 사이, 픽스쳐와 나사기둥의 사이로 나사 결합부를 두 군데로 분리하여 구성함과 동시에 분리 구성되는 나사 결합부의 결합 방향을 서로 반대가 되도록 함으로써 픽스쳐와 어버트먼트 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있을 뿐만 아니라, 픽스쳐와 어버트먼트의 접촉 부분이 부분적으로 응력을 받지 않고 전체적으로 밀착되므로 픽스쳐와 어버트먼트의 결합부 틈새로 외부물질이 침투되는 것을 방지함으로써 임플란트 내부에서의 세균 번식에 의한 임플란트 주위염과 임플란트 주위 점막염의 발생을 예방할 수 있는 효과를 추가로 갖는다.

[0038] 또한, 본 발명에 따르면, 나사기둥과 상,하부 어버트먼트의 사이에 나사링 및 체결구를 삽입 결합시킴으로써 상,하부 어버트먼트 사이의 결합력 및 상,하부 어버트먼트와 픽스쳐 사이의 결합력을 향상시킬 수 있을 뿐만 아니라, 픽스쳐의 매식 방향 및 나사기둥과 상,하부 어버트먼트 사이의 결합방향과, 나사기둥과 픽스쳐 사이의 결합방향을 반대로 함으로써 나사기둥의 풀림방지 효과를 극대화시킬 수 있도록 하는 효과를 추가로 갖는다.

[0039] 또한, 본 발명에 따르면 하부 어버트먼트의 내측 또는 상부 어버트먼트와 하부 어버트먼트의 사이에 스텝링을 삽입 설치하여 하부 어버트먼트의 내측면이 다각 형상으로 이루어지는 나사기둥의 포스트의 외주면에 밀착 고정되도록 함으로써 임플란트의 제조 과정에서 발생되는 공차에도 불구하고 흔들림 없이 견고한 고정 상태를 유지할 수 있도록 하는 효과를 추가로 갖는다.

[0040] 또한, 본 발명에 따르면 상부 어버트먼트와 하부 어버트먼트의 외주면에 시팅 그루브 또는 시팅 릿지를 각각 형성시켜 인공치아의 내측면에 시팅 그루브와 시팅 릿지의 형상에 대응되는 돌출부와 홈이 형성되도록 함으로써 상부 어버트먼트와 하부 어버트먼트를 견고히 고정시켜 풀림 현상을 방지할 수 있는 효과를 추가로 갖는다.

도면의 간단한 설명

[0041] 도 1은 일반적인 종래의 임플란트가 시술된 모습을 개략적으로 나타낸 도면.

도 2는 종래의 치아 임플란트의 결합 모습을 나타낸 단면도.

도 3은 본 발명에 따른 치과용 임플란트의 일실시예를 나타낸 결합 단면도.

도 4는 도 3에 나타낸 본 발명을 분리하여 나타낸 단면도.

도 5의 (a),(b),(c)는 도 3에 나타낸 본 발명 중 어버트먼트의 실시예를 분리하여 나타낸 단면도.

도 6의 (a),(b),(c)는 도 3에 나타낸 본 발명 중 나사기둥의 실시예를 나타낸 도면.

도 7은 본 발명에 따른 치과용 임플란트의 제2실시예를 나타낸 결합 단면도.

도 8은 본 발명에 따른 치과용 임플란트의 제3실시예를 나타낸 결합 단면도.

도 9는 본 발명에 따른 치과용 임플란트의 제4실시예를 분리하여 나타낸 단면도.

도 10은 도 9에 나타낸 본 발명의 결합 단면도.

도 11의 (a),(b),(c)는 도 9에 나타낸 본 발명 중 하부 어버트먼트의 결합과정을 나타낸 단면도.

도 12의 (a),(b)는 도 10에 나타낸 본 발명 중 픽스쳐와 하부 어버트먼트 사이의 결합부를 나타낸 평단면도.

도 13은 본 발명에 따른 치과용 임플란트의 제5실시예를 분리하여 나타낸 단면도.

도 14는 도 13에 나타낸 본 발명의 결합 단면도.

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도 15는 본 발명에 따른 치과용 임플란트의 제6실시예를 분리하여 나타낸 단면도.

도 16은 본 발명에 따른 치과용 임플란트 중 상,하부 어버트먼트의 다른 실시예를 분리하여 나타낸 도면.

발명을 실시하기 위한 구체적인 내용

[0042] 이하, 첨부된 도면을 참고로 하여 본 발명에 따른 치과용 임플란트의 바람직한 실시예들을 상세히 설명하기로 한다.

[0043] 도 3은 본 발명에 따른 치과용 임플란트의 일실시예를 나타낸 결합 단면도이고, 도 4는 도 3에 나타낸 본 발명을 분리하여 나타낸 단면도이며, 도 5의 (a),(b),(c)는 도 3에 나타낸 본 발명 중 어버트먼트의 실시예를 분리하여 나타낸 단면도이고, 도 6의 (a),(b),(c)는 도 3에 나타낸 본 발명 중 나사기둥의 실시예를 나타낸 도면이며, 도 7은 본 발명에 따른 치과용 임플란트의 제2실시예를 나타낸 결합 단면도이고, 도 8은 본 발명에 따른 치과용 임플란트의 제3실시예를 나타낸 결합 단면도이며, 도 9는 본 발명에 따른 치과용 임플란트의 제4실시예를 분리하여 나타낸 단면도이고, 도 10은 도 9에 나타낸 본 발명의 결합 단면도이며, 도 11의 (a),(b),(c)는 도 9에 나타낸 본 발명 중 하부 어버트먼트의 결합과정을 나타낸 단면도이고, 도 12는 본 발명에 따른 치과용 임플란트의 제5실시예를 분리하여 나타낸 단면도이며, 도 13은 도 12에 나타낸 본 발명의 결합 단면도이고, 도 14는 본 발명에 따른 치과용 임플란트의 제6실시예를 분리하여 나타낸 단면도이며, 도 15는 본 발명에 따른 치과용 임플란트 중 상,하부 어버트먼트의 다른 실시예를 분리하여 나타낸 도면이다.

[0044] 본 발명은 별도의 나사기둥(300,300')을 이용하여 픽스쳐(100)와 어버트먼트(200)를 결합시킴으로써 임플란트 나사결합부의 파절을 방지함과 동시에 접촉면 전체에 골고루 힘이 전달되도록 하여 응력이 부분적으로 집중되는 현상을 방지할 수 있고, 픽스쳐(100)와 어버트먼트(200) 사이의 나사결합 방향을 달리하여 픽스쳐(100)와 어버트먼트(200) 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있는 치과용 임플란트(1)에 관한 것으로, 그 일실시예의 구성은 도 3 및 도 4에 나타낸 바와 같이, 픽스쳐(100)와 어버트먼트(200) 및 나사기둥(300)을 포함하여 이루어진다.

[0045] 보다 상세히 설명하면, 상기 픽스쳐(fixture)(100)는 임플란트(1)의 뿌리 역할을 하는 것으로 자연치아의 치근 형상을 갖도록 형성되고, 그 외주면에는 나사산(110)이 형성되어 치조골의 내측으로 삽입 결합될 수 있도록 구성되어 있다.

[0046] 또한, 상기 픽스쳐(100)의 상부 중심에는 후술할 나사기둥(300)이 삽입되어 체결되는 제1암나사(122)가 형성되고, 상기 제1암나사(122)의 상부에는 후술할 어버트먼트(200)의 하부가 끼움 결합되는 테이퍼홈(132) 및 회전방지홈(134)이 어버트먼트(200)의 하부 형상과 대응되도록 형성된다.

[0047] 다음, 상기 어버트먼트(abutment)(200)는 픽스쳐(100)의 상부에 연결 설치되고, 그 상부에 인공치아(400)가 결합되는 것으로, 임플란트(1)의 연결 기둥 역할을 하는 것이다.

[0048] 이때, 상기 어버트먼트(200)는 픽스쳐(100)의 내측으로 삽입 결합되어 고정되는 하부 어버트먼트(210)와, 하부 어버트먼트(210)의 상부에 회전 가능하도록 끼움 결합되는 상부 어버트먼트(220)로 분리 구성되는데, 이는 어버트먼트(200)와 픽스쳐(100)의 결합을 용이하게 하면서도 어버트먼트(200)의 고정력을 향상시킬 수 있도록 하기 위한 것으로 이에 대해서는 후술하기로 한다.

[0049] 다음, 상기 나사기둥(300)은 어버트먼트(200)와 픽스쳐(100)의 내측으로 삽입되어 어버트먼트(200)와 픽스쳐(100)를 체결 고정시키는 역할을 하는 것으로, 나사기둥(300)의 외주면에는 수나사(310)가 형성되어 있다.

[0050] 보다 상세히 설명하면, 상기 상부 어버트먼트(220)의 중심부에는 측벽에 제2암나사(222a)가 형성된 체결공(222)이 형성되고, 상기 하부 어버트먼트(210)의 중심부에는 관통공(218)이 형성되며, 픽스쳐(100)의 중심부에는 측벽에 제1암나사(122)가 형성된 체결홈(120)이 형성되어 외주면에 수나사(310)가 형성된 나사기둥(300)이 상부 어버트먼트(220), 하부 어버트먼트(210) 및 픽스쳐(100)의 중심부를 통해 삽입 결합되어 상부 어버트먼트(220)에 형성된 제2암나사(222a) 및 픽스쳐(100)의 중심부에 형성된 제1암나사(122)에 체결 고정될 수 있도록 구성되어 있다.

[0051] 즉, 본 발명의 바람직한 실시예에 의하면, 픽스쳐(100)에 나사기둥(300)을 체결 고정시킨 후, 그 상부에 하부 어버트먼트(210) 및 상부 어버트먼트(220)를 순차적으로 결합시키는데, 먼저 치조골의 내측으로 삽입 결합된 픽스쳐(100)에 형성된 체결홈(120)의 내측으로 나사기둥(300)을 삽입시켜 체결홈(120)의 측벽에 형성된 제1암나사

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(122)에 체결 고정시킨다.

[0052] 다음, 하부 어버트먼트(210)를 나사기둥(300)에 끼워 넣음으로써 픽스쳐(100)에 결합시키는데, 하부 어버트먼트(210)에 형성된 관통공(218)을 통해 나사기둥(300)에 끼움 결합하여 하부 어버트먼트(210)의 하단부가 픽스쳐(100)의 상부에 삽입 결합되도록 한다.

[0053] 이때, 도시하지는 않았지만, 상기 하부 어버트먼트(210)의 중심부에 형성된 관통공(218)의 측벽에도 암나사를 형성하여 하부 어버트먼트(210)가 나사기둥(300)의 외주면에 나사 결합되도록 구성할 수도 있음은 물론이다.

[0054] 다음, 상부 어버트먼트(220)에 형성된 제2암나사(222a)를 이용하여 상부 어버트먼트(220)를 나사기둥(300)의 상단부에 체결 고정시키면 픽스쳐(100)와 어버트먼트(200)의 결합이 완료되는데, 상기와 같은 결합방식에 의해 픽스쳐(100)와 어버트먼트(200)의 결합을 보다 용이하고 정확하게 할 수 있을 뿐만 아니라, 나사기둥(300)에 의해 픽스쳐(100)와 어버트먼트(200)가 나사 결합되는 면적이 증가되므로 픽스쳐(100)와 어버트먼트(200) 사이의 결합력을 증가시킬 수 있게 된다.

[0055] 또한, 픽스쳐(100)와 어버트먼트(200)를 결합시키기 위한 나사기둥(300)을 별도로 구비하고, 나사기둥(300)에 나사 결합되는 부분을 픽스쳐(100)의 내측과 상부 어버트먼트(220)의 내측으로 분리 구성함으로써 음식물을 씹는 경우 등의 저작작용시 받는 하중을 분산시킬 수 있게 되어 나사기둥(300)의 파절 위험을 최소화 할 수 있을 뿐만 아니라, 나사기둥(300)의 파절시에도 파절된 나사기둥(300)을 용이하게 제거할 수 있게 된다.

[0056] 한편, 상기 나사기둥(300)의 외주면에 형성되는 수나사(310)는 도 6의 (b),(c)에 나타낸 바와 같이, 제1 및 제2 수나사(312,314)로 분리되도록 형성시킬 수도 있는데, 상기 제1수나사(312)는 나사기둥(300)의 하단부 외주면, 즉 픽스쳐(100)에 형성된 제1암나사(122)와 체결되는 부분에 형성되고, 제2수나사(314)는 나사기둥(300)의 상단부 외주면, 즉 상부 어버트먼트(220)에 형성된 제2암나사(222a)와 체결되는 부분에 형성된다.

[0057] 이때, 상기 제1암나사(122) 및 제1수나사(312)와, 제2암나사(222a) 및 제2수나사(314)는 서로 반대방향의 나사산을 갖도록 형성될 수 있는데, 이는 나사결합이 풀리는 것을 원천적으로 방지함으로써 픽스쳐(100)와 어버트먼트(200) 사이의 결합력을 유지시킬 수 있도록 하기 위함이다.

[0058] 보다 상세히 설명하면, 상기 제1암나사(122)와 제1수나사(312)를 오른나사로 형성할 경우 제2암나사(222a)와 제2수나사(314)를 왼나사로 형성하고, 제1암나사(122)와 제1수나사(312)를 왼나사로 형성할 경우 제2암나사(222a)와 제2수나사(314)를 오른나사로 형성함으로써, 픽스쳐(100)에 나사기둥(300)을 결합시키는 경우의 나사기둥(300)의 회전방향과, 나사기둥(300)에 상부 어버트먼트(220)를 결합시키는 경우의 상부 어버트먼트(220)의 회전방향이 서로 반대가 되도록 하는 것이다.

[0059] 이와 같은 결합방식은 나사기둥(300)이 일방향으로 회전하여 제1암나사(122)와 제1수나사(312) 사이의 결합부 또는 제2암나사(222a)와 제2수나사(314) 사이의 결합부가 풀리려 하는 경우, 상기와 반대방향으로의 회전에 의해 결합된 제2암나사(222a)와 제2수나사(314) 사이의 결합부 또는 제1암나사(122)와 제1수나사(312) 사이의 결합이 보다 강하게 이루어지게 되어 나사기둥(300)이 더 이상 회전하는 것을 방지함으로써 나사결합이 풀리는 것을 원천적으로 방지할 수 있게 되고, 그에 따라 픽스쳐(100)와 어버트먼트(200) 사이의 견고한 결합상태가 유지될 수 있게 되는 것이다.

[0060] 한편, 본 발명에 따른 치과용 임플란트(1)는 전술한 바와 같이 어버트먼트(200)를 상부 어버트먼트(220)와 하부 어버트먼트(210)로 분리 구성함으로써 상,하부 어버트먼트(220,210)의 높이, 기울기, 굵기 등의 형상을 다양하게 선택하여 조립할 수 있게 되는데, 그 일실시예로 도 5의 (a)에 나타낸 바와 같이, 상부 어버트먼트(220)의 하단에는 돌출부(224)가 형성되고, 하부 어버트먼트(210)의 상단에는 돌출부(224)의 형상에 대응되는 안착홈(212)이 형성되어 상부 어버트먼트(220)가 하부 어버트먼트(210)의 상부에 안정적으로 설치될 수 있도록 구성할 수 있다.

[0061] 이때, 상기 상부 어버트먼트(220)는 나사기둥(300)과의 체결 고정을 위해 하부 어버트먼트(210)에 회전 가능하도록 끼움 결합되는 것이므로 상기 돌출부(224) 및 안착홈(212)은 그 수평 단면이 원형을 이루도록 형성된다.

[0062] 다음, 도 5의 (b)에 나타낸 바와 같이, 상부 어버트먼트(220)가 하부 어버트먼트(210)의 상부에 단순히 안치되도록 하여 나사기둥(300)에 의해서만 결합되도록 구성할 수도 있고, 도 5의 (c)에 나타낸 바와 같이, 상부 어버트먼트(220)의 하단에 원통 형상의 연장부(226)를 돌출 형성시키고, 하부 어버트먼트(210)의 상단에 상기 연장부(226)가 삽입 결합되는 삽입홈(213)을 형성시킬 수도 있다.

[0063] 이때, 상기 연장부(226)의 내측에는 상부 어버트먼트(220)에 구비되는 제2암나사(222a)가 형성된 체결공(222)이

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연장 형성되어 나사기둥(300)에 나사결합되는 면적을 증가시킴으로써 나사기둥(300)에 의한 어버트먼트(200)와 픽스쳐(100) 사이의 결합력을 향상시킨 수 있도록 구성된다.

[0064] 다음, 상기 픽스쳐(100)에 끼움 결합되는 어버트먼트(200)의 하부 즉, 하부 어버트먼트(210)의 하단에는 테이퍼부(214)와 회전방지부(216)가 형성되는데, 상기 테이퍼부(214)는 하부로 갈수록 직경이 작아지는 원추형상으로 이루어진 것으로, 하부 어버드먼드(210)가 픽스쳐(100)의 상단부에 보다 안정적으로 설치될 수 있도록 하는 역할을 하는 것이다.

[0065] 즉, 상기 픽스쳐(100)의 상부에는 상기 테이퍼부(214)의 형상에 대응되도록 하는 원추형의 테이퍼홈(132)이 형성되어 하부 어버드먼드(210)가 픽스쳐(100)의 내측으로 삽입 결합되는 경우 하부 어버드먼드(210)와 픽스쳐(100) 사이의 접촉면적을 넓힘으로써 보다 안정적으로 설치되도록 하여 결합력을 향상시킬 수 있도록 하는 역할을 하게 된다.

[0066] 또한, 상기 회전방지부(216)는 테이퍼부(214)의 하부에 다각형의 형상을 갖도록 돌출 형성되는 것으로, 픽스쳐(100)의 테이퍼홈(132) 하부에는 상기 회전방지부(216)의 형상에 대응되는 다각형으로 이루어진 회전방지홈(134)이 형성되어 상기 회전방지부(216)가 회전방지홈(134)에 끼움 결합되는 경우 하부 어버드먼드(210)가 픽스쳐(100)의 상부에 끼움 결합된 상태에서 회전하는 것을 방지함으로써 픽스쳐(100)에 끼움 결합된 하부 어버트먼드(210)의 고정력을 향상시킬 수 있도록 하는 역할을 하게 된다.

[0067] 한편, 본 발명의 제2실시예에 따르면, 전술한 바와 같은 나사기둥(300)을 이용한 픽스쳐(100)와 어버트먼트(200)의 결합 방식은 어버트먼트(200)의 하단부가 픽스쳐(100)의 내측으로 삽입 결합되는 인터널 타입 임플란트(Internal type implant) 뿐만 아니라, 도 7에 나타낸 바와 같이 픽스쳐(100)의 상단부가 어버트먼트(200)의 하단부 내측으로 삽입 결합되는 익스터널 타입 임플란트(External type implant)에도 적용될 수 있다.

[0068] 즉, 상기 픽스쳐(100)의 상단부에 고정부(140)가 돌출 형성되고, 상기 어버트먼트(200) 즉, 하부 어버트먼트(210)의 하단부에는 상기 고정부(140)가 끼움 결합되는 결합홈(219)이 형성되어 픽스쳐(100)가 하부 어버트먼트(220)의 내측으로 삽입 결합되는 경우에도 나사기둥(300)을 이용한 결합구조를 적용할 수 있는 것이다.

[0069] 이때, 상기 픽스쳐(100)의 고정부(140) 및 하부 어버트먼트(210)에 형성된 결합홈(219)은 전술한 회전방지부(216) 및 회전방지홈(134)과 마찬가지로 다각형의 형상으로 이루어져 하부 어버트먼트(210)가 픽스쳐(100)의 상부에 끼움 결합된 상태에서 회전하는 것을 방지할 수 있도록 구성되어 있다.

[0070] 한편, 본 발명에 따른 치과용 임플란트(1)의 제3실시예에 의하년, 도 8에 나타낸 바와 같이, 상부 어버트먼트(220)와 하부 어버트먼트(210)의 외주면에 하나 이상의 시팅 그루브(seating groove)(250) 또는 시팅 릿지(seating ridge)(260)가 더 형성될 수 있는데, 상기 시팅 그루브(250) 및 시팅 릿지(260)는 상부 어버트먼트(220)와 하부 어버트먼트(210) 사이의 고정력을 강화시키는 역할을 하는 것이다.

[0071] 보다 상세히 설명하면, 전술한 바와 같은 과정에 의해 나사기둥(300)을 이용하여 상,하부 어버트먼트(220,210)와 픽스쳐(100)를 결합시킨 상태에서 상,하부 어버트먼트(220,210)의 외주면에 치과용 접착제(cement)를 이용하여 인공치아(보철물)(400)를 씌우게 되는데, 이때, 치과용 버(bur) 등을 이용하여 외주면에 시팅 그루브(250)를 형성시킨 상부 어버트먼트(220)와, 제조 과정에서 외주년에 시팅 릿지(260)를 일체로 형성시킨 하부 어버트먼트(210)를 사용하는 경우, 인상채득한 보철제작용 석고모델, 즉 인공치아(보철물)(400)의 내측면에 시팅 그루브(250)의 형상에 대응되는 돌출부(미도시)와, 시팅 릿지(260)의 형상에 대응되는 홈(미도시)이 형성된다.

[0072] 따라서, 시팅 그루브(250)가 형성된 상부 어버트먼트(220)와, 시팅 릿지(260)가 형성된 하부 어버트먼트(210)에 인공치아(400)를 부착시키면 인공치아(400)에 형성된 돌출부가 시팅 그루브(250)의 내측으로 삽입 결합되고, 하부 어버트먼트(210)에 형성된 시팅 릿지(260)가 인공치아(400)에 형성된 홈의 내측으로 삽입 결합되어 상부 어버트먼트(220)와 하부 어버트먼트(210)가 풀리지 않고 고정된 상태를 유지할 수 있게 되는 것이다.

[0073] 또한, 상기 시팅 그루브(250)와 시팅 릿지(260)는 상,하부 어버트먼트(220,210)와 인공치아(400) 사이의 접착면적을 증가시키므로 상,하부 어버트먼트(220,210)와 인공치아(400) 사이의 결합력을 증대시키는 역할도 하게 된다.

[0074] 이때, 상기 상부 어버트먼트(220)와 하부 어버트먼트(210)에 시팅 그루브(250) 또는 시팅 릿지(260)가 선택적으로 형성될 수도 있음은 물론이다. 즉, 상부 어버트먼트(220)에 시팅 릿지(260)가 형성되고, 하부 어버트먼트(210)에 시팅 그루브(250)가 형성되거나, 상,하부 어버트먼트(220,210) 모두에 시팅 그루브(250) 또는 시팅 릿지(260)가 형성될 수도 있는 것이다.

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[0075] 한편, 본 발명에 따른 치과용 임플란트(1')의 제4실시예에 의하면, 도 9에 나타낸 바와 같이, 나사기둥(300')을 제1 및 제2수나사(312',314')와, 제1 및 제2수나사(312',314')의 사이에 형성되는 포스트(316')로 구성할 수 있는데, 상기 제1수나사(312')는 전술한 실시예들과 마찬가지로 나사기둥(300')의 하단부에 형성되어 픽스쳐(100')의 체결홈(120')에 형성되는 제1암나사(122')에 체결되어 나사기둥(300')을 픽스쳐(100')에 고정시키는 역할을 하는 것이다.

[0076] 다음, 상기 제2수나사(314')는 나사기둥(300')의 상단부에 형성되는 것으로, 그 외주면에는 후술할 나사링(320')이 결합되어 상부 어버트먼트(220')의 내측에 삽입 결합된다.

[0077] 즉, 전술한 실시예들과는 다르게 나사기둥(300')이 상부 어버트먼트(220')와 직접 결합하는 것이 아니라, 내주면에 제2암나사(324')가 형성되고 외주면에는 제3수나사(326')가 형성된 중공 형상의 나사링(320')을 나사기둥(300')의 제2수나사(314')에 끼움 결합시킨 후 상부 어버트먼트(220')의 내측에 형성되는 제3암나사(226')가 형성된 제1체결홀(222')에 나사링(320')의 제3수나사(326')를 체결 고정시키는 것으로, 이와 같은 결합방식에 의해 전체적으로 나사기둥(300')과 상부 어버트먼트(220') 사이의 나사 결합 면적이 증가하게 되어 체결력이 강화되는 것이다.

[0078] 한편, 상기 나사기둥(300')의 제2수나사(314') 하부에 형성되는 포스트(316')의 외측에는 체결구(330')가 끼움 결합되는데, 상기 체결구(330')는 포스트(316')의 외주면에 끼움 결합되어 하부 어버트먼트(210')의 조임 작용에 의해 픽스쳐(100')의 체결홈(120')에 형성되는 제1암나사(122')에 체결되는 나사기둥(300')의 제1수나사(312')가 풀리는 방향으로 회전함으로써 하부 어버트먼트(210')가 흔들림 없이 고정될 수 있도록 하여 하부 어버트먼트(210')의 풀림 현상을 방지할 수 있도록 하는 역할을 하는 것이다.

[0079] 보다 상세히 설명하면, 상기 나사기둥(300')의 포스트(316')는 다각 형상으로 이루어지고, 상기 체결구(330')의 내측에는 포스트(316')의 단면 형상에 대응되는 다각 형상이 홀이 형성되어 포스트(316')의 외측으로 끼움 결합될 수 있도록 구성되어 있다.

[0080] 또한, 상기 체결구(330')는 나사결합부(332')와 회전방지부(334')로 구성되는데, 상기 나사결합부(332')는 체결구(330')의 상부에 형성되는 것으로, 그 외주면에는 제4수나사(338')가 형성되어 하부 어버트먼트(210')의 내측에 형성되는 제4암나사(218')에 나사 결합될 수 있도록 구성되어 있다.

[0081] 또한, 상기 회전방지부(334')는 전술한 실시예에서의 하부 어버트먼트(210)에 형성되는 회전방지부(216)와 동일한 역할을 하는 것으로, 픽스쳐(100')에 형성된 회전방지홈(134')에 끼움 결합된다.

[0082] 즉, 상기 회전방지부(334')는 사각, 육각 또는 팔각 등의 다각 형상으로 이루어져 회전방지부(334')와 동일한 형상을 이루도록 하여 픽스쳐(100')의 상단부에 형성된 회전방지홈(134')에 끼움 결합되어 체결구(330')가 픽스쳐(100')의 내측으로 삽입 결합된 경우 더 이상의 회전을 방지하여 체결구(330')와 픽스쳐(100') 사이의 풀림 현상을 방지하는 것이다.

[0083] 보다 상세히 설명하면, 상기 나사기둥(300')의 포스트(316') 및 체결구(330')의 내측에 형성되는 홀과, 픽스쳐(100')에 형성된 회전방지홈(134') 및 체결구(330')의 회전방지부(334')는 모두 다각 형상으로 이루어져 포스트(316')와 체결구(330') 사이의 결합부 및 픽스쳐(100')와 체결구(330') 사이의 결합부의 회동을 방지할 수 있도록 구성된 것에 특징이 있으나, 도 12의 (a)에 나타낸 바와 같이, 나사기둥(300')과 체결구(330') 및 픽스쳐(100')의 제조 과정에서의 공차 등에 의해 각 결합부가 밀착되지 않게 되어 결합 후 흔들림이 발생할 수 있고, 이와 같은 흔들림이 장기화되는 경우 결합부가 풀리게 되는 문제가 발생할 수 있다.

[0084] 따라서, 상기 나사기둥(300')의 포스트(316')에 체결구(330')을 끼움 결합시킨 상태에서 하부 어버트먼트(210')를 체결구(330')의 나사결합부(332') 외측으로 결합시킨 후, 하부 어버트먼트(210')를 회전시켜 조이면, 체결구(330')가 일방향으로 약간 회전하게 되어 다각 형상으로 이루어진 포스트(316')와 체결구(330') 사이의 결합부 및 픽스쳐(100')와 체결구(330') 사이의 결합부가 나사기둥(300')이 회전하려는 방향으로 밀착되어 제조 과정에서의 공차에 의해 발생될 수 있는 어긋남을 없앰으로써 픽스쳐(100')와 나사기둥(300') 및 체결구(330')가 보다 견고히 결합될 수 있다.

[0085] 이때, 상기 픽스쳐(100')와 나사기둥(300') 사이의 나사결합 방향, 즉 제1암나사(122')와 제1수나사(312')의 나사 방향과, 하부 어버트먼트(210')와 체결구(330') 사이의 나사결합 방향 즉, 제4암나사(218')와 제4수나사(338')의 나사 방향은 서로 반대가 되도록 하는 것이 바람직한데, 그 이유는 포스트(316')와 체결구(330') 사이

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의 결합부 및 픽스쳐(100')와 체결구(330') 사이의 결합부가 픽스쳐(100')와 나사기둥(300')의 결합이 풀리는 방향으로 밀착되도록 하기 위함이다.

[0086] 즉, 제1암나사(122')가 형성된 픽스쳐(100')의 체결홈(120')에 나사기둥(300')의 제1수나사(312')를 체결 고정시킨 상태에서 체결구(330')를 나사기둥(300')의 포스트(316') 외주면에 끼움 결합하여 회전방지부(334')가 픽스쳐(100')의 회전방지홈(134')의 내측에 삽입 결합되도록 한 후, 체결구(330')의 나사결합부(332')의 외측으로 하부 어버트먼트(210')를 결합시키게 되는데, 이때, 제1암나사(122') 및 제1수나사(312')와, 하부 어버트먼트(210')의 제4암나사(218') 및 나사결합부(332')의 제4수나사(338')가 반대 방향으로 형성된 경우에는 하부 어버트먼트(210')를 회전시켜 조이는 경우 도 12의 (b)에 나타낸 바와 같이, 체결구(330')가 픽스쳐(100')의 체결홈(120')에 삽입 결합된 나사기둥(300')의 제1수나사(312')가 풀리는 방향으로 회전하게 되어 포스트(316')와 체결구(330') 사이의 결합부 및 픽스쳐(100')의 회전방지홈(134')과 체결구(330')의 회동방지부(334') 사이의 결합부가 나사기둥(300')이 풀리려는 방향으로 틈새 없이 밀착되므로, 다각 형상의 결합부 형상으로 인해 픽스쳐(100')와 나사기둥(300') 사이의 나사 결합이 풀리지 않게 되는 것이다.

[0087] 한편, 본 실시예에서도 픽스쳐(100'), 어버트먼트(200') 및 나사기둥(300')의 나사 결합방향을 달리하여 나사기둥(300')의 결합이 풀리는 것을 원천적으로 방지할 수 있는데, 그 일실시예로 제1수나사(312')와 제1암나사(122')의 나사 결합 방향을 나머지 모든 나사 결합 방향과 반대로 할 수 있다.

[0088] 즉, 제1수나사(312')와 제1암나사(122')의 나사 결합 방향을 왼나사/또는 오른나사로 할 경우, 픽스쳐(100')에 형성된 나사산(110')의 결합 방향과 제2 내지 제4수나사(314',326',338')와 제2 내지 제4암나사(324',226',218')에 형성된 나사산의 결합 방향을 오른나사/또는 왼나사로 하여 나사 결합이 풀리는 것을 원천적으로 방지할 수 있는 것이다.

[0089] 현재 주로 사용되고 있는 임플란트의 나사 결합방향이 오른나사이므로 이하에서는, 제1수나사(312')와 제1암나사(122')의 나사 결합 방향이 왼나사이고, 나머지 부분들의 나사 결합 방향이 오른나사인 경우를 예를 들어 설명하기로 한다.

[0090] 먼저, 외주면에 나사산(110')이 형성된 픽스쳐(100')를 치조골에 오른 나사 방향으로 삽입 결합시킨다.

[0091] 그 후, 픽스쳐(100')의 체결홈(120')에 형성된 제1암나사(122')에 나사기둥(300')의 제1수나사(312')를 결합시키는데, 이때 상기 제1암나사(122')와 제1수나사(312')는 왼나사 방향으로 형성되어 나사기둥(300')을 왼쪽 방향으로 회전시켜 나사기둥(300')을 픽스쳐(100')의 내측으로 삽입 결합시킨다.

[0092] 다음, 나사결합부(332')와 회전방지부(334')로 이루어진 체결구(330')을 나사기둥(300')의 포스트(316') 외측으로 끼움 결합시킨다.

[0093] 다음, 상기 나사기둥(300')의 상부에 형성된 제2수나사(314')에 내주면에 제2암나사(324')가 형성된 나사링(320')을 오른나사 방향으로 회전 결합시킨다.

[0094] 그 후, 도 11의 (a)에 나타낸 바와 같이, 하부 어버트먼트(210')에 형성된 제2체결홈(212')을 통해 하부 어버트먼트(210')를 체결구(330')의 나사결합부(332') 외주면에 결합시키는데, 이때, 상기 제2체결홈(212')에 형성된 제4암나사(218')와, 체결구(330')의 외주면에 형성된 제4수나사(338')는 모두 오른나사 방향이므로 하부 어버트먼트(210')를 오른나사 방향으로 회전시켜 결합시킨다.

[0095] 즉, 도 11의 (b)에 나타낸 바와 같이, 하부 어버트먼트(210')를 나사링(320')의 상부로부터 끼움 결합시켜 오른나사 방향으로 지속적으로 회전시키면, 체결구(330')가 오른나사 방향, 즉 픽스쳐(100')의 체결홈(120')에 삽입 결합된 나사기둥(300')의 제1수나사(312')가 풀리는 방향으로 회전하게 되어 포스트(316')와 체결구(330') 사이의 결합부 및 픽스쳐(100')와 체결구(330') 사이의 결합부가 틈새 없이 밀착되므로, 다각 형상의 결합부 형상으로 인해 픽스쳐(100')와 나사기둥(300') 사이의 나사 결합이 풀리지 않게 된다.

[0096] 다음, 도 11의 (c)에 나타낸 바와 같이, 상기 상부 어버트먼트(220')의 제1체결홈(222')에 형성된 제3암나사(226')를 나사링(320')의 외주면에 형성된 제3수나사(326')에 결합시키는데, 이때 상기 제3암나사(226')와 제3수나사(326')는 모두 오른나사로 형성되므로, 상부 어버트먼트(220')를 오른나사 방향으로 회전시키면, 상부 어버트먼트(220')가 나사링(320')을 따라 회전하면서 하강하여 하부 어버트먼트(210')를 강하게 가압하게 되고, 상기와 같은 과정에 의해 본 발명에 따른 치과용 임플란트(1')의 설치가 완료된다.

[0097] 즉, 치과용 임플란트(1') 구조에 있어서 가장 문제가 되는 부분은 장기간 사용시 임플란트에 가해지는 충격에

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의해 나사결합이 풀리는 것이다.

[0098] 상기와 같이 구성된 본 발명의 경우, 픽스쳐(100')와 나사기둥(300')의 결합이 왼나사 방향으로 이루어져 있으므로, 나사기둥(300')의 결합이 풀리기 위해서는 오른나사 방향으로의 회전이 이루어져야 한다.

[0099] 하지만, 본 발명에서는 픽스쳐(100')와 나사기둥(300') 사이의 결합부를 제외한 부분의 나사 결합을 모두 오른나사 방향으로 형성하였으므로, 나사기둥(300')이 오른나사 방향으로 회전하는 경우, 상부 어버트먼트(220') 및 하부 어버드먼드(210')와 나사링(320') 및 체결구(330') 사이의 결합력이 더욱 견고해지므로 나사기둥(300')이 더 이상 회전하지 못하게 되므로, 나사기둥(300')의 회전에 의한 풀림현상을 원천적으로 방지할 수 있게 되는 것이다.

[0100] 이때, 별도로 도시하지는 않았지만, 상기 상부 어버드먼드(220')와 하부 어버드먼드(210')의 구조는 도 5의 (a),(b),(c)에 나타낸 바와 같은 전술한 실시예와 마찬가지로 다양한 형상으로 형성될 수 있고, 상,하부 어버트먼드(220',210')의 외주면에 시팅 그루브(250') 또는 시팅 릿지(260')가 형성될 수도 있음은 물론이다.

[0101] 한편, 본 발명에 따른 치과용 임플란트(1")의 제5실시예에 의하면, 도 13에 나타낸 바와 같이, 하부 어버트먼트(210")의 내측에 제1스텝링(340")이 삽입 설치되는 것에 특징이 있는 것으로, 상기 제1스텝링(340")은 픽스쳐(100")의 회전방지홈(134") 내측에 삽입 결합된 상태의 하부 어버트먼트(210")를 픽스쳐(100")의 내측에 삽입 결합된 나사기둥(300")이 풀리는 방향으로 미세하게 회전시킴으로써 나사기둥(300")의 풀림을 방지할 수 있도록 구성되어 있다.

[0102] 보다 상세히 설명하면, 상기 나사기둥(300")은 전술한 제4실시예와 마찬가지로 제1 및 제2수나사(312",314")와, 제1 및 제2수나사(312",314")의 사이에 형성되는 포스트(316")로 구성되는데, 상기 포스트(316")는 사각 또는 육각과 같은 다각 형상으로 이루어진다.

[0103] 또한, 상기 하부 어버트먼트(210")는 그 내측에 포스트(316")의 외주면에 끼움 결합되는 다각 형상의 관통공(218")이 형성되고, 관통공(218")의 상부에는 그 상단부에 톱니 형상의 제1스텝부(215")가 형성되며, 하부 어버트먼트(210")의 하단부에는 픽스쳐(100")의 상부 내측에 형성되는 다각 형상의 회전방지홈(134")에 삽입 결합되는 회전방지부(216")가 회전방지홈(134")과 동일한 형상으로 형성된다.

[0104] 이때, 상기 제1스텝부(215")의 톱니 형상은 픽스쳐(100")의 내측에 결합된 나사기둥(300")이 풀리는 방향을 향해 상향으로 경사지도록 형성된다.

[0105] 또한, 상기 제1스텝부(215")와 상부 어버트먼트(220")의 사이에는 제1스텝링(340")이 삽입 설치되는데, 상기 제1스텝링(340")의 내측에는 나사기둥(300")의 포스트(316") 형상에 대응되는 다각 형상의 홀이 형성되고, 제1스텝링(340")의 하단부에는 제1스텝부(215")의 톱니 형상과 동일한 형상을 갖는 제2스텝부(345")가 형성되어 있다.

[0106] 즉, 제1암나사(122")가 형성된 픽스쳐(100")의 체결홈(120")에 나사기둥(300")의 제1수나사(312")를 체결 고정시킨 상태에서 하부 어버트먼트(210")를 나사기둥(300")의 상부로부터 끼움 결합시키면, 하부 어버트먼트(210")의 회전방지부(216")가 픽스쳐(100")에 형성된 다각 형상의 회전방지홈(134")에 삽입 결합되고, 하부 어버트먼트(210")의 내측에 형성되는 다각 형상의 관통공(218")은 나사기둥(300")의 포스트(316")에 의해 지지되어 하부 어버트먼트(210") 및 나사기둥(300")의 회전이 제한되므로, 픽스쳐(100")에 삽입 결합된 나사기둥(300")의 풀림 현상을 방지할 수 있게 된다.

[0107] 하지만, 픽스쳐(100")와 하부 어버트먼트(210") 및 나사기둥(300")의 제조 과정에서의 공차 등에 의해 다각 형상으로 이루어진 각 결합부, 즉 픽스쳐(100")의 회전방지홈(134")과 하부 어버트먼트(210")의 회전방지부(216") 사이의 결합부 및 하부 어버트먼트(210")의 관통공(218")과 나사기둥(300")의 포스트(316") 사이의 결합부가 밀착되지 않게 되어 결합 후 흔들림이 발생할 수 있고, 이와 같은 흔들림이 장기화되는 경우 결합부가 풀리게 되는 문제가 발생할 수 있게 된다.

[0108] 따라서, 상기 포스트(316")의 외측으로 제1스텝링(340")을 삽입시켜 제1스텝링(340")이 하부 어버트먼트(210")의 내측, 즉 제1스텝부(215")의 상부에 위치되도록 한 후, 상부 어버트먼트(220")를 나사기둥(300")의 제2수나사(314")에 결합시키면, 상부 어버트먼트(220")가 하강하면서 제1스텝링(340")의 상단부를 가압하게 되고, 그에 따라 제1스텝링(340")이 하강하게 된다.

[0109] 이때, 상기 제1스텝링(340")의 하단부에 형성된 제2스텝부(345")가 하부 어버트먼트(210")에 형성된 제1스텝부(215")와 만나게 되어 톱니의 경사 방향을 따라 제1스텝링(340")은 픽스쳐(100")와 나사기둥(300") 사이의 결합 방향(도 14를 기준으로 하였을 때 시계방향)으로 회전하게 되고, 제1스텝부(215")가 일체로 형성된 하부 어버트먼트(210")는 픽스쳐(100")와 나사기둥(300") 사이의 결합이 풀리는 방향(도 14를 기준으로 하였을 때 반시계방향)으로 회전하게 된다.

[0110] 이와 같은, 하부 어버트먼트(210')의 회전에 의해 픽스쳐(100")의 회전방지홈(134")과 하부 어버트먼트(210")의 회전방지부(216") 사이의 결합부 및 하부 어버트먼트(210")의 관통공(218")과 나사기둥(300")의 포스트(316") 사이의 결합부는 최소한의 틈새도 존재하지 않도록 완벽하게 밀착되어 각 결합부에서의 결합력이 극대화되고, 각 결합부가 형성하는 다각 형상의 모양으로 인해 나사기둥(300")은 픽스쳐(100")와의 결합이 풀리는 방향으로 회전할 수 없게 되므로, 장기간의 사용에도 나사 결합이 풀리는 현상이 발생되지 않는 치과용 임플란트(1")를 구성할 수 있게 되는 것이다.

[0111] 한편, 본 실시예에서도 상,하부 어버트먼트(220",210")의 외주면에 시팅 브리지(250") 또는 시팅 릿지(260")가 형성될 수 있는 등 나머지 구성요소들은 전술한 실시예들과 동일하므로 이에 대한 상세한 설명을 생략하기로 한다.

[0112] 다음, 도 15는 본 발명에 따른 치과용 임플란트(1')의 제6실시예를 나타낸 것으로, 전술한 제4실시예와 제5실시예의 특징적인 구성을 조합한 것이다.

[0113] 보다 상세히 설명하면, 상기 제6실시예는 다각 형상으로 이루어지는 포스트(316')의 외주면에 끼움 결합되는 체결구(330')의 상단에 픽스쳐(100')의 내측에 결합된 나사기둥(300')이 풀리는 방향을 향해 상향으로 경사진 톱니 형상을 갖는 제1스텝부(335')를 형성하고, 상기 제1스텝부(335')의 상부 즉, 체결구(330')와 나사링(320')의 사이에는 그 하단부에 제1스텝부(335')의 톱니 형상과 동일한 형상의 제2스텝부(345')가 형성된 제1스텝링(340')을 삽입 설치한 것에 특징이 있는 것이다.

[0114] 따라서, 임플란트(1')의 결합과정에서 상부 어버트먼트(220')를 나사기둥(300')의 제2수나사(314')에 결합시키는 경우, 상부 어버트먼트(220')의 회전에 의해 나사링(320')이 하강하게 되어 그 하부에 설치된 제1스텝링(340')을 가압하게 되고, 그에 따라 제2스텝부(345')가 체결구(330')에 형성된 제1스텝부(335')를 따라 미끄러지면서 체결구(330')를 픽스쳐(100')와 나사기둥(300') 사이의 결합이 풀리는 방향으로 회전시키게 되므로, 포스트(316')와 체결구(330') 사이의 결합부 및 픽스쳐(100')와 체결구(330') 사이의 결합부가 나사기둥(300')이 풀리려는 방향으로 틈새 없이 밀착될 수 있게 되고, 다각 형상의 결합부 형상으로 인해 픽스쳐(100')와 나사기둥(300') 사이의 나사 결합이 풀리지 않게 되는 것이다.

[0115] 한편, 상기와 같은 스텝링의 개념은 상부 어버트먼트(220")와 하부 어버트먼트(210") 사이의 결합에서도 적용될 수 있는데, 보다 상세히 설명하면, 도 16에 나타낸 바와 같이, 하부 어버트먼트(210")의 상단부에 픽스쳐(100")의 내측에 결합된 나사기둥(300")이 풀리는 방향을 향해 상향으로 경사진 경사면(217"a)을 포함하는 계단 형상의 제3스텝부(217")를 형성시키고, 상부 어버트먼트(220")와 하부 어버트먼트(210")의 사이에는 그 하단부에 제3스텝부(217")와 동일한 형상의 제4스텝부(355")가 형성된 제2스텝링(350")을 삽입 결합시킬 수 있다.

[0116] 즉, 전술한 제5실시예에서와 마찬가지로 픽스쳐(100")와 나사기둥(300") 및 하부 어버트먼트(210")를 차례대로 결합시킨 상태에서, 하부 어버트먼트(210")의 상부에 제2스텝링(350")을 위치시킨 후, 제2스텝링(350")의 상부로부터 상부 어버트먼트(220")를 결합시키면, 상부 어버트먼트(220")의 가압에 의해 제2스텝링(350")이 하강하게 되고, 제2스텝링(350")의 하단부에 형성된 제4스텝부(355")가 하부 어버트먼트(210")의 상단부에 형성된 제3스텝부(217")를 따라 미끄러지면서 하부 어버트먼트(210")를 픽스쳐(100")에 결합된 나사기둥(300")이 풀리려는 방향으로 회전시키게 되므로, 다각 형상으로 이루어진 픽스쳐(100")와 하부 어버트먼트(210") 사이의 결합부가 나사기둥(300")이 풀리려는 방향으로 틈새없이 밀착되어 나사기둥(300")이 풀리려는 방향으로 회전하는 것을 방지할 수 있게 되는 것이다.

[0117] 따라서, 전술한 바와 같은 본 발명에 따른 치과용 임플란트(1,1',1")에 의하면 픽스쳐(100,100',100")와 어버트먼트(200,200',200")의 결합을 위해 별도의 나사기둥(300,300',300")을 사용하여 픽스쳐(100,100',100")와 어버트먼트(200,200',200")가 나사 결합되는 면적을 증가시킴으로써 픽스쳐(100,100',100")와 어버트먼트

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(200,200',200") 사이의 결합력을 증가시키고, 나사결합되는 부분에 전체적으로 하중이 분산되어 전달되므로 응력집중에 의한 나사기둥(300,300',300")의 파절 위험을 최소화할 수 있으며, 나사기둥(300,300',300")의 파절시에도 파절된 나사기둥(300,300',300")을 용이하게 제거할 수 있을 뿐만 아니라, 픽스쳐(100,100',100")에 나사기둥(300,300',300")을 결합시킨 후 그 상부에 어버트먼트(200,200',200")를 체결 고정시킬 수 있도록 하여 픽스쳐(100,100',100")와 어버트먼트(200,200',200")의 결합을 보다 용이하고 정확하게 할 수 있고, 다양한 방법에 의해 나사기둥(300,300',300")이 풀리는 것을 다중으로 방지할 수 있도록 함으로써 임플란트(1,1',1")의 제조 과정에서 발생되는 공차에도 불구하고 흔들림 없이 견고한 고정 상태를 유지할 수 있도록 할 뿐만 아니라, 장기적인 사용에도 나사의 풀림현상을 원천적으로 방지할 수 있는 등의 다양한 장점을 갖는 것이다.

[0118] 전술한 실시예들은 본 발명의 가장 바람직한 예에 대하여 설명한 것이지만, 상기 실시예에만 한정되는 것은 아니며, 픽스쳐(100,100')와 어버트먼트(200,200')를 견고히 결합시키는 역할을 하는 나사기둥(300,300')의 형상을 다양하게 변형시킬 수 있는 등 본 발명의 기술적 사상을 벗어나지 않는 범위 내에서 다양한 변형이 가능하다는 것은 당업자에게 있어서 명백한 것이다.

산업상 이용가능성

[0119] 본 발명은 치과용 임플란트에 관한 것으로, 보다 상세하게는 별도의 나사기둥을 이용하여 픽스쳐와 어버트먼트를 결합시킴으로써 임플란트 나사결합부의 파절을 방지함과 동시에 접촉면 전체에 골고루 힘이 전달되도록 하여 응력이 부분적으로 집중되는 현상을 방지할 수 있고, 픽스쳐와 어버트먼트 사이의 나사결합 방향을 달리하여 픽스쳐와 어버트먼트 사이의 결합력을 향상시키고, 나사의 풀림을 원천적으로 방지할 수 있는 치과용 임플란트에 관한 것이다.

부호의 설명

[0120]

1,1',1" : 치과용 임플란트	100,100',100" : 픽스쳐
110,110' : 나사산	120,120',120" : 체결홈
122,122',122" : 제1암나사	132 : 테이퍼홈
134,134',134" : 회전방지홈	140 : 고정부
200,200',200" : 어버트먼트	210,210',220" : 하부 어버트먼트
212 : 안착홈	212' : 제2체결홀
213 : 삽입홈	214 : 테이퍼부
215",335' : 제1스텝부	216,216",334' : 회전방지부
218,218" : 관통공	217" : 제3스텝부
217"a : 경사면	218' : 제4암나사
219 : 결합홈	220,220',220" : 상부 어버트먼트
222 : 체결공	222a : 제2암나사
222' : 제1체결홀	224 :돌출부
226 : 연장부	226' : 제3암나사
250,250',250" : 시팅 그루브	260,260',260" : 시팅 릿지
300,300',300" : 나사기둥	310 : 수나사
312,312',312" : 제1수나사	314,314',314" : 제2수나사

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316',316" : 포스트 320' : 나사링

324' : 제2암나사 326' : 제3수나사

330' : 체결구 332' : 나사결합부

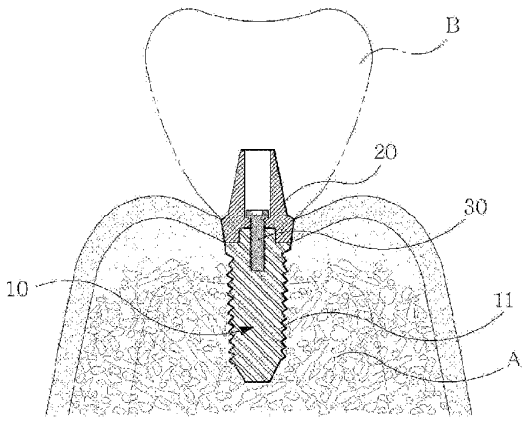
338' : 제4수나사 340',340" : 제1스텝링

345',345" : 제2스텝부 350" : 제2스텝링

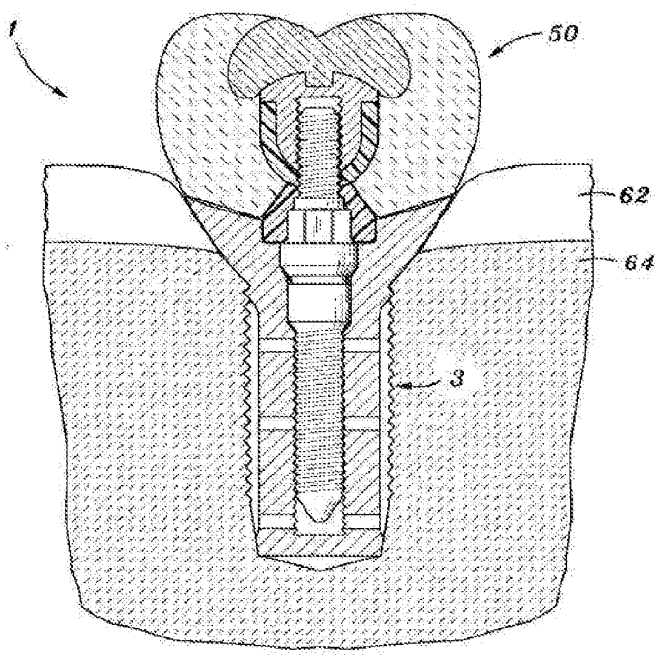
355" : 제4스텝부 400 : 인공치아

도면

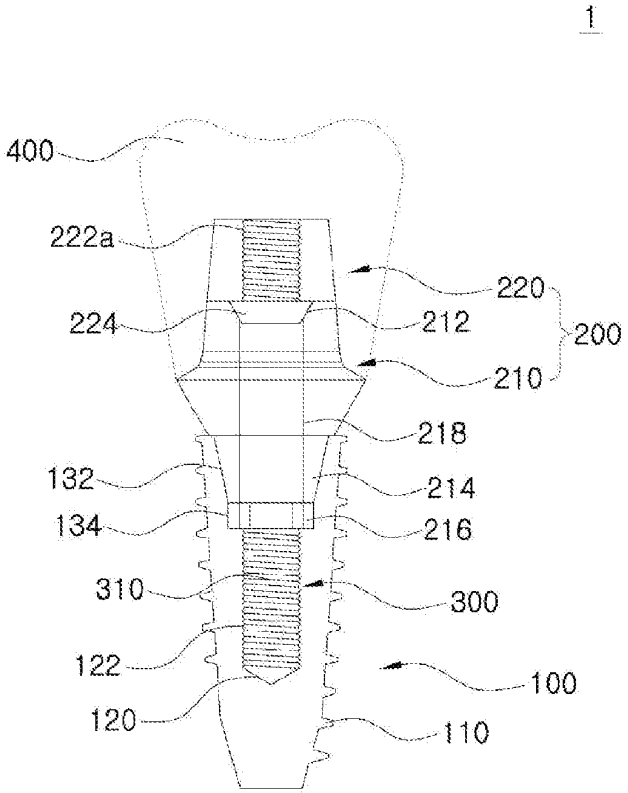
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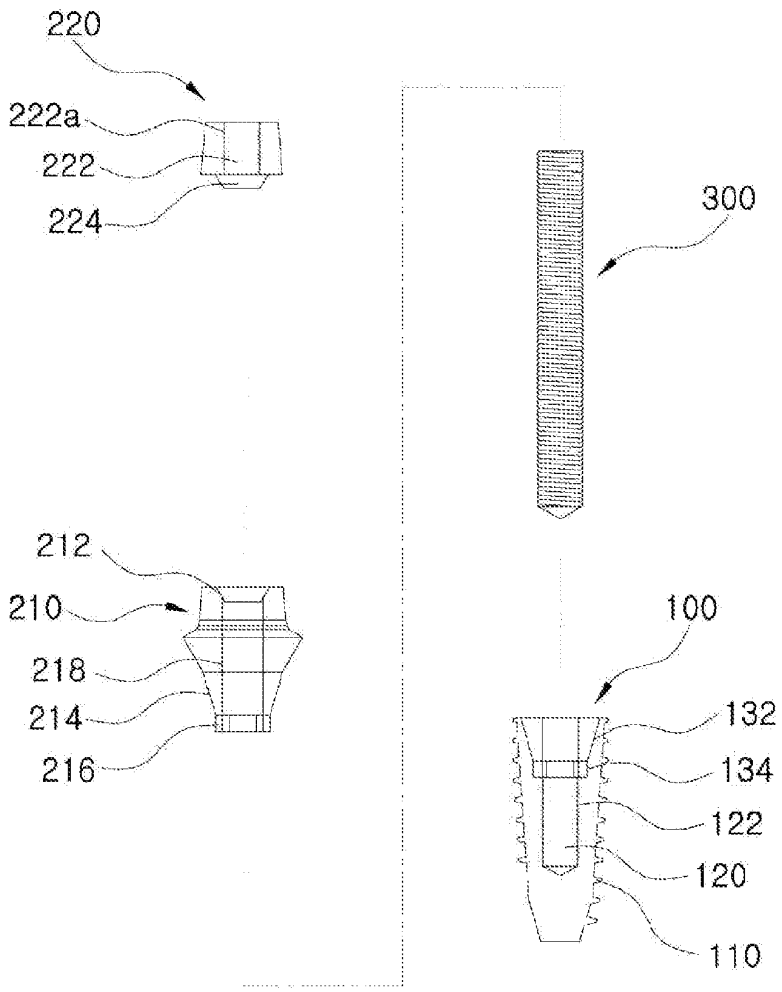
도면2



도면3


1
400
222a
220
224
212
200
210
218
132
214
134
216
310
300
122
100
120
110

도면4

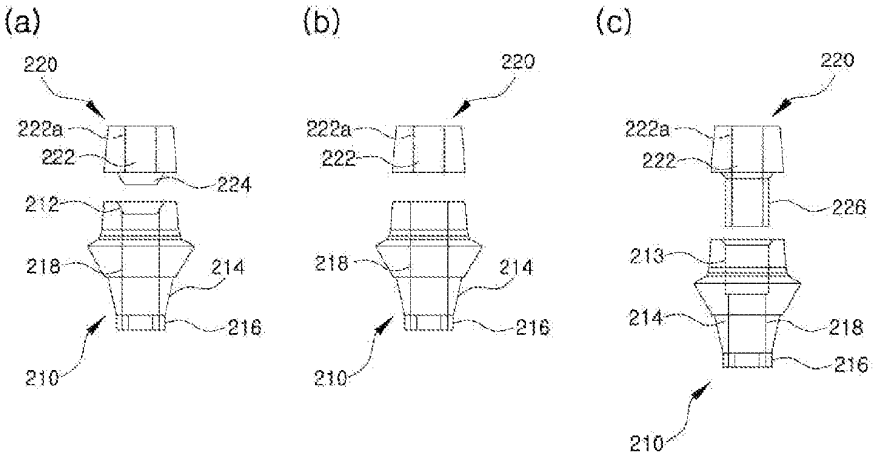


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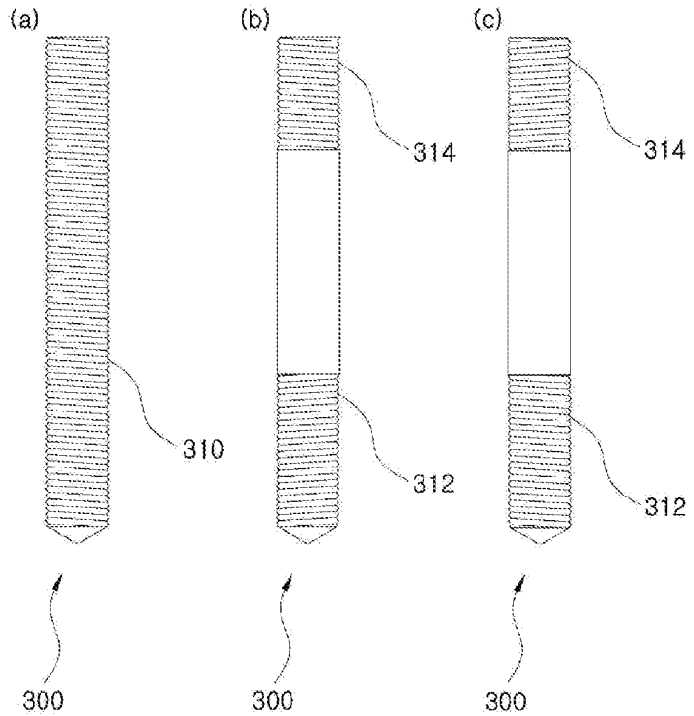
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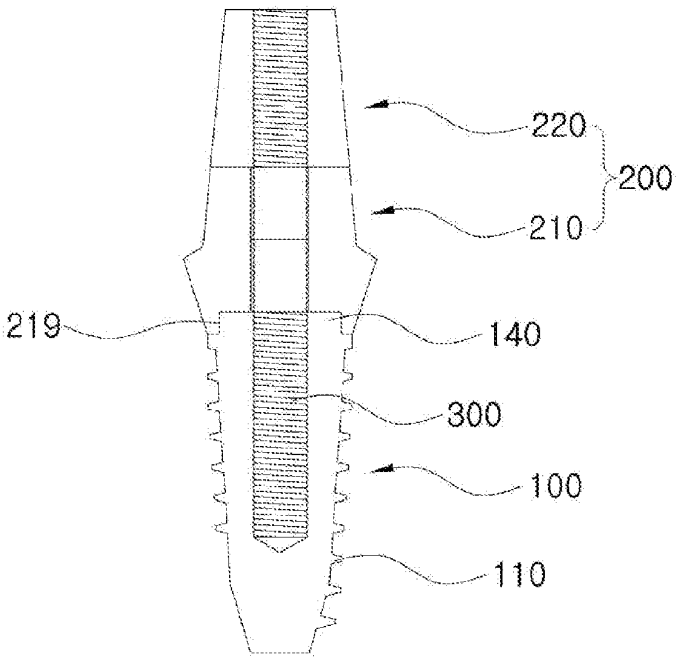
도면5


(a)
(b)
(c)
220
222a
222
224
212
218
214
216
210
226
213

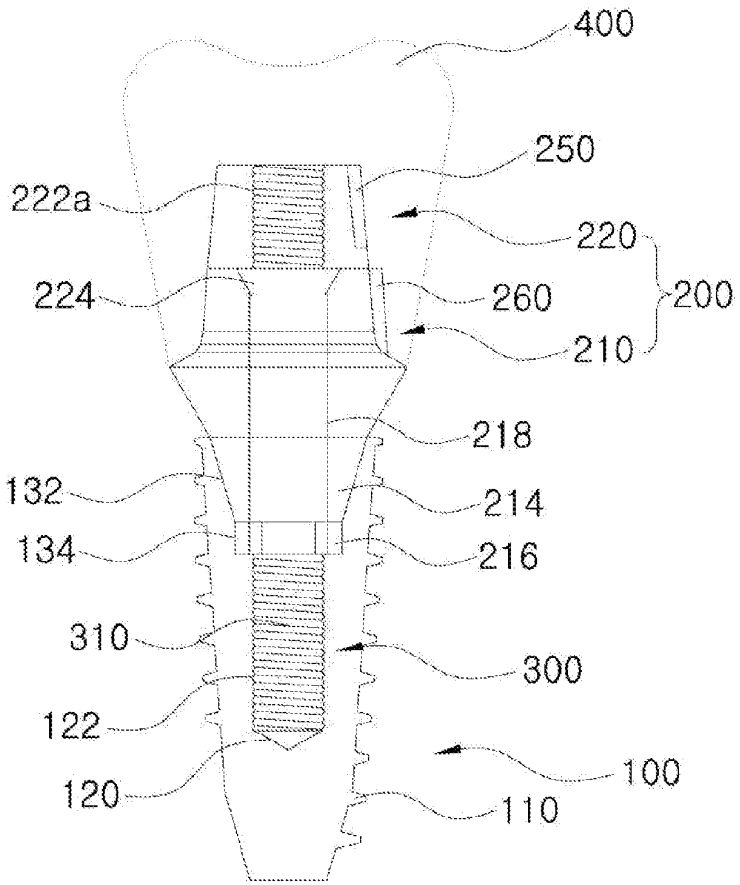
도면6


(a)
(b)
(c)
310
314
312
300

도면7

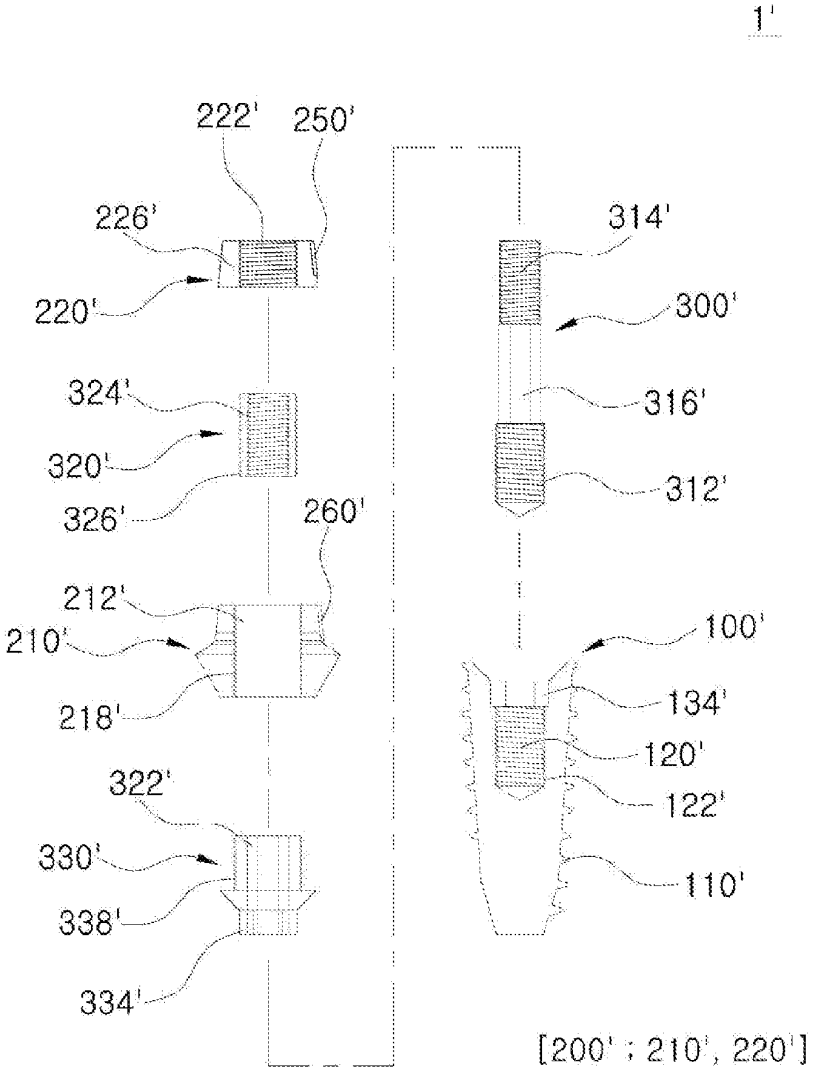


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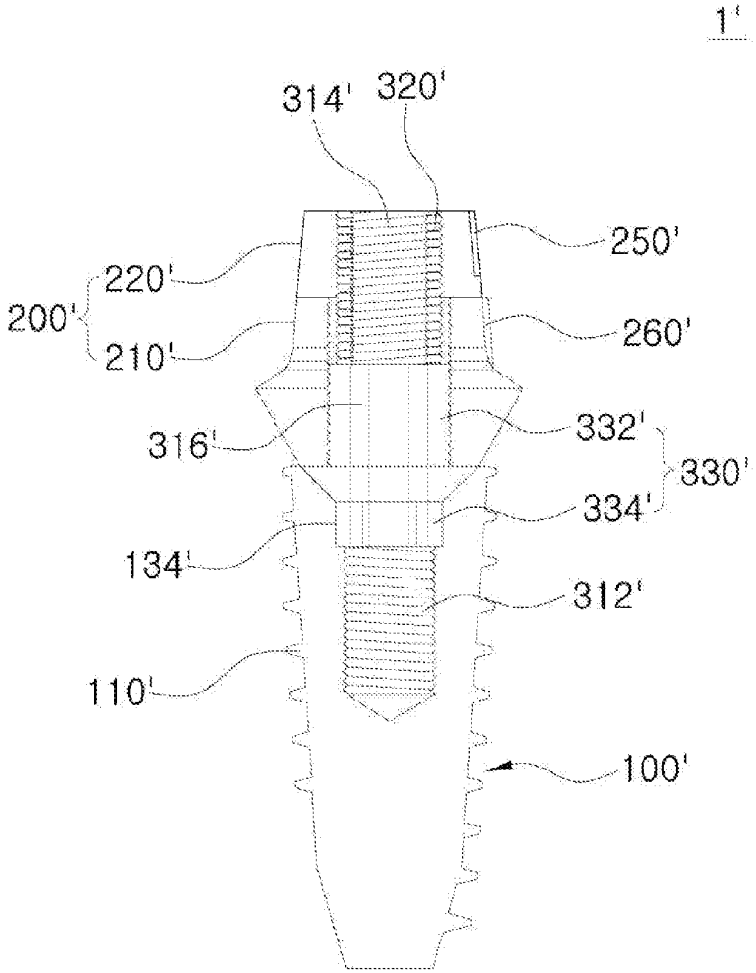


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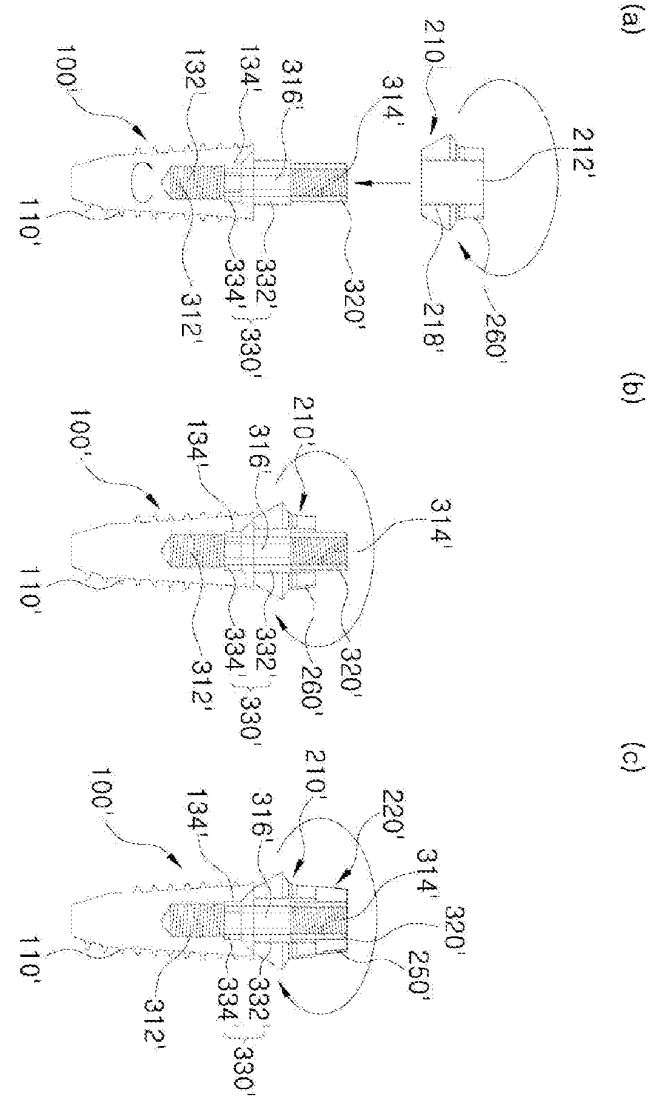
도면9


1'
222'
250'
226'
220'
324'
320'
326'
260'
212'
210'
218'
322'
330'
338'
334'
314'
300'
316'
312'
100'
134'
120'
122'
110'
[200' ; 210', 220']

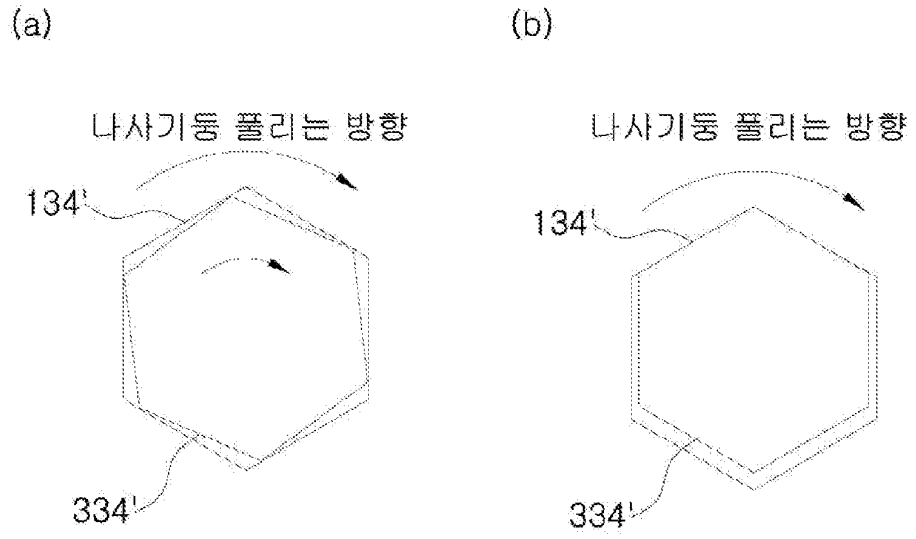
도면10



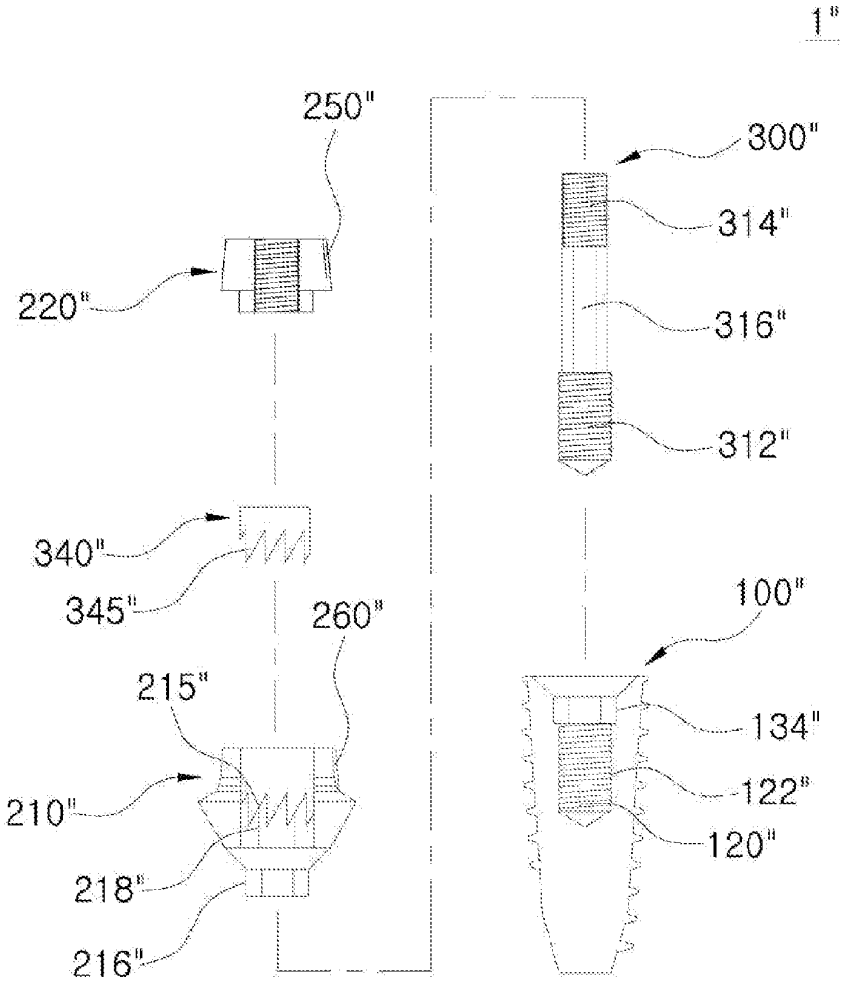
도면11


(a)
(b)
(c)
100'
110'
132'
134'
210'
212'
218'
220'
250'
260'
312'
314'
316'
320'
330'
332'
334'

도면12

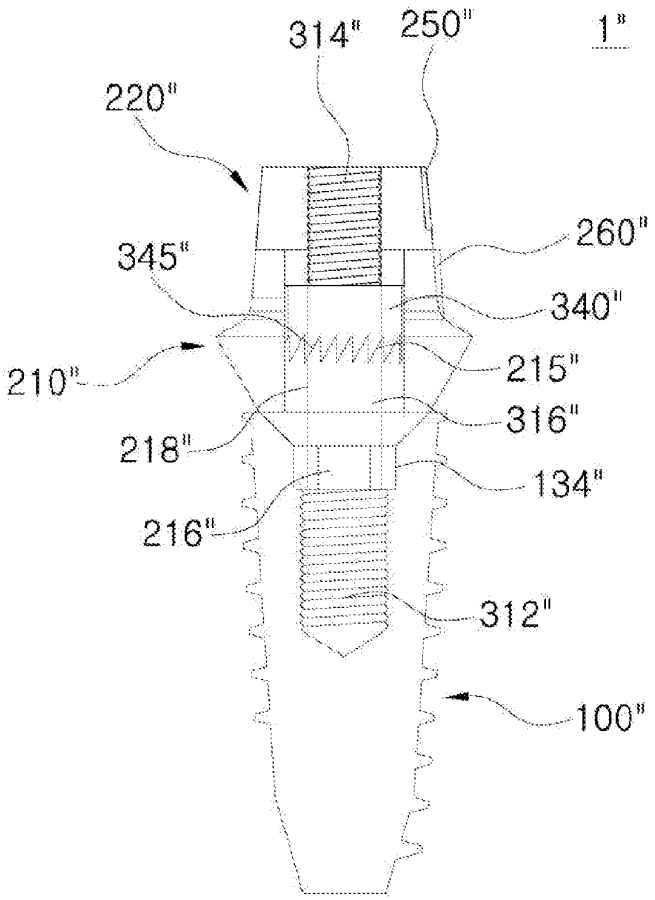


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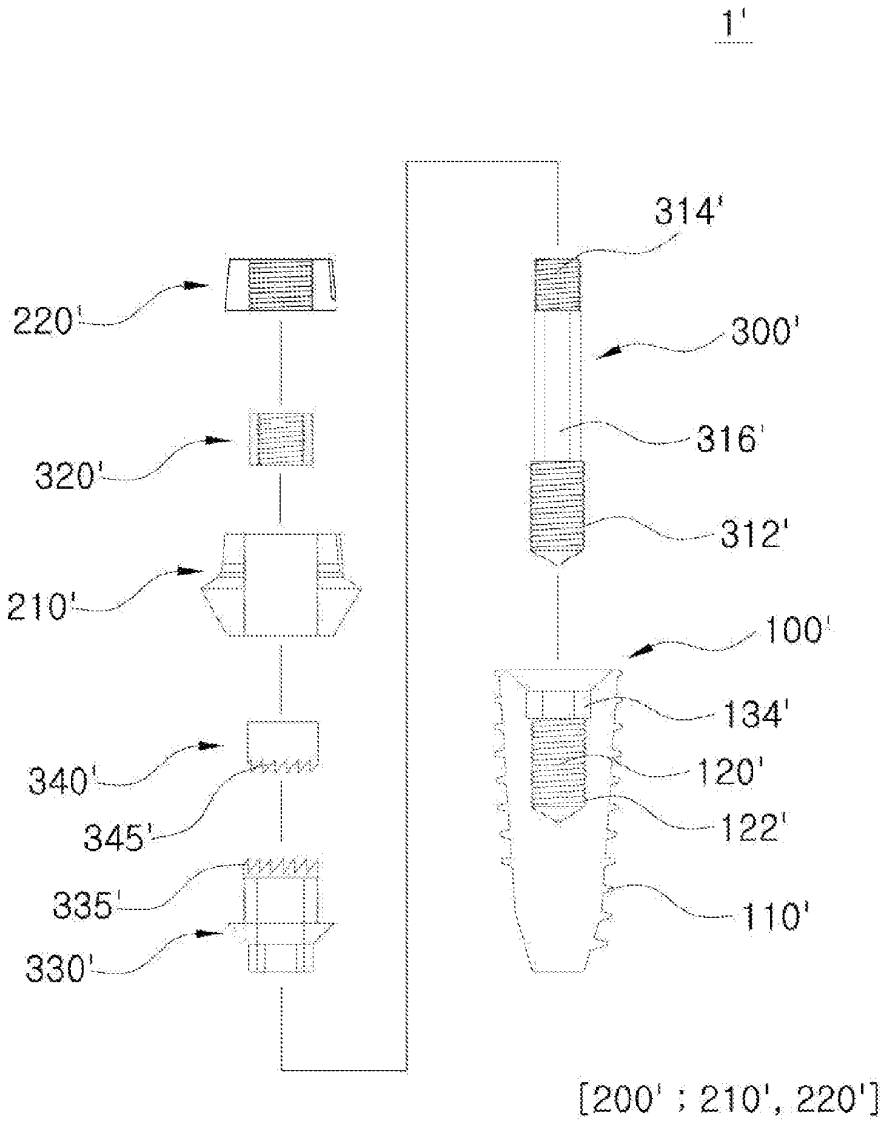


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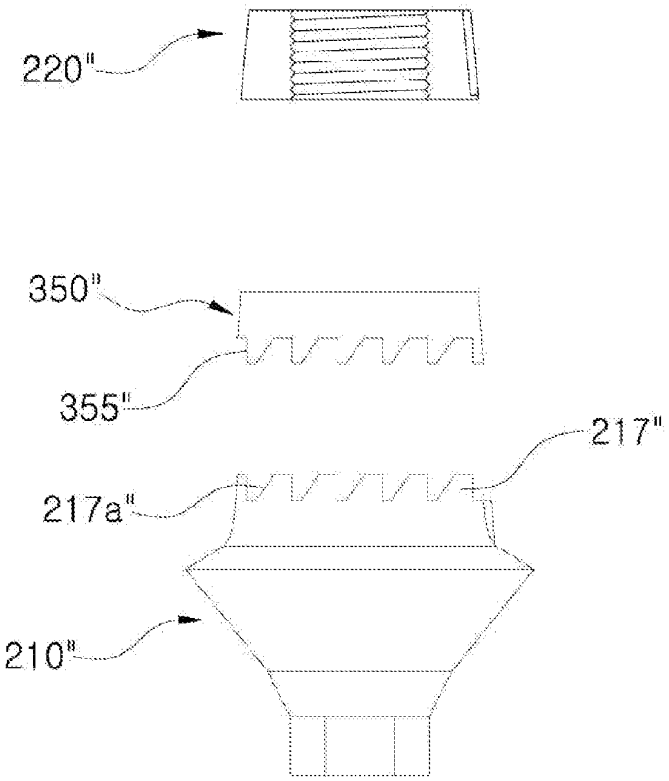
도면14



도면15


1'
314'
220'
300'
316'
320'
312'
210'
100'
134'
340'
120'
345'
122'
335'
110'
330'
[200' ; 210', 220']

도면16



Espacenet

KR20140080313A DENTAL IMPLANT

Applicants: DENTOZ CO LTD [KR]

Inventors: CHOI HO JUN [KR]

Classifications:
IPC ***A61C13/263; A61C8/00;***

CPC **A61C8/0059 (KR); A61C8/006 (KR); A61C8/0062 (KR); A61C8/0068 (KR);**

Priorities: KR20120149984A 2012-12-20

Application: KR20120149984A·2012-12-20

Publication: KR20140080313A·2014-06-30

Published as: **KR101509643B1**; KR20140080313A

DENTAL IMPLANT

Abstract

The present invention relates to a dental implant capable of preventing the fracture of an implant screw binding part by binding a fixture and an abutment using an additional screw support, while preventing stress from being concentrated partially through controlling power to be evenly delivered at a contact surface, improving binding force between the fixture and the abutment by differing screwed directions of the fixture and the abutment, and fundamentally preventing the release of a screw. The present invention relates to the dental implant including the fixture and the abutment, wherein the abutment is divided into a lower abutment inserted into the fixture and an upper abutment connected to the upper part of the lower abutment, and the upper abutment and the fixture are fixed by the screw support.

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DESCRIPTION KR20140080313A

11 Dental implant {Dental implant}

[0001]

15 The present invention relates to a dental implant, and more particularly, by combining a fixture and an abutment using a separate screw column, the fracture of the implant screw coupling part is prevented and the force is uniformly transmitted to the entire contact surface so that the stress is reduced. For dental implants that can prevent partial concentration, improve the bonding force between the fixture and the abutment by changing the screwing direction between the fixture and the abutment, and prevent loosening of the screw. it's about

[0002]

25 In general, an implant means an artificial substitute configured to reproduce the same shape and function as a natural tooth, and the configuration is as shown in FIG. A fixture (10) made of titanium imitating the root shape of natural teeth to be installed in A), and an abutment (abutment) 20 and a fixing screw 30 for fixing the fixture 10 and the abutment 20 to each other.

[0003]

33 That is, in the conventional general implant structure, the abutment 20 is positioned on the upper portion of the fixture 10 having a screw hole formed therein, and then the fixing screw is inserted into the screw hole of the fixture 10 through the abutment 20 . The fixture 10 and the abutment 20 are configured to be fixedly coupled to each other by the rotation of the fixing screw 30 by inserting and coupling the 30 .

[0004]

41 However, in the above configuration, the head portion of the fixing screw 30 is inserted into the abutment 20 to be supported by the coupling portion of the fixture 10 and the abutment 20, so that the fixing screw 30 is inserted into the abutment 20. The length of 30 is short, so the bonding force between the fixture 10 and the abutment 20 is weak, and the load received during mastication, such as when chewing food, is concentrated on the narrow surface area of the fixing screw 30, and the fixture (10) There is a problem in that the fixing screw 30 may be fractured or loosened at the coupling portion of the abutment 20 and the abutment 20 .

[0005]

52 As a prior art for solving this problem, US Patent Publication No. US2003/0224328 discloses a dental implant 1 having a biological function, its main technical configuration is as shown in FIG. 2 , the gingival bone in the patient's mouth. In the dental implant 1 having a biological function for attaching the crown 50 to the 64, the gum line 62 (the tooth and the root part 3 planted below the line formed by meeting the gums), means for fixing the root part 3 to the inside of the socket formed in the patient's gingival bone 64, and the crown part 50 and a flexible abutment post 18 for connecting the crown part 50 to the root part 3, wherein the flexible abutment post 18 is the crown part 50 It is characterized in that it is formed so as to be able to be bent in order to be movable with respect to the root part 3 fixed inside the socket formed in the gingival bone 64 of the patient.

[0006]

66 The configuration is characterized in that it is configured to provide a supply passage for distributing human growth factors to the bone structure surrounding the root part, but the configuration is complicated, and the crown 50 and the root part 3) is weak, and there is a problem that there is a risk that the screw coupling of the crown part 50 and the root part 3 by the abutment post 18 is loosened.

[0007]

74 However, in the above configuration, since the screw part 5 is integrally formed with the upper mounting table 2, there is still a risk that the upper mounting table 2 on which the screw part 5 is formed is broken, and the upper mounting table 2 is broken. In this case, there is a disadvantage in that it is difficult to remove the fractured screw portion 5 .

[0008]

82 In addition, since the screw portion 5 is screwed only on the inside of the artificial tooth fixture 11, the surface area of the screwed portion is small, and the coupling force between the artificial tooth fixture 11 and the upper installation table 2 and the lower installation table 6 T his weak, there is a problem that there is a risk that the screw connection is loosened.

[0009]

90 In addition, since the conventional configuration is a structure in which the crown part 50 is connected to the root part 3 as a whole without the surface in which the abutment is in contact with the gum part, it can be applied only when the gum bone is perfectly present, T here is also a problem in that a lot of plaque and tartar are deposited in the vicinity of the line 62 .

[]

98 T he present invention has been devised to solve the problems of the prior art as described above, and an object of the present invention is to reduce the area in which the fixture and the abutment are screwed by using a separate screw column for coupling the fixture and the abutment. By increasing the bond strength between the fixture and the abutment, it is possible to minimize the risk of fracture of the screw pillar, and to provide a dental implant that can easily remove the fractured screw pillar even when the screw pillar is broken. have. In addition, the present invention provides a dental implant capable of more easily and accurately coupling the fixture and the abutment by first coupling the screw column to the fixture and then fixing the abutment on the upper part. T here is a purpose. In addition, the present invention provides a dental implant that can be assembled by selecting various shapes such as height, inclination, thickness, etc. of the upper and lower abutments by separating the abutment into an upper abutment and a lower abutment. T here is another purpose to provide. In addition, the present invention is configured by separating the screw coupling portion in two places between the upper abutment and the screw pillar and between the fixture and the screw pillar using a screw column, and at the same time the direction of coupling of the screwed portion configured separately is opposite to each other A nother object of the present invention is to provide a dental implant capable of improving the bonding force between the fixture and the abutment and fundamentally preventing the loosening of the screw. In addition, the present invention improves the coupling force between the upper and lower abutments and the coupling force between the upper and lower abutments and the fixture by inserting and coupling the screw ring and the fastener between the screw column and the upper and lower abutments. It is another object to provide a dental implant that can. In

addition, the present invention is for dentistry to maximize the effect of preventing loosening of the screw column by reversing the implantation direction of the fixture, the coupling direction between the screw column and the upper and lower abutments, and the coupling direction between the screw column and the fixture. Another object is to provide an implant. In addition, the present invention inserts and installs a step ring inside the lower abutment or between the upper abutment and the lower abutment so that the lower abutment is in close contact with the post of the screw column having a polygonal shape. Another object of the present invention is to provide a dental implant capable of maintaining a solid fixation state without shaking despite the tolerance generated during the process.

132 In addition, the present invention forms a seating groove or a seating ridge on the outer peripheral surfaces of the upper abutment and the lower abutment, respectively, so that protrusions and grooves corresponding to the shapes of the seating groove and the seating ridge are formed on the inner surface of the artificial tooth. Another object of the present invention is to provide a dental implant capable of fixing the abutment and the lower abutment.

138 The present invention for achieving the above objects, In the dental implant comprising a fixture and an abutment, the abutment is a lower abutment fitted to the fixture, and the lower abutment It is composed of an upper abutment that is connected to and installed on the upper part, and the upper abutment and the fixture are fastened and fixed by a screw column. At this time, the fixture and the upper abutment are respectively formed with first and second female screws to which the screw posts are coupled, and the first and second male screws are formed on the screw posts at positions corresponding to the first and second female screws. characterized. In addition, the first female screw, the first male screw, and the second female screw and the second male screw are formed to have threads in opposite directions to each other. And, a protrusion is formed at a lower end of the upper abutment, and a seating groove into which the protrusion is fitted is formed at an upper end of the lower abutment. In addition, an extension portion having a second female screw is formed protruding from the lower end of the upper abutment, and an insertion groove into which the extension portion is inserted and coupled is formed at the upper end of the lower abutment. In addition, a coupling groove is formed in the lower portion of the lower abutment, and a fixing part to be fitted into the coupling groove is protruded from the upper end of the fixture. And, a seating groove is formed on the outer peripheral surface of the upper abutment, and a seating ridge is formed on the outer peripheral surface of the lower abutment. On the other hand, the screw column is characterized in that it is composed of first and second male screws formed at the lower end and upper end, respectively, and a post having a polygonal shape formed between the first and second male screws. At this time, the second male screw is formed on the outer circumferential surface of the screw column, the second female screw is formed on the inner circumferential surface, the screw ring having the third male screw is formed on the outer

circumferential surface is coupled, and the third female screw to which the third male screw is fastened is coupled to the upper abutment. It is characterized in that the formed first fastening hole is formed. In addition, the post of the screw pillar is fitted with a fastener having a fourth male screw formed on an outer circumferential surface, and a second fastening hole having a fourth female screw to which the fourth male screw is fastened is formed in the lower abutment.

170 And, the lower end of the fastener is formed with a rotation preventing portion made of a polygonal shape, it is characterized in that the upper portion of the fixture is formed with a rotation preventing groove to which the rotation preventing portion is fitted. In addition, at the upper end of the fastener, a first step portion of a sawtooth shape inclined upward in the direction in which the screw column coupled to the inside of the fixture is unwound is formed, and between the screw ring and the fastener, the lower end corresponds to the first step portion It is characterized in that the first step ring formed with the second step portion of the shape to be installed. In addition, the screw direction of the first female screw and the first male screw is characterized in that formed in the opposite direction to the screw thread formed in the fixture, the second to fourth female screw and the second to fourth male screw. And, on the inside of the lower abutment, a first step portion having a sawtooth shape inclined upward in the direction in which the screw column coupled to the inside of the fixture is released is formed at the upper end portion, and the first step portion is formed on the upper portion of the first step portion at the lower end portion It is characterized in that the first step ring formed with the second step portion having a shape corresponding to the step portion is inserted and coupled to the inside of the lower abutment. In addition, the upper end of the lower abutment is formed with a step- shaped third step portion including an inclined surface inclined upward in the direction in which the screw column coupled to the inner side of the fixture is released, the lower abutment and the upper abutment It is characterized in that a second step ring is installed between the ment and the fourth step portion having a shape corresponding to the third step portion at the lower end.

193 According to the present invention, the coupling force between the fixture and the abutment is increased by increasing the area where the fixture and the abutment are screwed by using a separate screw column for coupling the fixture and the abutment, and the screwed portion As the load is distributed and transmitted to the whole, it is possible to minimize the risk of fracture of the screw pillar due to stress concentration, and also has the effect of easily removing the fractured screw pillar even when the screw pillar is fractured. In addition, the present invention further has the effect of more easily and accurately coupling the fixture and the abutment by allowing the abutment to be fastened to the upper part after coupling the screw column to the fixture. In addition, the present invention has an additional effect that can be assembled by selecting various shapes such as the height, inclination, thickness, etc. of the upper and lower abutments by separating the abutment into an upper abutment and a lower abutment. . In addition, the present invention is

configured by separating the screw coupling portion in two places between the upper abutment and the screw pillar and between the fixture and the screw pillar using a screw column, and at the same time the direction of coupling of the screwed portion configured separately is opposite to each other T his not only improves the bonding force between the fixture and the abutment and prevents loosening of the screw, but also ensures that the contact part between the fixture and the abutment is in close contact as a whole without being partially stressed. By preventing the penetration of foreign substances into the joint gap of the implant, it has the additional effect of preventing the occurrence of peri- implantitis and peri- implant mucositis due to bacterial propagation inside the implant. In addition, according to the present invention, the coupling force between the upper and lower abutments and the coupling force between the upper and lower abutments and the fixture by inserting and coupling the screw ring and the fastener between the screw column and the upper and lower abutments Not only can it improve, but also to maximize the effect of preventing loosening of the screw column by reversing the direction of implantation of the fixture, the coupling direction between the screw column and the upper and lower abutments, and the coupling direction between the screw column and the fixture. have an additional effect.

224 In addition, according to the present invention, by inserting a step ring inside the lower abutment or between the upper abutment and the lower abutment, the inner surface of the lower abutment is formed on the outer peripheral surface of the post of the screw column having a polygonal shape. By making it closely fixed, it has an additional effect of maintaining a solid fixed state without shaking despite tolerances generated during the manufacturing process of the implant. In addition, according to the present invention, by forming a seating groove or a seating ridge on the outer peripheral surfaces of the upper abutment and the lower abutment, respectively, protrusions and grooves corresponding to the shapes of the seating groove and the seating ridge are formed on the inner surface of the artificial tooth. By firmly fixing the upper abutment and the lower abutment, it additionally has an effect of preventing loosening.

[0041]

239 1 is a view schematically showing a state in which a conventional conventional implant has been operated.

241 Figure 2 is a cross- sectional view showing a conventional dental implant combination.

243 Figure 3 is a combined cross- sectional view showing an embodiment of the dental implant according to the present invention.

245 Figure 4 is a cross- sectional view showing the present invention shown in Figure 3 separated.

247 5 (a), (b), (c) is a cross- sectional view showing an embodiment of the abutment of

the present invention shown in FIG. 3 separately.

249 Figure 6 (a), (b), (c) is a view showing an embodiment of the screw column of the present invention shown in Figure 3;

251 7 is a combined cross- sectional view showing a second embodiment of the dental implant according to the present invention.

253 8 is a combined cross- sectional view showing a third embodiment of the dental implant according to the present invention.

255 9 is a cross- sectional view showing a fourth embodiment of a dental implant according to the present invention separately.

257 10 is a cross- sectional view of the present invention shown in FIG.

258 11 (a), (b), (c) is a cross- sectional view showing the coupling process of the lower abutment in the present invention shown in FIG.

260 Figure 12 (a), (b) is a plan sectional view showing a coupling portion between the fixture and the lower abutment of the present invention shown in Figure 10.

262 13 is a cross- sectional view showing a fifth embodiment of a dental implant according to the present invention separately.

264 14 is a cross- sectional view of the present invention shown in FIG. 13;

265 15 is a cross- sectional view showing a sixth embodiment of a dental implant according to the present invention separately.

267 16 is a view showing separately another embodiment of the upper and lower abutments of the dental implant according to the present invention.

[0042]

272 Hereinafter, preferred embodiments of the dental implant according to the present invention will be described in detail with reference to the accompanying drawings.

[0043]

277 Figure 3 is a combined cross- sectional view showing an embodiment of the dental implant according to the present invention, Figure 4 is a cross- sectional view showing the present invention shown in Figure 3 separately, Figure 5 (a), (b), (c) is a cross- sectional view showing an embodiment of the abutment of the present invention shown in FIG. 3 separately, and (a), (b), (c) of FIG. 6 is an embodiment of a screw column of the present invention shown in FIG. Figure 7 is a combined cross- sectional view showing a second embodiment of the dental implant according to the present invention, Figure 8 is a combined cross- sectional view showing a third embodiment of the dental implant according to the present invention, Figure 9 is the present invention A cross- sectional view showing a fourth embodiment of a dental implant according to FIG. 10 is a combined cross- sectional view of the present invention shown in FIG. 9, (a), (b), (c) of FIG. A cross- sectional view showing the coupling process of the lower abutment in the present invention, Fig. 12

is a cross- sectional view showing a fifth embodiment of the dental implant according to the present invention separately, Fig. 13 is a combined cross- sectional view of the present invention shown in Fig. 12 , FIG. 14 is a cross- sectional view showing a sixth embodiment of a dental implant according to the present invention, and FIG. 15 is a view showing another embodiment of upper and lower abutments of the dental implant according to the present invention. .

[0044]

299 The present invention prevents fracture of the implant screw coupling portion by coupling the fixture 100 and the abutment 200 using separate screw pillars 300 and 300 ′ and at the same time allows the force to be uniformly transmitted to the entire contact surface so that the stress is partially can be prevented from being concentrated, and the screw coupling direction between the fixture 100 and the abutment 200 is changed to improve the coupling force between the fixture 100 and the abutment 200, and loosening of the screw relates to a dental implant (1) capable of fundamentally preventing is made including

[0045]

310 In more detail, the fixture 100 serves as the root of the implant 1 and is formed to have the root shape of a natural tooth, and a screw thread 110 is formed on its outer peripheral surface to be inserted into the inner side of the alveolar bone. It is designed to be

[0046]

317 In addition, a first female screw 122 to which a screw column 300 to be described later is inserted and fastened is formed in the upper center of the fixture 100 , and an abutment 200 to be described later is formed on the upper portion of the first female screw 122 .), a tapered groove 132 and an anti- rotation groove 134 to which the lower portion is fitted are formed to correspond to the lower shape of the abutment 200 .

[0047]

326 Next, the abutment (abutment) 200 is installed to be connected to the upper portion of the fixture 100, the artificial tooth 400 is coupled to the upper portion, and serves as a connecting pillar of the implant (1).

[0048]

332 At this time, the abutment 200 includes a lower abutment 210 that is inserted and fixed to the inside of the fixture 100 and an upper abutment that is rotatably fitted to the upper portion of the lower abutment 210 . It consists of a separate abutment 220, which facilitates the coupling of the abutment 200 and the fixture 100 while improving the fixing force of the abutment 200, which will be described later.

[0049]

340 Next, the screw column 300 is inserted into the abutment 200 and the fixture 100 to serve to fasten and fix the abutment 200 and the fixture 100, the screw column 300 A male screw 310 is formed on the outer peripheral surface of the .

[0050]

346 In more detail, a fastening hole 222 having a second female screw 222a formed on the sidewall is formed in the central portion of the upper abutment 220 , and a through hole 218 is formed in the central portion of the lower abutment 210 .) is formed, and in the center of the fixture 100, a fastening groove 120 having a first female screw 122 formed on the side wall is formed, and a screw column 300 having a male screw 310 formed on the outer circumferential surface is the upper abutment 220), the lower abutment 210 and the second female screw 222a formed in the upper abutment 220 by being inserted through the center of the fixture 100 and the first female screw 122 formed in the center of the fixture 100 .) so that it can be fastened and fixed.

[0051]

359 T hat is, according to a preferred embodiment of the present invention, after fastening and fixing the screw column 300 to the fixture 100, the lower abutment 210 and the upper abutment 220 are sequentially coupled thereto. , First, by inserting the screw column 300 into the inside of the fastening groove 120 formed in the fixture 100 inserted and coupled to the inside of the alveolar bone, the first female screw 122 formed on the side wall of the fastening groove 120 is fastened and fixed. .

[0052]

368 Next, the lower abutment 210 is coupled to the fixture 100 by inserting it into the screw column 300 , and is inserted into the screw column 300 through the through hole 218 formed in the lower abutment 210 . By combining, the lower end of the lower abutment 210 is inserted and coupled to the upper portion of the fixture 100 .

[0053]

375 At this time, although not shown, a female screw is also formed on the side wall of the through hole 218 formed in the center of the lower abutment 210 so that the lower abutment 210 is screwed to the outer circumferential surface of the screw column 300 . Of course you can do it.

[0054]

382 Next, when the upper abutment 220 is fastened to the upper end of the screw column 300 using the second female screw 222a formed in the upper abutment 220, the fixture 100 and the abutment 200 is completed, the coupling of the fixture 100 and the abutment 200 can be made more easily and accurately by the coupling method as described above, as well as the fixture 100 and the abutment by the screw column 300 . Since the area to which the abutment 200 is screwed is increased, it is possible to increase the coupling force between the fixture 100 and the abutment 200 .

[0055]

393 In addition, a screw column 300 for coupling the fixture 100 and the abutment 200 is separately provided, and the part screwed to the screw column 300 is attached to the inner side of the fixture 100 and the upper abutment (220), it is possible to distribute the load received during the chewing action, such as when chewing food, thereby minimizing the risk of fracture of the screw pillar 300 as well as when the screw pillar 300 is broken. The fractured screw column 300 can be easily removed.

[0056]

402 On the other hand, the male screw 310 formed on the outer circumferential surface of the screw column 300 may be formed to be separated into first and second male screws 312 and 314, as shown in (b) and (c) of FIG. 6 , The first male screw 312 is formed on the outer peripheral surface of the lower end of the screw column 300 , that is, a portion fastened with the first female screw 122 formed in the fixture 100 , and the second male screw 314 is the screw column 300 . It is formed on the outer peripheral surface of the upper end of the, that is, the portion fastened to the second female screw (222a) formed in the upper abutment (220).

[0057]

413 At this time, the first female screw 122 and the first male screw 312 and the second female screw 222a and the second male screw 314 may be formed to have threads in opposite directions to each other, which prevents the screw coupling from being

loosened. This is to ensure that the bonding force between the fixture 100 and the abutment 200 can be maintained by fundamentally preventing it.

[0058]

421 More specifically, when the first female screw 122 and the first male screw 312 are formed as a right- hand screw, the second female screw 222a and the second male screw 314 are formed as a left- hand screw, and the first female screw 122 is formed as a left- hand screw. And when the first male screw 312 is formed as a left- hand screw, by forming the second female screw 222a and the second male screw 314 as a right- hand screw, a screw column in the case of coupling the screw column 300 to the fixture 100 (The direction of rotation of 300 and the direction of rotation of the upper abutment 220 in the case of coupling the upper abutment 220 to the screw column 300 are to be opposite to each other.

[0059]

433 In this coupling method, the screw column 300 rotates in one direction so that the coupling part between the first female screw 122 and the first male screw 312 or the coupling part between the second female screw 222a and the second male screw 314 is In the case of loosening, the coupling portion between the second female screw 222a and the second male screw 314 coupled by rotation in the opposite direction to the above, or the coupling between the first female screw 122 and the first male screw 312 . Since this is made stronger, it is possible to fundamentally prevent the screw coupling from being loosened by preventing the screw column 300 from rotating any more, and accordingly, the solid coupling state between the fixture 100 and the abutment 200 will be able to be maintained.

[0060]

446 On the other hand, in the dental implant 1 according to the present invention, as described above, the upper and lower abutments (It is possible to assemble by selecting various shapes such as height, inclination, thickness, etc. of 220 and 210 , and as one embodiment thereof, as shown in FIG.) is formed, and a seating groove 212 corresponding to the shape of the protrusion 224 is formed at the upper end of the lower abutment 210 so that the upper abutment 220 is positioned on the upper portion of the lower abutment 210 . It can be configured to be installed stably.

[0061]

456 At this time, since the upper abutment 220 is rotatably fitted to the lower abutment 210 for fastening and fixing with the screw column 300, the protrusion 224 and the

seating groove 212 are T he horizontal cross section is formed to form a circle.

[0062]

462 Next, as shown in FIG. 5 (b), the upper abutment 220 may be configured to be simply seated on the upper portion of the lower abutment 210 to be coupled only by the screw column 300, as shown in FIG. As shown in (c) of 5, a cylindrical extension 226 is protruded from the lower end of the upper abutment 220, and the extension 226 is formed on the upper end of the lower abutment 210. An insertion groove 213 to be inserted and coupled may be formed.

[0063]

471 At this time, the fastening hole 222 in which the second female screw 222a provided in the upper abutment 220 is formed is extended inside the extension part 226 to increase the area screwed to the screw column 300 . By doing so, it is configured to improve the coupling force between the abutment 200 and the fixture 100 by the screw column 300 .

[0064]

479 Next, a tapered portion 214 and a rotation preventing portion 216 are formed at the lower portion of the abutment 200 fitted to the fixture 100 , that is, at the lower end of the lower abutment 210 , the tapered portion Reference numeral 214 has a conical shape that decreases in diameter toward the bottom, and serves to enable the lower abutment 210 to be more stably installed at the upper end of the fixture 100 .

[0065]

487 T hat is, a conical tapered groove 132 is formed in the upper portion of the fixture 100 to correspond to the shape of the tapered portion 214 , so that the lower abutment 210 is inserted and coupled to the inside of the fixture 100 . In this case, by increasing the contact area between the lower abutment 210 and the fixture 100, it is installed more stably, thereby serving to improve the coupling force.

[0066]

495 In addition, the anti- rotation part 216 is protruded to have a polygonal shape at the lower portion of the tapered part 214, and the lower portion of the tapered groove 132 of the fixture 100 has a shape of the anti- rotation part 216. When the anti-rotation groove 134 made of a corresponding polygon is formed so that the anti-rotation part 216 is fitted into the anti- rotation groove 134 , the lower abutment 210

is fitted to the upper portion of the fixture 100 . It serves to improve the fixing force of the lower abutment 210 fitted to the fixture 100 by preventing it from rotating in the current state.

[0067]

506 On the other hand, according to the second embodiment of the present invention, in the coupling method of the fixture 100 and the abutment 200 using the screw column 300 as described above, the lower end of the abutment 200 is the fixture 100) as well as an internal type implant that is inserted into the inside of the external type implant (External type implant) can also be applied.

[0068]

514 T hat is, the fixing part 140 is formed to protrude from the upper end of the fixture 100 , and the fixing part 140 is fitted to the lower end of the abutment 200 , that is, the lower abutment 210 . Even when the groove 219 is formed and the fixture 100 is inserted and coupled to the inside of the lower abutment 220 , the coupling structure using the screw column 300 can be applied.

[0069]

522 At this time, the coupling groove 219 formed in the fixing part 140 and the lower abutment 210 of the fixture 100 has a polygonal shape like the above- described rotation preventing part 216 and rotation preventing groove 134 . It is configured to prevent the lower abutment 210 from rotating in a state fitted to the upper portion of the fixture 100 .

[0070]

530 On the other hand, according to the third embodiment of the dental implant 1 according to the present invention, as shown in FIG. 8 , one or more seating grooves (A seating groove 250 or a seating ridge 260 may be further formed, wherein the seating groove 250 and the seating ridge 260 include the upper abutment 220 and the lower abutment 210 .) to strengthen the fixation between them.

[0071]

538 In more detail, in a state in which the upper and lower abutments 220 and 210 and the fixture 100 are coupled using the screw column 300 by the process as described above, the outer peripheral surfaces of the upper and lower abutments 220 and 210 are T he artificial tooth (prosthesis) 400 is covered by using a dental adhesive

(cement), and at this time, the upper abutment (220) and the lower abutment 210 in which the seating ridge 260 is integrally formed on the outer circumferential surface during the manufacturing process, the impression taken of the prosthetic plaster model, that is, the artificial tooth (prosthesis) 400 A protrusion (not shown) corresponding to the shape of the seating groove 250 and a groove (not shown) corresponding to the shape of the seating ridge 260 are formed on the inner surface.

[0072]

551 T herefore, when the artificial tooth 400 is attached to the upper abutment 220 in which the seating groove 250 is formed and the lower abutment 210 in which the seating ridge 260 is formed, the protrusion formed in the artificial tooth 400 is T he seating ridge 260 formed in the lower abutment 210 is inserted and coupled to the inside of the seating groove 250, and the upper abutment 220 and the lower part are inserted and coupled to the inside of the groove formed in the artificial tooth 400. T he abutment 210 is not released and can be maintained in a fixed state.

[0073]

561 In addition, since the seating groove 250 and the seating ridge 260 increase the adhesion area between the upper and lower abutments 220 and 210 and the artificial tooth 400, the upper and lower abutments 220 and 210 and the artificial teeth (400) also serves to increase the bonding force between them.

[0074]

568 In this case, of course, the seating groove 250 or the seating ridge 260 may be selectively formed in the upper abutment 220 and the lower abutment 210 .

570 T hat is, a seating ridge 260 is formed in the upper abutment 220, a seating groove 250 is formed in the lower abutment 210, or a seating groove (250) or a seating ridge 260 may be formed.

[0075]

576 On the other hand, according to the fourth embodiment of the dental implant (1') according to the present invention, as shown in Figure 9, the screw column 300' with the first and second male screws (312', 314'), It may be configured as a post 316' formed between the first and second male screws 312' and 314', and the first male screw 312' is the screw column 300' as in the above- described embodiments.) is formed at the lower end of the fixture 100' and is fastened to the first female screw 122' formed in the fastening groove 120' of the fixture 100' to fix the screw column 300' to the fixture 100'. .

[0076]

587 Next, the second male screw 314' is formed at the upper end of the screw column 300', and a screw ring 320', which will be described later, is coupled to its outer circumferential surface and inserted into the upper abutment 220'. are combined

[0077]

593 T hat is, unlike the above- described embodiments, the screw column 300' is not directly coupled to the upper abutment 220', but a second female screw 324' is formed on the inner circumferential surface and a third male screw 326' is formed on the outer circumferential surface.) of the hollow screw ring 320' formed thereon with the second male screw 314' of the screw column 300', and then the third female screw 226 formed inside the upper abutment 220'. ') is to fasten and fix the third male screw 326' of the screw ring 320' to the first fastening hole 222' formed therein. T he screwing area between the ment 220' is increased, so that the fastening force is strengthened.

[0078]

605 On the other hand, a fastener 330' is fitted to the outside of the post 316' formed under the second male screw 314' of the screw column 300', and the fastener 330' is a post (316') is fitted to the outer circumferential surface of the screw pillar (300') rotates in a direction in which the first male screw 312' is loosened so that the lower abutment 210' can be fixed without shaking, thereby preventing the lower abutment 210' from loosening. will play a role

[0079]

614 In more detail, the post 316' of the screw column 300' has a polygonal shape, and a polygonal shape corresponding to the cross- sectional shape of the post 316' is formed inside the fastener 330'. T his is formed so that it can be fitted to the outside of the post 316'.

[0080]

621 In addition, the fastener 330' is composed of a screw coupling part 332' and a rotation preventing part 334', wherein the screw coupling part 332' is formed on the upper part of the fastener 330'. , a fourth male screw 338' is formed on its outer circumferential surface so as to be screw- coupled to the fourth female screw 218' formed inside the lower abutment 210'.

[0081]

629 In addition, the anti- rotation part 334 ′ serves the same role as the anti- rotation part 216 formed in the lower abutment 210 in the above- described embodiment, and the anti- rotation groove formed in the fixture 100 ′ . (134') is fitted.

[0082]

635 T hat is, the anti- rotation part 334' is formed in a polygonal shape such as a square, hexagonal or octagonal shape to form the same shape as the anti- rotation part 334', and the anti- rotation groove 134' formed at the upper end of the fixture 100'.) to prevent further rotation when the fastener 330' is inserted and coupled to the inside of the fixture 100' to prevent loosening between the fastener 330' and the fixture 100'. .

[0083]

644 In more detail, the hole formed inside the post 316 ′ and the fastener 330 ′ of the screw column 300 ′ , and the anti- rotation groove 134 ′ and the fastener formed in the fixture 100 ′ . T he anti- rotation part 334' of the 330' is made of a polygonal shape, so the coupling part between the post 316' and the fastener 330' and the coupling between the fixture 100' and the fastener 330' It is characterized in that it is configured to prevent negative rotation, but as shown in FIG. As a result, each coupling part does not come into close contact, and shaking may occur after coupling.

[0084]

655 Accordingly, the lower abutment 210' is screwed into the screw coupling part 332' of the fastener 330' in a state where the fastener 330' is fitted to the post 316' of the screw column 300'.) After coupling to the outside, when the lower abutment 210' is rotated and tightened, the fastener 330' is slightly rotated in one direction between the post 316' and the fastener 330' having a polygonal shape. T he coupling part of the fixture 100' and the coupling part between the fixture 100' and the fastener 330' are in close contact in the direction in which the screw column 300' is going to rotate, thereby eliminating the deviation that may be caused by tolerances in the manufacturing process. 100'), the screw pillar 300', and the fastener 330' may be more firmly coupled.

[0085]

668 At this time, the screw coupling direction between the fixture 100' and the screw column 300', that is, the screw direction of the first female screw 122' and the first male screw 312', and the lower abutment 210'. It is preferable that the screwing direction between the and the fastener 330', that is, the screw direction of the fourth female screw 218' and the fourth male screw 338' be opposite to each other, because the post 316' T he coupling portion between the and the fastener 330 ' and the coupling portion between the fixture 100 ' and the fastener 330 ' are in close contact in the direction in which the coupling between the fixture 100 ' and the screw column 300 ' is released. am.

[0086]

680 T hat is, in a state in which the first male screw 312' of the screw column 300' is fastened to the fastening groove 120' of the fixture 100' in which the first female screw 122' is formed, the fastener 330') to the outer peripheral surface of the post 316' of the screw column 300' so that the anti- rotation part 334' is inserted and coupled to the inside of the anti- rotation groove 134' of the fixture 100', and then the fastener T he lower abutment 210' is coupled to the outside of the screw coupling part 332' of the 330'. At this time, the first female screw 122' and the first male screw 312', and the lower abutment When the fourth female screw 218' of the ment 210' and the fourth male screw 338' of the screw coupling part 332' are formed in opposite directions, the lower abutment 210' is rotated and tightened. As shown in (b) of 12, the direction in which the first male screw 312' of the screw column 300' in which the fastener 330' is inserted into the fastening groove 120' of the fixture 100' is loosened. between the coupling part between the post 316' and the fastener 330' and the rotation preventing groove 134' of the fixture 100' and the rotation preventing part 334' of the fastener 330'. Since the coupling portion of the screw pillar 300 ' is in close contact without a gap in the direction in which it is intended to be loosened, the screw coupling between the fixture 100 ' and the screw pillar 300 ' is not loosened due to the shape of the polygonal coupling portion.

[0087]

701 On the other hand, in this embodiment as well, by changing the screw coupling directions of the fixture 100', the abutment 200', and the screw pillar 300', it is possible to fundamentally prevent the coupling of the screw pillar 300' from loosening. , in one embodiment, the screw coupling direction of the first male screw 312 ' and the first female screw 122 ' may be reversed to all other screw coupling directions.

[0088]

710 That is, when the screw coupling direction of the first male screw 312' and the first female screw 122' is a left- hand screw/or a right- hand screw, the coupling direction of the screw thread 110' formed in the fixture 100' and the second to second The loosening of the screw coupling is fundamentally caused by setting the coupling direction of the threads formed on the four male screws 314', 326', 338' and the second to fourth female screws 324', 226', 218' to a right- hand thread/or a left- hand thread. that can be prevented.

[0089]

720 Since the screwing direction of implants currently mainly used is a right- hand screw, in the following, when the screwing direction of the first male screw 312' and the first female screw 122' is a left- hand screw, and the screwing direction of the remaining parts is a right- hand screw will be described with an example.

[0090]

727 First, the fixture (100') having a screw thread (110') formed on the outer circumferential surface is inserted and coupled to the alveolar bone in the right screw direction.

[0091]

733 Thereafter, the first male screw 312' of the screw column 300' is coupled to the first female screw 122' formed in the fastening groove 120' of the fixture 100', at this time the first female screw 122. ') and the first male screw 312' are formed in the left- hand direction to rotate the screw pillar 300' in the left direction to insert and couple the screw pillar 300' to the inside of the fixture 100'.

[0092]

741 Next, the fastener 330 ' comprising the screw coupling portion 332 ' and the rotation preventing portion 334 ' is fitted to the outside of the post 316 ' of the screw column 300 ' .

[0093]

747 Next, the screw ring 320' having the second female screw 324' formed on the inner circumferential surface of the second male screw 314' formed on the screw column 300' is rotated in the right- hand direction.

[0094]

753 T hen, as shown in (a) of Figure 11, the lower abutment 210' through the second fastening hole 212' formed in the lower abutment 210' of the fastener 330'. It is coupled to the outer circumferential surface of the screw coupling part 332', and at this time, the fourth female screw 218' formed in the second fastening hole 212' and the fourth male screw 338' formed on the outer circumferential surface of the fastener 330'.) is a right- hand thread direction, so the lower abutment 210' is rotated in the right- hand thread direction to be coupled.

[0095]

763 T hat is, as shown in (b) of Figure 11, when the lower abutment 210' is fitted from the top of the screw ring 320' and continuously rotated in the right- hand thread direction, the fastener 330' is T he right- hand screw direction, that is, the first male screw 312' of the screw column 300' inserted and coupled to the fastening groove 120' of the fixture 100' rotates in a direction in which the post 316' and the fastener are loosened. Since the coupling part between the 330' and the coupling part between the fixture 100' and the fastener 330' is in close contact without a gap, due to the polygonal coupling part shape, the fixture 100' and the screw column 300') T he screw connection between them is not loosened.

[0096]

775 Next, as shown in FIG. 11(c), the third female screw 226' formed in the first fastening hole 222' of the upper abutment 220' is applied to the outer peripheral surface of the screw ring 320'. It is coupled to the formed third male screw 326'. At this time, since both the third female screw 226' and the third male screw 326' are formed as right- hand screws, the upper abutment 220' is rotated in the right- hand direction. When the upper abutment 220' rotates along the screw ring 320', it descends to strongly press the lower abutment 210', and by the same process as above, the dental implant according to the present invention T he installation of (1') is completed.

[0097]

787 T hat is, the most problematic part in the structure of the dental implant 1' is that the screw coupling is loosened by the impact applied to the implant during long- term use.

[0098]

793 In the case of the present invention configured as described above, since the coupling

of the fixture 100 ′ and the screw column 300 ′ is made in the left- hand thread direction, in order to loosen the coupling of the screw column 300 ′ , rotation in the right- hand thread direction must be made. .

[0099]

800 However, in the present invention, since all of the screw couplings of the part except for the coupling part between the fixture 100' and the screw column 300' are formed in the right- hand thread direction, when the screw column 300' rotates in the right-hand thread direction, Since the coupling force between the upper abutment 220' and the lower abutment 210' and the screw ring 320' and the fastener 330' becomes stronger, the screw column 300' does not rotate any more. T herefore, it becomes possible to fundamentally prevent the loosening phenomenon caused by the rotation of the screw column 300'.

[0100]

811 At this time, although not shown separately, the structure of the upper abutment 220 ′ and the lower abutment 210 ′ is the above- described embodiment as shown in (a), (b) and (c) of FIG. 5 . It may be formed in various shapes as in the case of the upper and lower abutments 220' and 210', and of course, a seating groove 250' or a seating ridge 260' may be formed on the outer circumferential surface of the upper and lower abutments 220' and 210'.

[0101]

820 On the other hand, according to the fifth embodiment of the dental implant (1") according to the present invention, as shown in FIG. 13, the first step ring 340" is inserted and installed inside the lower abutment 210". As a feature of being, the first step ring 340" is the fixture 100" through the lower abutment 210" in a state of being inserted and coupled to the inside of the anti- rotation groove 134" of the fixture 100".) is configured to prevent loosening of the screw pillar 300" by finely rotating in the direction in which the screw pillar 300" inserted and coupled to the inside of the screw pillar 300" is loosened.

[0102]

831 More specifically, the screw column 300" is the same as in the fourth embodiment described above, with first and second male screws 312" and 314" and first and second male screws 312" and 314". It is composed of posts 316" formed between them, and the posts 316" have a polygonal shape, such as a square or hexagon.

[0103]

838 In addition, the lower abutment 210" is formed with a polygonal through- hole 218" fitted to the outer circumferential surface of the post 316" on its inner side, and an upper end of the through- hole 218" is formed in the upper part of the lower abutment 210". A sawtooth- shaped first step portion 215 ″ is formed, and the lower end of the lower abutment 210 ″ is inserted into a polygonal anti- rotation groove 134 ″ formed inside the upper portion of the fixture 100 ″ . The anti-rotation portion 216 ″ coupled thereto is formed in the same shape as the anti-rotation groove 134 ″ .

[0104]

849 At this time, the sawtooth shape of the first step portion 215 ″ is formed to be inclined upwardly in the direction in which the screw column 300 ″ coupled to the inner side of the fixture 100 ″ is loosened.

[0105]

855 In addition, a first step ring 340" is inserted and installed between the first step part 215" and the upper abutment 220", and the screw column is inside the first step ring 340". A hole having a polygonal shape corresponding to the shape of the post 316 ″ of 300 ″ is formed, and at the lower end of the first step ring 340 ″ , a first step having the same shape as the sawtooth shape of the first step part 215 ″ . A two-step portion 345" is formed.

[0106]

864 That is, in the state in which the first male screw 312" of the screw column 300" is fastened and fixed to the fastening groove 120" of the fixture 100" in which the first female screw 122" is formed, the lower abutment 210 ") is fitted from the top of the screw column 300", the anti- rotation part 216" of the lower abutment 210" is formed in the fixture 100" and the anti- rotation groove 134" of a polygonal shape. The through- hole 218" of a polygonal shape that is inserted into and coupled to the lower abutment 210" and formed inside the lower abutment 210" is supported by the post 316" of the screw column 300", and the lower abutment 210 ") and the rotation of the screw pillar 300" is limited, so that the loosening phenomenon of the screw pillar 300" inserted and coupled to the fixture 100" can be prevented.

[0107]

877 However, due to tolerances in the manufacturing process of the fixture 100", the

lower abutment 210", and the screw column 300", each coupling part formed in a polygonal shape, that is, the rotation preventing groove of the fixture 100" (134") and the coupling part between the anti- rotation part 216" of the lower abutment 210", and the through hole 218" of the lower abutment 210" and the post (300") of the screw column 316") may not come into close contact with each other, and vibration may occur after bonding.

[0108]

887 Accordingly, by inserting the first step ring 340" to the outside of the post 316", the first step ring 340" is inside the lower abutment 210", that is, the first step part 215".), when the upper abutment 220" is coupled to the second male screw 314" of the screw column 300", the upper abutment 220" descends while the first step T he upper end of the ring 340" is pressed, and accordingly, the first step ring 340" is lowered.

[0109]

896 At this time, the second step portion 345" formed at the lower end of the first step ring 340" meets the first step portion 215" formed on the lower abutment 210" to determine the inclination direction of the teeth. Accordingly, the first step ring 340 "is rotated in the coupling direction (clockwise when referring to FIG. 14) between the fixture 100" and the screw column 300", and the first step part 215") T he lower abutment 210 ″ formed integrally with the fixture 100 ″ rotates in a direction in which the coupling between the screw column 300 ″ is released (counterclockwise with reference to FIG. 14).

[0110]

907 As such, by the rotation of the lower abutment 210", the coupling portion between the rotation preventing groove 134" of the fixture 100" and the rotation preventing portion 216" of the lower abutment 210" and T he coupling part between the through hole 218" of the lower abutment 210" and the post 316" of the screw column 300" is perfectly close so that there is no minimum gap, so that the coupling force at each coupling part is reduced. Due to the shape of the polygonal shape formed by each coupling part, the screw column 300" cannot rotate in the direction in which the coupling with the fixture 100" is released. It will be possible to configure the dental implant (1") that does not.

[0111]

919 On the other hand, in this embodiment as well, the remaining components such as the

seating bridge 250 " or the seating ridge 260" may be formed on the outer peripheral surfaces of the upper and lower abutments 220 ", 210 ", etc., are Since it is the same as , a detailed description thereof will be omitted.

[0112]

926 Next, FIG. 15 shows a sixth embodiment of a dental implant 1' according to the present invention, in which the characteristic configurations of the above- described fourth and fifth embodiments are combined.

[0113]

932 More specifically, the sixth embodiment is a screw column 300' coupled to the inside of the fixture 100' to the upper end of the fastener 330' fitted to the outer circumferential surface of the post 316' having a polygonal shape.) to form a first step portion 335' having a sawtooth shape inclined upward toward the unwinding direction, and the upper portion of the first step portion 335', that is, the fastener 330' and the screw ring 320 ') is characterized in that a first step ring 340' having a second step portion 345' having the same shape as the sawtooth shape of the first step portion 335' is inserted and installed at the lower end thereof. .

[0114]

943 Therefore, when the upper abutment 220' is coupled to the second male screw 314' of the screw column 300' during the coupling process of the implant 1', the rotation of the upper abutment 220' is affected. As a result, the screw ring 320' is lowered to press the first step ring 340' installed thereunder, and accordingly, the second step portion 345' is a first step formed in the fastener 330'. As it slides along the part 335', the fastener 330' rotates in a direction in which the coupling between the fixture 100' and the screw column 300' is released, so the post 316' and the fastener 330') between the coupling part and the coupling part between the fixture 100' and the fastener 330' can be in close contact without a gap in the direction in which the screw column 300' is to be loosened, and due to the shape of the polygonal coupling part, the fixture The screw coupling between the (100') and the screw column (300') is not loosened.

[0115]

958 On the other hand, the concept of the step ring as described above can also be applied to the coupling between the upper abutment 220 ″ and the lower abutment 210 ″ . A third step portion (217"), and between the upper abutment 220" and the lower abutment 210", a fourth step portion 355" having the same shape as the third

step portion 217" is formed at the lower end thereof. T he second step ring 350 ″ in which is formed may be inserted and coupled.

[0116]

967 T hat is, in a state in which the fixture 100 ″ , the screw column 300 ″ , and the lower abutment 210 ″ are sequentially coupled as in the above- described fifth embodiment, the upper part of the lower abutment 210 ″ After positioning the second step ring 350" on the , when the upper abutment 220" is coupled from the upper part of the second step ring 350", the T he second step ring 350" is descended, and the fourth step portion 355" formed at the lower end of the second step ring 350" is formed at the upper end of the lower abutment 210" and the third step portion (217") and rotates the lower abutment 210" in the direction in which the screw column 300" coupled to the fixture 100" is to be loosened, so the fixture 100" and the lower T he coupling portion between the abutments 210 ″ is in close contact without a gap in the direction in which the screw column 300 ″ is to be loosened, so that it is possible to prevent the screw column 300 ″ from rotating in the direction to be loosened.

[0117]

983 T herefore, according to the dental implant (1,1',1") according to the present invention as described above, a separate screw for coupling the fixtures 100,100',100" and the abutments 200,200',200" Fixtures 100,100',100" and abutment by increasing the area where fixtures 100,100',100" and abutment 200,200',200" are threaded using posts 300,300',300" (200,200',200") increases the bonding force between the screws, and the load is distributed and transmitted as a whole to the screwed part, so it is possible to minimize the risk of fracture of the screw pillars 300,300',300" due to stress concentration, and the screw pillars Even when the (300,300',300") is broken, the broken screw pillar (300,300',300") can be easily removed as well as the screw pillar (300,300',300") on the fixture (100,100',100") After coupling the abutment (200,200',200") to the upper part to be able to fasten and fix the fixture (100,100',100") and the abutment (200,200',200") more easily and accurately In spite of the tolerances generated in the manufacturing process of the implant (1, 1', 1") by preventing multiple loosening of the screw pillars 300, 300', 300" by various methods, it is sturdy without shaking. Not only can it be maintained in a fixed state, but it also has various advantages such as being able to fundamentally prevent loosening of screws even in long- term use.

[0118]

1003 Although the above- described embodiments have been described with respect to

the most preferred example of the present invention, it is not limited to the above embodiment, and the screw pillars 300 and 300' that serve to firmly couple the fixtures 100 and 100' and the abutments 200 and 200'.) It is apparent to those skilled in the art that various modifications are possible without departing from the technical spirit of the present invention, such as various modifications of the shape.

[0119]

1012 T he present invention relates to a dental implant, and more particularly, by combining a fixture and an abutment using a separate screw column, the fracture of the implant screw coupling part is prevented and the force is uniformly transmitted to the entire contact surface so that the stress is reduced. For dental implants that can prevent partial concentration, improve the bonding force between the fixture and the abutment by changing the screwing direction between the fixture and the abutment, and prevent loosening of the screw. it's about

[0120]

1022 1,1',1": dental implant 100,100',100": fixture 110,110': thread 120,120',120": fastening groove 122,122',122": first female thread 132: taper groove 134,134',134": anti- rotation groove 140: Fixing part 200,200',200": abutment 210,210',220": lower abutment 212: seating groove 212': second fastening hole 213: insertion groove 214: tapered part 215",335': first step part 216,216",334': anti- rotation part 218,218": through hole 217": third step part 217"a: inclined surface 218': fourth female thread 219: coupling groove 220,220',220": upper abutment 222: fastening hole 222a: second female screw 222': first fastening hole 224: protrusion 226: extension 226': third female screw 250,250',250": seating groove 260,260',260": seating ridge 300,300',300": screw column 310 : Male thread 312,312',312" : 1st male thread 314,314',314" : 2nd male thread 316',316" : Post 320' : T hread ring 324' : 2nd female thread 326' : 3rd male thread 330' : Fastener 332 ': screw coupling part 338': fourth male thread 340', 340": first step ring 345', 345": second step part 350": second step ring 355": fourth step part 400: artificial tooth

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CLAIMS KR20140080313A

1.

14 A dental implant comprising a fixture having a thread formed on its outer circumferential surface and an abutment inserted and coupled to the inside of the fixture, wherein the abutment includes a lower abutment fitted to the fixture, and the lower abutment It consists of an upper abutment that is connected and installed on the upper part of the dental implant, characterized in that the upper abutment and the fixture are fastened and fixed by a screw column.

2.

23 According to claim 1, The fixture and the upper abutment is respectively formed with first and second female screws to which the screw posts are coupled, the first and second screw posts at positions corresponding to the first and second female screws. Dental implant, characterized in that the male thread is formed.

3.

30 The dental implant of claim 2, wherein the first female screw and the first male screw, and the second female screw and the second male screw are formed to have threads in opposite directions to each other.

4.

36 The dental implant according to claim 2, wherein a protrusion is formed at a lower end of the upper abutment, and a seating groove into which the protrusion is fitted is

formed at an upper end of the lower abutment.

5.

42 According to claim 2, Dentistry, characterized in that the lower end of the upper abutment has an extension formed with a second female screw protruding from an inner circumferential surface, and an insertion groove into which the extension is inserted and coupled to the upper end of the lower abutment. for implants.

6.

49 T he dental implant according to claim 2, wherein a coupling groove is formed in a lower portion of the lower abutment, and a fixing part to be fitted into the coupling groove is protruded from an upper end of the fixture.

7.

55 T he dental implant of claim 1, wherein a seating groove is formed on an outer circumferential surface of the upper abutment, and a seating ridge is formed on an outer circumferential surface of the lower abutment.

8.

61 According to claim 2, T he screw column is for dentistry, characterized in that consisting of first and second male screws respectively formed on the lower end and upper end thereof, and a polygonal- shaped post formed between the first and second male screws. implant.

9.

68 According to claim 8, T he second male screw outer circumferential surface of the screw column, A second female screw is formed on the inner circumferential surface, a screw ring having a third male screw formed on the outer circumferential surface is coupled, and a third male screw is fastened to the upper abutment. Dental implant, characterized in that the first fastening hole formed with a third female screw is formed.

10.

77 10 . T he method of claim 9 , wherein a fastener having a fourth male screw formed thereon is fitted to the post of the screw column, and a second fastening hole having a fourth female screw to which a fourth male screw is fastened is formed in the lower

abutment. Characterized by dental implants.

11.

84 The dental implant according to claim 10, wherein a polygonal anti- rotation part is formed at a lower end of the fastener, and a rotation- preventing groove into which the anti- rotation part is fitted is formed on the upper portion of the fixture.

12.

90 According to claim 10, The upper end of the fastener is formed with a first step portion of a sawtooth shape inclined upward in the direction in which the screw column coupled to the inner side of the fixture is loosened, and between the screw ring and the fastener, a first step is formed at the lower end. Dental implant, characterized in that the first step ring formed with a second step portion having a shape corresponding to the step portion is installed.

13.

99 The dental use of claim 10 , wherein the screw directions of the first female screw and the first male screw are opposite to the screw threads formed in the fixture and the second to fourth female screws and the second to fourth male screws. implant.

14.

105 According to claim 8, The inner side of the lower abutment is formed with a first step portion in the shape of a sawtooth inclined upward in the direction in which the screw column coupled to the inner side of the fixture is released at the upper end portion, The upper portion of the first step portion A dental implant, characterized in that the first step ring formed with a second step portion having a shape corresponding to the first step portion at the lower end is inserted and coupled to the inside of the lower abutment.

15.

115 According to claim 1, The upper end of the lower abutment is formed with a step-shaped third step portion including an inclined surface inclined upward toward the loosening direction of the screw column coupled to the inside of the fixture, the lower abutment Dental implant, characterized in that the second step ring is installed between the upper abutment and the fourth step portion having a shape corresponding to the third step portion at the lower end.

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(54) **Title:** CONNECTION SYSTEM FOR A DENTAL IMPLANT

(54) **Bezeichnung:** VERBINDUNGSSYSTEM FÜR EIN DENTALIMPLANTAT

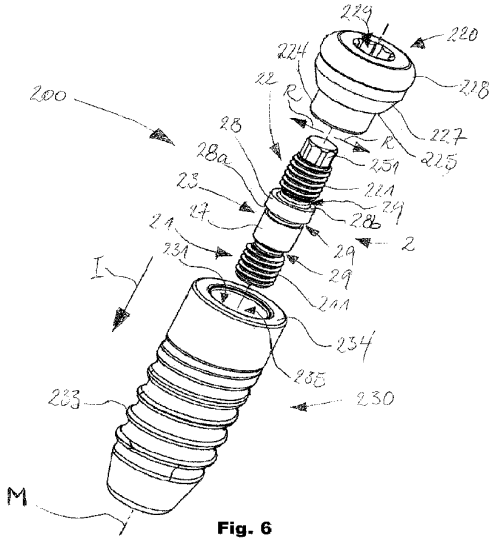


Fig. 6

(57) **Abstract:** The present invention relates to a connector (1, 1', 1", 2, 3) for connecting ceramic components of a dental implant (100, 100', 200, 300). The invention further relates to a prosthesis (120, 120', 220, 320) for a dental implant (100, 100', 200, 300). The invention moreover relates to a base body (130, 230, 330) for a dental implant (100, 100', 200, 300), with an inner thread (132, 232, 332), which is designed to match a base thread (111, 111', 111", 211, 311) of a connector (1, 1', 1", 2, 3), and/or with a receiver (135, 235, 325), which is designed to match a prosthesis (120, 120', 220, 320). Finally, the invention relates to a connection System for a dental implant (100, 100', 200, 300). In order to provide dental implants (100, 100', 200, 300) which satisfy the general requirements for successful Implantation and use and can easily adapt to bone variations and implant availability, provision is made according to the invention that the connector (1, 1', 1", 2, 3) has a base portion (11, 11', 11", 21, 31), on which a bäse thread (111, 111', 111", 211, 311) is formed for screwing the connector (1, 1', 1", 2, 3) into a base body (130, 230, 330) of the dental implant (100, 100', 200, 300), and a holding portion (12, 12', 12", 22, 32), on which a holding thread (121, 131, 131', 221, 321) is formed for screwing a prosthesis (120, 120', 220, 320) of the dental implant (100, 100', 200, 300) onto the connector (1, 1', 1", 2, 3) orthat the prosthesis (120, 120', 220, 320) is provided with a mating holding thread (2102, 3102) for screwing the prosthesis (120, 120', 220, 320) onto a connector (1, 1', 1", 2, 3) of the dental implant (100, 100', 200, 300).

(57) **Zusammenfassung:** Die vorliegende Erfindung betrifft einen Verbinder (1, 1', 1", 2, 3) zum Verbinden keramischer Komponenten eines Dentalimplantats (100, 100', 200, 300). Des Weiteren betrifft

[Fortsetzung auf der nächsten Seite]

WO 2018/029650 A1

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— *mit internationalem Recherchenbericht (Artikel 21 Absatz 3)*

die Erfindung eine Prothetik (120, 120', 220, 320) für ein Dentalimplantat (100, 5 100', 200, 300). Ferner betrifft die Erfindung einen Basiskörper (130, 230, 330) für ein Dentalimplantat (100, 100', 200, 300), mit einem Innengewinde (132, 232, 332), das komplementär zu einem Basisgewinde (111, 111', 111", 211, 311) eines Verbinders (1, 1', 1", 2, 3) ausgestaltet ist und/oder mit einer Aufnahme (135, 235, 325), die komplementär zu einer Prothetik (120, 120', 220, 320) ausgestaltet ist. Schliesslich 10 betrifft die Erfindung ein Verbindungssystem für ein Dentalimplantat (100, 100', 200, 300). Um Dentalimplantate (100, 100', 200, 300) bereitzustellen, die den allgemeinen Anforderungen für eine erfolgreiche Implantation sowie Verwendung genügen und sich einfach an Knochenvariationen und Implantatangebot anpassen lassen ist erfindungsgemäss vorgesehen, dass der Verbinder (1, 1', 1", 2, 3) einen Basisabschnitt 15 (11, 11', 11", 21, 31), an dem ein Basisgewinde (111, 111', 111", 211, 311) zum Einschrauben des Verbinders (1, 1', 1", 2, 3) in einen Basiskörper (130, 230, 330) des Dentalimplantats (100, 100', 200, 300) ausgeformt ist, und einen Halteabschnitt (12, 12', 12", 22, 32), an dem ein Haltegewinde (121, 131, 131', 221, 321) zum Aufschrauben einer Prothetik (120, 120', 220, 320) des Dentalimplantats (100, 100', 200, 300) auf den 20 Verbinder (1, 1', 1", 2, 3) ausgeformt ist, besitzt bzw. dass die Prothetik (120, 120', 220, 320) mit einem Gegenhaltegewinde (2102, 3102) zum Aufschrauben der Prothetik (120, 120', 220, 320) auf einen Verbinder (1, 1', 1", 2, 3) des Dentalimplantats (100, 100', 200, 300) versehen ist.

Verbindungssystem für ein Dentalimplantat

Die vorliegende Erfindung liegt auf dem Gebiet der Dentalimplantate. Sie betrifft einen Verbinder zum Verbinden keramischer Komponenten eines Dentalimplantats. Des Weiteren betrifft die Erfindung eine Prothetik für ein Dentalimplantat. Ferner betrifft die Erfindung einen Basiskörper für ein Dentalimplantat. Schliesslich betrifft die Erfindung ein Verbindungssystem für ein Dentalimplantat.

Technologischer Hintergrund

Dentalimplantate können einteilig und mehrteilig ausgestaltet sein. Heutzutage haben sich die mehrteiligen gegenüber den einteiligen Dentalimplantaten durchgesetzt, da mehrteilige Dentalimplantate bessere Anpassungsfähigkeit und Schutz vor unerwünschten Belastungen während des Einheilungsprozesses bieten als einteilige Dentalimplantate.

Eine grosse Anzahl von aus dem Stand der Technik bekannten mehrteiligen Dentalimplantaten ist dreiteilig aufgebaut und umfasst somit einen in einen Kieferknochen einzusetzenden Basiskörper, ein am Basiskörper zu befestigendes Abutment und eine auf das Abutment aufzusetzende Suprakonstruktion. Der auch als Implantatkörper bekannte Basiskörper soll die Zahnwurzel ersetzen und ist meistens zylindrisch oder konisch geformt. In der Regel weist der Basiskörper ein Gewinde auf, über welches der Basiskörper durch Einschrauben im Kieferknochen befestigt werden kann und dadurch eine primäre Festigkeit im Kieferknochen erreicht. Während Basiskörper und Abutment in den Kiefer eingebettet bzw. von der Suprakonstruktion abgedeckt sind, liegt letztere im Mundraum frei und stellt den eigentlichen Zahnaufbau dar. Das auch als Implantataufbau bekannte Abutment dient gewissermassen als Zwischenglied zwischen Basiskörper und Suprakonstruktion und wird in den Basiskörper üblicherweise eingeschraubt und/oder eingeklebt.

Der Basiskörper sollte aus einem möglichst bioinerten Material gefertigt sein, um für den Patienten weitgehend verträglich und komplikationsfrei eingesetzt werden zu können

und eine Rückbildung des Zahnfleisches zu unterbinden. Sowohl Material als auch Struktur des Basiskörpers sollen einen hohen Osseointegrationsgrad ermöglichen. Diese Anforderungen an die so genannte Biokompatibilität sowie an eine hohe Periointegration gelten auch für das Abutment und die Suprakonstruktion. Als Material mit vorteilhaften Verarbeitungseigenschaften sowie hoher Biokompatibilität hat sich mehrheitlich Keramik, insbesondere Zirkoniumoxid, durchgesetzt. Als Alternative zur Keramik wird oft Titan eingesetzt, das jedoch keine so gute Biokompatibilität und Periointegration wie Keramik aufweist.

Für den Langzeiterfolg einer Implantation ist eine verlässliche und gegen Knochen sowie Zahnfleisch abgedichtete Verbindung von Abutment und Basiskörper entscheidend. Eine mangelhafte Verbindung zwischen Abutment und Basiskörper kann zur Lockerung des Dentalimplantats und zur Beschädigung des Dentalimplantats führen. Undichte Verbindungen können das Eindringen von Bakterien in das Implantat zulassen, die zu Periimplantitis führen und somit u.a. Kieferknochenschwund herbeiführen können. Weiter stellen im Gebiss auftretende Kräfte für einen Langzeiterfolg von Implantaten hohe Anforderungen an deren Material und Konstruktion. So müssen die Implantate sämtliche im Gebiss auftretenden Kräfte aufnehmen können, ohne zu brechen, einzureissen oder sich zu lockern. Daher ist es sowohl beim Einsetzen als auch über die gesamte Lebensdauer des Dentalimplantates wesentlich, wo und wie genau eine Krafteinleitung in die einzelnen Komponenten des Implantates stattfindet.

Je nach Position des einzusetzenden Dentalimplantats im Kiefer und Knochenangebot an der Position können verschiedene Implantattypen sowie insbesondere verschiedene Längen bzw. Grössen der Dentalimplantate erforderlich sein. Aufgrund der je nach Kiefersituation variierenden geeigneten Grösse des Dentalimplantats kommen in der Regel Serien mit Bestandteilen verschiedener Grössen zum Einsatz, welche für einen hohen Langzeiterfolg wie eingangs genannt eine verlässliche Verbindung zwischen Abutment und Basiskörper bereitstellen sollten. So können die Serien beispielsweise mehrere Basiskörper verschiedener Grösse beinhalten, zum Beispiel mit Längen von 6, 8, 10, 12, 14 oder 16 mm bei unterschiedlichen Durchmessern von beispielsweise 3.3, 4.1 oder 4.8 mm sowie verschiedenartige Abutments, die geradlinig oder abgewinkelt ausgestaltet sind und ebenfalls in verschiedenen Grössen vorliegen können.

Zusammenfassend haben Dentalimplantate hohen Anforderungen an Biokompabilität, Dichtigkeit, Krafteinleitung und Systemflexibilität zu genügen.

Beispielsweise beschreibt die von der Anmelderin eingereicht europäische Patentanmeldung mit der Veröffentlichungsnummer EP 2 735 279 A1, deren Offenbarungsgehalt durch Bezugnahme vollständig hierin mit aufgenommen wird, ein Dentalimplantat mit einem in einem Kieferknochen verankerbaren Basiskörper aus Keramik und einem mittels einer Schraube am Basiskörper befestigbaren Implantataufbau, wobei in einem zusammengesetzten Zustand des Dentalimplantats ein Gewindeabschnitt der Schraube in ein in einem Sackloch des Basiskörpers ausgebildetes Innengewinde eingreift. Die Schraube drückt den Implantataufbau gegen den Basiskörper. Ein formschlüssiger Eingriff zwischen dem Gewindeabschnitt der Schraube und dem Innengewinde des Loches besteht ausschliesslich in einer dem Implantataufbau abgewandten, unteren Hälfte des Basiskörpers, die sich über die Hälfte der Länge des Basiskörpers erstreckt.

Damit soll gemäss der EP 2 735 279 A1 erreicht werden, dass mechanische Spannungen homogen über eine gesamte Länge des Basiskörpers verteilt werden. Das Innengewinde, in das die Spannungen direkt über die Schraube eingeleitet werden, ist relativ weit vom Kontaktbereich zwischen Basiskörper und Implantataufbau entfernt tief im Fuss des Basiskörpers angeordnet. Um eine verlässliche Befestigung des Basiskörpers mit dem Implantataufbau mittels der Schraube zu erreichen, muss die Länge der Schraube mit der Länge des Sacklochs des Basiskörpers sowie eines Teils des Implantataufbaus übereinstimmen. Für verschieden lange Dentalimplantate sind dementsprechend jeweils unterschiedliche Schrauben vorzusehen. Die Bereitstellung unterschiedlicher Schrauben ist nicht nur kostspielig, sondern darüber hinaus auch in der Anwendung mühsam, führt also zu unerwünschten Mehrkosten und Aufwänden.

Darstellung der Erfindung

Es ist daher eine Aufgabe der Erfindung, Dentalimplantate bereitzustellen, die den allgemeinen Anforderungen für eine erfolgreiche Implantation sowie Verwendung genügen und sich zumindest einfacher an Knochenvariationen und Implantatangebot anpassen lassen als aus dem Stand der Technik bekannte Dentalimplantate.

Diese Aufgabe wird erfindungsgemäss durch einen Verbinder gemäss unabhängigem Anspruch 1, einer Prothetik gemäss unabhängigen Anspruch 10, einem Basiskörper gemäss Anspruch 13 und durch ein Verbindungssystem gemäss Anspruch 14 gelöst. Bevorzugte Ausgestaltungen der Erfindung sind in den abhängigen Ansprüchen und in der vorliegenden Offenbarung angegeben.

Insbesondere wird die Aufgabe durch einen Verbinder zum Verbinden keramischer Komponenten eines Dentalimplantats gelöst, mit einem Basisabschnitt, an dem ein Basisgewinde zum Einschrauben des Verbinders in einen Basiskörper des Dentalimplantats ausgeformt ist, und mit einem Halteabschnitt, an dem ein Haltegewinde zum Aufschrauben einer Prothetik des Dentalimplantats auf den Verbinder ausgeformt ist.

Insbesondere wird die Aufgabe mit einer Prothetik für ein Dentalimplantat gelöst, mit einem Gegenhaltegewinde zum Aufschrauben einer Prothetik auf einen Verbinder des Dentalimplantats.

Insbesondere wird die Aufgabe mit einem Basiskörper für ein Dentalimplantat gelöst, mit einem Innengewinde, das komplementär zu einem Basisgewinde eines erfindungsgemässen Verbinders ausgestaltet ist und/oder mit einer Aufnahme, die komplementär zu einer erfindungsgemässen Prothetik ausgestaltet ist.

Insbesondere wird die Aufgabe durch einen Verbindungssystem für ein Dentalimplantat gelöst, mit wenigstens einem erfindungsgemässen Verbinder und/oder mit wenigstens einer erfindungsgemässen Prothetik und/oder mit wenigstens einem erfindungsgemässen Basiskörper.

Die erfindungsgemässe Lösung hat gegenüber dem Stand der Technik den Vorteil, dass Verbinder und Prothetik an den jeweiligen Basiskörper angepasst ausgewählt werden können. Beispielsweise können eine Vielzahl verschiedener Prothetiken durch die Verwendung des Verbinders auf den Basiskörper aufgeschraubt werden. Dabei können die Verbinder ebenfalls an die jeweiligen Gegebenheiten angepasst sein oder es kann ein an die Gegebenheiten anpassbarer Einheitsverbinder verwendet werden.

Somit hilft die Erfindung als Verbindungssystem eine Art Systembaukasten für Zahnaufbauten und andere Bestandteile von Dentalimplantaten bereitzustellen, die von der Einheilphase des Implantats bis zu seinem gebrauchsfertigen Aufbau Verwendung finden. So kann es sich bei der Prothetik beispielsweise um einen Gingivaformer zur Anpassung des Zahnfleisches an eine Form einer später verwendeten Abutments handeln. Alternativ oder zusätzlich können Prothetik und Verbinder gemeinsam als Implantatschraube in Form einer Einheilschraube zur Abdichtung des Basiskörpers bzw. Implantates gegen Bakterien während der Einheilung dienen.

Erfindungsgemässe Einheitsverbinder bzw. Verbinder können folglich zusammen mit erfindungsgemässen Abutments und/oder Prothetiken verwendet werden. Die Abutments und/oder Prothetiken können als Kopf bzw. Kopfteil von zusammen mit dem Verbinder bzw. Einheitsverbinder gebildeten Schrauben verwendet werden bzw. zumindest abschnittsweise einen Kopf oder Kopfteil einer Schraube bilden, beispielsweise einer Implantat- oder Einheilschraube. Mit anderen Worten können Abutment, Prothetik und/oder Kopfteil äquivalent mit einem erfindungsgemässen Verbinder bzw. Einheitsverbinder zusammenwirken und dementsprechend dazu erforderliche Ausgestaltungsformen und Merkmale aufweisen, wie sie hierin unter Bezug auf Abutment, Prothetik und/oder Kopfteil beschrieben sind.

Die erfindungsgemässe Lösung kann durch die folgenden weiteren, jeweils für sich vorteilhaften Ausführungsformen beliebig ergänzt und weiter verbessert werden, wobei ein Fachmann ohne Weiteres klar und eindeutig erkennen wird, dass Vorrichtungsmerkmale von Komponenten eines erfindungsgemässen Verbindungssystems entsprechende Schritte erfindungsgemässer Verfahren zur Herstellung und zum Einsatz eines erfindungsgemässen Verbindungssystems und seiner Komponenten begründen und umgekehrt.

So ist gemäss einer ersten weiteren Ausführungsform vorgesehen, dass der Verbinder aus einem Metall oder einer Metalllegierung, vorzugsweise zumindest anteilig aus Titan, gefertigt ist. Somit weist der Verbinder eine höhere Elastizität als die aus Keramik gefertigten Komponenten des Dentalimplantates, wie beispielsweise der Basiskörper, die Prothetik und das Abutment auf. In Anbetracht dessen, dass diese keramischen Komponenten aufgrund entsprechender Werkstoffeigenschaften insbesondere Zugkräfte, Biegemomente und Scherspannungen schlechter aufnehmen können als

metallische Komponenten, hilft der Einsatz des metallischen Verbinders, dem gesamten Dentalimplantat eine vorteilhafte Dauerfestigkeit und Widerstandsfähigkeit zu verleihen, indem es einerseits von der Druckfestigkeit, Abriebfestigkeit und Biokompatibilität der Keramik und andererseits der Elastizität und Zähigkeit des metallischen Verbinders profitiert.

Durch eine derartige Kombination von Keramik und Metall stellt ein erfindungsgemässes Verbindungsystem sozusagen ein hybrides Dentalimplantatsystem dar. Dabei ist es für das Zahnfleisch Ideal, keinen Kontakt zu metallischen Verbinder zu haben. Dies wird erfindungsgemäss dadurch erreicht, dass der Verbinder vorteilhafterweise innerhalb eines von Basiskörper und Prothetik gebildeten Innenraums des Dentalimplantats oder zumindest durch Basiskörper und/oder Prothetik vom Zahnfleisch beabstandet angeordnet ist. Der Innenraum ist vorteilhafterweise hermetisch abgeschlossen, indem eine Kontaktfläche der Prothetik abdichtend auf einer Kontaktfläche des Basiskörpers aufliegt.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass der Verbinder zwischen dem Basisabschnitt und dem Halteabschnitt wenigstens ein Schulterelement aufweist, dass in einer radialen Richtung des Verbinders zumindest abschnittsweise über einen Aussenumfang des Basisabschnitts und/oder des Halteabschnitts hinweg ragt. Das Schulterelement kann sowohl zur Handhabung des Verbinders als solchen dienen als auch einen Anschlag für den Verbinder ausbilden. So kann der Verbinder bis zum Schulterelement als Anschlag am Basiskörper in den Basiskörper eingeschraubt werden. Das Schulterelement hilft also, den Verbinder präzise und unter taktiler und/oder optischer Rückmeldung im Basiskörper zu befestigen. Mit dem Basisgewinde in den Basiskörper eingeschraubt, kann der Verbinder durch das Haltegewinde eine Anbringungsmöglichkeit für vielerlei Prothetiken bzw. für Austauschprothetiken aus Verschleiss- oder ästhetischen Gründen bereitstellen.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass das wenigstens eine Schulterelement an einem Ringbund ausgeformt ist, dessen Aussendurchmesser grösser ist als ein Aussendurchmesser des Basisabschnitts und/oder des Halteabschnitts. Der Ringbund kann konzentrisch zum Basisgewinde und/oder Haltegewinde angeordnet sein. Somit trägt der Ringbund zu einer

gleichmässigen Kräfteübertragung zwischen Verbinder und Prothetik und/oder zwischen Verbinder und Basiskörper bei.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass am Verbinder wenigstens ein Eingriffsmittel ausgeformt ist zum betätigen des Verbinders mit einem Werkzeug. Das Eingriffsmittel hilft, ein vorteilhafterweise komplementär zum Eingriffsmittel ausgestaltetes Werkzeug präzise am Verbinder anzusetzen und den jeweiligen Anforderungen entsprechend Kräfte und/oder Momente vom Werkzeug auf den Verbinder zu übertragen.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass das wenigstens eine Eingriffsmittel zumindest abschnittsweise mit einer Aussenprofilierung versehen ist. Beispielsweise kann die Aussenprofilierung als Aussensechskant ausgeformt sein. Ein Aussendurchmesser der Aussenprofilierung kann beispielsweise kleiner sein als ein Aussendurchmesser von Basisgewinde und/oder Haltegewinde. Dies ermöglicht ein radiales Spiel zwischen Eingriffsmittel und anderen Komponenten des Dentalimplantats, insbesondere jeweiliger Innenumfänge von Basiskörper und/oder Prothetik. Ein derartiges radiales Spiel hilft, eine Überbestimmung von Toleranzen der Komponenten des Dentalimplantates zu vermeiden sowie gewisse Freiheitsgrade bei der Handhabung der Komponenten sowie deren Montage bereitzustellen.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass ein Kopfende des Verbinders als das wenigstens eine Eingriffsmittel ausgestaltet ist. Somit bleibt das Eingriffsmittel des in den Basiskörper eingesetzten Verbinders gut zugänglich. Die Zugänglichkeit kann beispielsweise verbessert werden, indem das Kopfende des Verbinders in einem vollständig in den Basiskörper eingesetzten Zustand des Verbinders entgegen einer Einsetzrichtung über eine Oberkante des Basiskörpers hinaus ragt. Alternativ oder zusätzlich kann das Eingriffsmittel an einem Ringbund oder als solcher am Verbinder ausgeformt sein.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass wenigstens eine Ringnut zwischen dem Basisabschnitt und dem Halterabschnitt ausgeformt ist, an der sich der Aussenumfang des Verbinders gegenüber den jeweils umliegenden Abschnitten verjüngt. Eine derartige Ringnut hilft zum einen, ungewünschtes Verkanten, Reiben oder Anschlagen des Verbinders beim Einsetzen des Verbinders in den

Basiskörper oder beim Aufsetzen der Prothetik auf den Verbinder zu verhindern. Zum anderen helfen derartige Ringnuten, dem Verbinder gezielt gewünschte Elastizitäten zu verleihen bzw. seine Biegsamkeit an gewünschter Stelle zu erhöhen, damit beispielsweise eher der Verbinder nachgibt, als dass die Kontaktflächen zwischen Verbinder und Keramik und/oder Kontaktflächen zwischen Keramiken durch unausgewogene Belastungen überstrapaziert werden.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass das Basisgewinde und/oder das Haltegewinde als Linksgewinde ausgestaltet sind bzw. ist. Gewinde von Implantaten sind in der Regel als Rechtsgewinde ausgestaltet. Einer Ausgestaltung des Basisgewindes und/oder des Haltegewindes als Linksgewinde hilft zu verhindern, dass sich eine Verschraubung ungewünscht löst. Wenn beispielsweise das Haltegewinde als Rechtsgewinde und das Basisgewinde als Linksgewinde ausgestaltet ist, dann kann die Prothetik vom Haltegewinde abgeschraubt werden, ohne dass die Verschraubung zwischen Verbinder und Basiskörper dabei gelöst wird.

Bei einer erfindungsgemässen Prothetik kann die erfindungsgemässe Lösung gemäss einer ersten weiteren vorteilhaften Ausführungsform dadurch verbessert werden, dass der Gegenhalteabschnitt mit einem Sackloch versehen ist, in dem das Gegenhaltegewinde angeordnet ist. Durch die Anordnung des Gegenhaltegewindes im Sackloch kann das Gegenhaltegewinde bzw. ein oberer Endabschnitt des Verbinders von der Prothetik umschlossen sein. Mit anderen Worten kann die Prothetik kappenartig auf den Verbinder aufgesetzt werden. Dies hilft, einen hermetisch abgeschlossenen Innenraum des Dentalimplantates zwischen Prothetik und Basiskörper zu bilden. In diesem Innenraum kann der Verbinder von der Umgebung des Dentalimplantates, sprich Zahnfleisch und Mundraum, abgeschirmt aufgenommen sein.

Gemäss einer weiteren vorteilhaften Ausführungsform ist vorgesehen, dass das Gegenhaltegewinde zumindest abschnittsweise entlang eines Fortsatzes der Prothetik verläuft, der dazu ausgestaltet ist, in eine Aufnahme eines Basiskörpers des Dentalimplantats einzugreifen. Somit kann die Prothetik sich in radialer Richtung mit dem Basiskörper überdecken. Dies hilft zum einen bei der Montage der Prothetik, diese gegenüber dem Basiskörper zu positionieren bzw. zentrieren. Zum anderen hilft die Überdeckung, eine hohe Stabilität des Dentalimplantats und eine Abdichtung dessen Innenraumes zu gewährleisten.

Bei einem erfindungsgemässen Verbindungsystem kann die erfindungsgemässe Lösung gemäss einer ersten weiteren vorteilhaften Ausführungsform dadurch verbessert werden, dass in einem Endmontagezustand des Dentalimplantats der Verbinder in einem von Prothetik und Basiskörper umschlossenen Innenraum des Dentalimplantats aufgenommen ist. Somit können insbesondere aus Metallen oder Metalllegierungen gefertigte Verbinder bzw. Einheitsverbinder im Innenraum angeordnet von vorzugsweise aus keramischen Werkstoffen gefertigten Basiskörpern und Prothetiken umgeben sein, um einen Kontakt der Verbinder zum Zahnfleisch zu vermeiden. Dabei ist es weiterhin von Vorteil, wenn der Innenraum hermetisch abgedichtet ist. Dazu sollte die Prothetik im Endmontagezustand bündig abdichtend am Basiskörper anliegen.

Vor dem Endmontagezustand kann der Verbinder in einem Vormontagezustand des Dentalimplantates entweder zuerst mit dem Basiskörper oder mit der Prothetik verbunden sein. Wenn der Verbinder im Vormontagezustand mit dem Basiskörper verbunden ist, dann kann er mit seinem Basisgewinde in den Basiskörper eingesetzt sein, während sein Haltegewinde von Aussehalb des Basiskörpers zugänglich angeordnet ist, um die Prothetik daran zu befestigen und somit das Dentalimplantat vom Vormontagezustand in den Endmontagezustand zu überführen. Wenn der Verbinder im Vormontagezustand mit der Prothetik verbunden ist, dann lassen sich diese wie eine Implantatschraube handhaben, die zum Überführen des Dentalimplantats vom Vormontagezustand in den Endmontagezustand in den Basiskörper eingeschraubt wird.

Alternativ oder zusätzlich wird die Aufgabe durch eine Implantatschraube für ein Dentalimplantat, mit einem keramischen Kopfteil und mit einem in einen Basiskörper des Dentalimplantats einschraubbaren nicht-keramischen Basisgewinde, gelöst.

Diese erfindungsgemässe Lösung hat gegenüber dem Stand der Technik den Vorteil, dass Kopfteil und Basisgewinde an den jeweiligen Basiskörper angepasst ausgewählt werden können. Beispielsweise insbesondere können eine Vielzahl verschiedener Kopfteile durch die Verwendung des Basisgewindes auf den Basiskörper aufgeschraubt werden. Dabei kann das Basisgewinde ebenfalls an die jeweiligen Gegebenheiten angepasst sein oder es kann ein an die Gegebenheiten anpassbarer Verbinder bzw. Einheitsverbinder verwendet werden, an dem das Basisgewinde ausgeformt ist.

Der Kopfteil besteht beispielsweise aus Keramik, um eine möglichst hohe Biokompatibilität einer erfindungsgemässen Implantatschraube zu gewährleisten. Der Kopfteil kann unverlierbar mit einer Prothetik verbunden oder an einer Prothetik bzw. als Prothetik ausgeformt sein. Beispielsweise ist der Kopfteil bzw. die Prothetik rotationssymmetrisch ausgestaltet. An Kopfteil bzw. Prothetik kann eine Kontaktfläche ausgeformt sein, die dazu ausgebildet ist, bündig auf dem Basiskörper aufzuliegen. Somit kann das Basisgewinde zwischen Kopfteil bzw. Prothetik und Basiskörper eingeschlossen aufgenommen sein. Das Basisgewinde besteht beispielsweise aus einem nicht-keramischen Werkstoff. Als nicht keramischer Werkstoff kann vorzugsweise ein Metall oder eine Metalllegierung verwendet werden, um einer erfindungsgemässen Implantatschraube eine möglichst hohe Zähigkeit zu verleihen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Kopfteil über einen Formschluss zur Übertragung eines um eine Mittelachse der Implantatschraube wirkenden Drehmoments mit dem Basisgewinde verbunden ist. Der Formschluss hilft, Relativdrehungen zwischen Kopfteil und Basisgewinde zumindest um die Mittelachse herum zu verhindern. Durch den Formschluss können Drehmomente präzise und sicher vom Kopfteil auf das Basisgewinde übertragen werden und umgekehrt. Durch den Formschluss können erfindungsgemässe zweiteilige Implantatschrauben aus Kopfteil und Basisgewinde gehandhabt werden, wie es bei einteiligen Implantatschrauben möglich ist.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Kopfteil mit einer Ausnehmung versehen ist, in der wenigstens abschnittsweise ein Verbinder aufgenommen ist, an dem das Basisgewinde ausgeformt ist. Die Ausnehmung ist beispielsweise sacklochartig ausgestaltet. Die Ausgestaltung der Ausnehmung als Sackloch hilft, den Verbinder bzw. ein oberes Ende des Verbinders vorzugsweise mit der Ausnehmung zu umschliessen. Zum einen lässt sich somit eine möglichst innige und feste Verbindung zwischen Kopfteil und Verbinder herstellen. Zum anderen ist eine zumindest abschnittsweise Einbettung des nicht-keramischen Verbinders in das keramische Material des Kopfteils begünstigt. Der Verbinder kann den jeweiligen Anforderungen entsprechend ausgestaltet bzw. ausgewählt sein. Beispielsweise ist der Verbinder bolzenförmig und/oder zumindest abschnittsweise zylindrisch ausgeformt. Das Basisgewinde kann dementsprechend die Form eines Gewindebolzens aufweisen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass in der Ausnehmung ein Gegenhaltegewinde zum Aufschrauben des Kopfteils auf den Verbinder angeordnet ist. Das Gegenhaltegewinde ermöglicht, den Verbinder in den Kopfteil einzuschrauben, um somit eine formschlüssige Verbindung zwischen Kopfteil und Verbinder herzustellen. Kopfteil und Verbinder können daher einfach miteinander kombiniert werden.

Gemäss einerweiteren Ausführungsform ist vorgesehen, dass dem Gegenhaltegewinde eine mit dem Kopfteil verbundene Verzahnung zugeordnet ist. Beispielsweise ist die Verzahnung an der Prothetik bzw. dem Kopfteil ausgeformt. Die Verzahnung kann beispielsweise beim Zusammenführen des Kopfteils bzw. der Prothetik mit dem Verbinder in dessen Material eindringen und eine form- und/oder kraftschlüssige Verbindung zwischen Kopfteil bzw. Prothetik und Verbinder herbeiführen helfen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Verzahnung das Gegenhaltegewinde umkränzt. Mit anderen Worten umgibt die Verzahnung kranzförmig das Gegenhaltegewinde und/oder überlappt sich mit diesem. Beispielsweise kann die Verzahnung eine Öffnung zur Ausnehmung bzw. dem darin angeordneten Gegenhaltegewinde umgeben. Dies begünstigt einen möglichst symmetrischen und daher ausgeglichenen Eingriff der Verzahnung in das Material des Verbinders.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Verzahnung flache Zahnflanken und/oder steile Zahnflanken aufweist, wobei die flachen Zahnflanken in eine Schraubrichtung des Gegenhaltegewindes Weisen bzw. die steilen Zahnflanken entgegen der Schraubrichtung weisen. Bei der Schraubrichtung handelt es sich beispielsweise um diejenige Richtung, in der das Gegenhaltegewinde und folglich das Kopfteil bzw. die Prothetik auf den Verbinder aufschraubbar ausgestaltet ist. Indem die flachen Zahnflanken in Richtung der Schraubrichtung weisen, begünstigen sie selbst nach ihrem Kontakt mit dem Verbinder ein weiteres Aufschrauben des Kopfteils bzw. der Prothetik auf den Verbinder, da sie über das Material des Verbinders gleiten. Hingegen bewirken die steilen Zahnflanken, dass die Verzahnung sich beim Bewegen des Kopfteils bzw. der Prothetik relativ zum Verbinder entgegen der Schraubrichtung in das Material des Verbinders graben bzw. dieses derart verdrängen, dass ein inniger Form- und/oder Kraftschluss zwischen Kopfteil bzw. Prothetik und Verbinder bewirkt ist. Ein derartiger Form- und/oder Kraftschluss verhindert insbesondere ein ungewolltes Lösen der Schraubverbindung zwischen Kopfteil bzw. Prothetik und Verbinder.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass eine mit dem Kopfteil verbundene Stirnseite in Richtung zum Basisgewinde hin weist und/oder wenigstens abschnittsweise am Verbinder anliegt. Beispielsweise kann die Stirnseite an Kopfteil bzw. Prothetik ausgeformt sein und weist vorzugsweise in axialer Richtung, d. h. in eine im Wesentlichen parallel zur Mittelachse verlaufende Richtung. Eine derartige Stirnseite begünstigt eine Kraft- und/oder Momentenübertragung zwischen Kopfteil bzw. Prothetik und Verbinder einerseits sowie zwischen Implantatschraube und Basiskörper andererseits.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Stirnseite ringförmig ausgebildet ist. Die Stirnseite kann beispielsweise eine Öffnung zur Ausnehmung bzw. dem Basisgewinde umschliessen bzw. einen Rand der Öffnung ausbilden. Eine ringförmige ausgestaltete, vorzugsweise rotationssymmetrisch zur Mittelachse angeordnete Stirnseite begünstigt eine möglichst gleichmässige Kraft- und/oder Momentenübertragung zwischen Kopfteil bzw. Prothetik und Verbinder einerseits sowie zwischen Implantatschraube und Basiskörper andererseits.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass wenigstens ein Zahn an der Stirnseite ausgeformt ist, an dem eine von der Stirnseite weg weisende Zahnspitze ausgeformt ist. Beispielsweise kann die Verzahnung aus einer Vielzahl derartiger Zähne gebildet sein. Die Zahnspitzen können von der Stirnseite hervorragen und somit in das Material des Verbinders eindringen, um eine möglichst innige kraft- und/oder formschlüssige zwischen Kopfteil bzw. Prothetik und Verbinder zu bewirken.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der wenigstens eine Zahn zumindest abschnittsweise die Verzahnung ausbildet. Mit anderen Worten umfasst die Verzahnung den von der Stirnseite weg weisenden Zahn. Der wenigstens eine Zahn kann entsprechend eine flache und eine steile Zahnflanke aufweisen, wie oben beschrieben ist. Vorteilhafterweise ist eine Vielzahl von die Verzahnung bildenden Zähnen rotationssymmetrisch zur Mittelachse entlang der Stirnseite angeordnet, um eine möglichst gleichmässige Kraftübertragung zwischen Kopfteil bzw. Prothetik und Verbinder zu gewährleisten.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Verbinder einem Halteabschnitt aufweist, an dem ein Haltegewinde zum Aufschrauben des Kopfteils auf

den Verbinder ausgeformt ist. Das Haltegewinde ist vorzugsweise komplementär zum Gegenhaltegewinde ausgestaltet. Dies begünstigt, eine möglichst spielfreie zuverlässige Schraubverbindung zwischen Kopfteil bzw. Prothetik und Verbinder herzustellen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Verbinder einen Ringbund aufweist, der zumindest abschnittsweise in Richtung zum Kopfteil hin weist. Am Ringbund kann der Kopfteil bzw. die Prothetik, insbesondere deren Stirnseite, zur Anlage kommen. Dies begünstigt zum einen eine innige Verbindung zwischen Kopfteil bzw. Prothetik und Verbinder. Zum anderen kann durch eine bündige Auflage des Kopfteils bzw. der Prothetik am Ringbund des Verbinders eine ordnungsgemässe Vereinigung von Kopfteilbeziehung Prothetik und Verbinder optisch und/oder haptisch einfach verifiziert werden.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass wenigstens ein Eingriffsmittel zum Ansetzen eines Werkzeugs zum Einschrauben des Verbinders am Ringbund ausgeformt ist. Beispielsweise kann eine Aussenkontur des Ringbundes als Eingriffsmittel ausgestaltet sein. Vorzugsweise ist die Aussenkontur als Aussensechskant ausgeformt. Das Eingriffsmittel des Verbinders vereinfacht es, möglichst materialschonend Kräfte und/oder Drehmomente über ein Werkzeug auf den Verbinder zu übertragen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass wenigstens ein Eingriffsmittel zum Ansetzen eines Werkzeugs zum Einschrauben der Implantatschraube am Kopfteil ausgeformt ist. Beispielsweise kann eine Innenkontur des Eingriffsmittels des Kopfteils bzw. der Prothetik als Innensechskant oder Innensechsrund ausgeformt sein. Das Eingriffsmittel des Kopfteils bzw. der Prothetik vereinfacht es, möglichst materialschonend Kräfte und/oder Drehmomente über ein Werkzeug auf den Kopfteil bzw. die Prothetik einerseits und andererseits auf die Implantatschraube zu übertragen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Kopfteil über eine Klebeverbindung mit dem Basisgewinde verbunden ist. Beispielsweise ist der Kopfteil bzw. die Prothetik mit dem Verbinder verklebt. Die Verklebung kann alternativ oder zusätzlich zu einer oben beschriebenen Schraubverbindung zwischen Kopfteil bzw. Prothetik und Verbinder eingesetzt werden, um diese innig miteinander zu verbinden. In

Kombination mit einer Schraubverbindung kann die Verklebung wie eine Schraubensicherung wirken. Zwischen Kopfteil bzw. Prothetik und Verbinder kann eine Kavität ausgeformt sein, in die ein Kleber eindringen bzw. die vom Kleber aufgefüllt sein kann. Zur Bereitstellung der Kavität kann beispielsweise eine Ringnut am Basisgewinde bzw. in dessen Nähe vorzugsweise am Verbinder ausgeformt sein.

Ferner betrifft die Erfindung einen Einheitsverbinder zum Verbinden eines Abutments eines Dentalimplantats mit einem Basiskörper des Dentalimplantat, umfassend einen entlang einer Einsetzrichtung in den Basiskörper einsetzbaren und darin fixierbaren Basisabschnitt und einen Abutmenthalteabschnitt zum Halten des Abutments am Basiskörper, wobei der Abutmenthalteabschnitt wenigstens zwei entlang der Einsetzrichtung voneinander beabstandete Haltepositionen für das Abutment bereitstellt.

Die Erfindung betrifft weiter ein Einheitsverbindungssystem für Dentalimplantate umfassend mindestens einen erfindungsgemässen Einheitsverbinder. Mit Hilfe des Einheitsverbinders kann das Einheitsverbinder System für eine Vielzahl verschieden grosser und verschiedenartiger Dentalimplantate verwendet werden. Neben wenigstens einem Einheitsverbinder kann das Einheitsverbindungssystem noch weitere Elemente, wie Halteelemente, Zusatzhalteelemente sowie mit diesen und/oder dem Einheitsverbinder zusammenwirkende Werk und/oder Messzeuge beinhalten.

In der Regel weisen sowohl der Basiskörper als auch das Abutment Bohrungen auf, welche den Einheitsverbinder aufnehmen können, wobei im zusammengesetzten Zustand des Dentalimplantats ein unterer Bereich des Einheitsverbinders sich im Basiskörper befindet und ein oberer Bereich des Einheitsverbinders sich im Abutment befindet. Der Einheitsverbinder kann je nach Länge des Basiskörpers als auch des Abutments oben aus dem Abutment herausragen. Bevorzugt ist der erste Endbereich beim Einsetzen des Einheitsverbinders in den Basiskörper mit dem Basiskörper verbindbar, vorzugsweise fest verankerbar. Optional kann der Einheitsverbinder in den Basiskörper eingeklebt oder alternativ bajonettverschlussartig verbunden werden.

Der Einheitsverbinder bietet den Vorteil, dass er dank der veränderbaren Länge für Dentalimplantate von verschiedener Grösse verwendet werden kann. Bei herkömmlichen Lösungen mit konventionellen Schrauben hingegen müssen die Grössen bzw. Längen der Bestandteile mit der Schraube genau abgestimmt sein, um

eine verlässliche Verbindung von Basiskörper und Abutment zu gewährleisten. Indem der erfindungsgemässe Einheitsverbinder wenigstens zwei Haltepositionen bereitstellt, ermöglicht er es sowohl bei verschieden grossen Basiskörper als auch verschieden grossen Abutments eingesetzt zu werden. Somit kann beispielsweise bei gesamten Serien für Dentalimplantate eine formschlüssig abgedichtete Verbindung des Basiskörpers mit dem Abutment durch den gleichen Einheitsverbinder erzielt werden, der vorteilhafterweise möglichst tief im Basiskörper verankert sein kann. Dies hilft zum einen, einen stabilen Aufbau des Dentalimplantates zu gewährleisten. Zum anderen lassen sich durch eine gegenüber dem Stand der Technik erhöhte Variabilität Produktionskosten für Dentalimplantate senken und deren Anwendung vereinfachen.

Durch die Wirkverbindung des zweiten Endbereichs des Einheitsverbinders mit dem Abutment kann der Einheitsverbinder den Basiskörper mit dem Abutment, vorzugsweise kraft und formschlüssig abdichtend, verbinden. Die Wirkverbindung kann u.a. formschlüssig, kraftschlüssig und/oder stoffschlüssig, u.a. auch indirekt über ein Halte- bzw. Verbindungsmittel, wie z.B. in Ausgestaltung einer Hülse, erfolgen. Formschlüssig ist im dem Fachmann bekannten Rahmen der Fertigung der Bestandteile des Dentalimplantats zu verstehen. Abdichtend ist im Zusammenhang mit der Verbindung zwischen dem Abutment und dem Basiskörper so zu verstehen, dass die Kontaktflächen zwischen dem Basiskörper und dem Abutment so dicht sind, dass z.B. keine Bakterien zwischen Basiskörper und Abutment eindringen können, was dabei hilft Periimplantitis zu vermeiden.

Ein erfindungsgemässer Einheitsverbinder lässt sich insbesondere durch die Abdichtung bei mehrteiligen Dentalimplantaten aus Keramik besonders vorteilhaft einsetzen. Bei derartigen Dentalimplantaten ist in der Regel ein Innenraum bzw. eine Kavität zwischen Basiskörper und Abutment gebildet. Bei ordnungsgemässer Montage des Abutments am Basiskörper ist der Innenraum hermetisch gegenüber Kieferknochen und Zahnfleisch abgedichtet. Der Einheitsverbinder kann daher von Kieferknochen und Zahnfleisch isoliert im Innenraum aufgenommen sein. Somit kann der Einheitsverbinder auch aus anderen Materialien als Keramik, beispielsweise rostfreier Stahl und/oder Titan o.ä., gefertigt sein, ohne Abstriche bei der Biokompatibilität des Dentalimplantates machen zu müssen, weil diese durch die keramische Beschaffenheit der den Einheitsverbinder umhüllenden Komponenten des Implantates gewährleistet ist.

Die erfindungsgemässe Lösung lässt sich mit den folgenden weiteren, jeweils für sich vorteilhaften erfindungsgemässen Ausführungsformen beliebig kombinieren und weiter verbessern.

Gemäss einer ersten weiteren Ausführungsform sind die Haltepositionen stufenlos variabel wählbar. Eine stufenlos variable Wählbarkeit der Haltepositionen erlaubt es, eine Vielzahl verschiedenartiger Basiskörper und Abutments mit dem gleichen Typ Einheitsverbinder miteinander zu verbinden. Auch hilft die stufenlos variable Wählbarkeit der Haltepositionen dabei, etwaige Fertigungstoleranzen sowie Abweichungen oder Ungleichmässigkeiten beim implantieren bzw. Aufbauen des Implantats auszugleichen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Basisabschnitt ein erstes Aussengewinde aufweist, welches mit einem Innengewinde des Basiskörpers in Eingriff bringbar ausgestaltet ist und die wenigstens zwei Haltepositionen bereitstellt. Durch das Aussengewinde kann der Einheitsverbinder auf einfache Weise in den Basiskörper eingeschraubt und somit form- sowie kraftschlüssig damit verbunden werden. Entlang des Aussengewindes können die Haltepositionen stufenlos variabel wählbar bereitgestellt sein.

Gemäss einerweiteren Ausführungsform eines erfindungsgemässen Einheitsverbinders ist vorgesehen, dass eine parallel zur Einsetzrichtung gemessene Länge des ersten Aussengewindes im Wesentlichen mit einer parallel zur Einsetzrichtung gemessene Länge des Innengewindes übereinstimmt oder zumindest lediglich geringfügig die Länge des Innengewindes unterschreitet. Somit können Innengewinde und Aussengewinde sich im Wesentlichen vollständig überdecken. Zum einen hilft dies, durch die Dimensionierung der Gewinde selber einen unteren Anschlag für den Einheitsverbinder bereitzustellen und somit seinen Einsetzweg in Einsetzrichtung zu begrenzen. Zum anderen ist die form- und kraftschlüssige Verbindung zwischen Einheitsverbinder und Basiskörper präzise auf den Bereich besagter Gewinde beschränkt und darin konzentriert. Unnötige Gewindegänge und damit verbundene Materialschwächungen sind vermieden.

Gemäss einerweiteren Ausführungsform eines erfindungsgemässen Einheitsverbinders ist vorgesehen, dass der Einheitsverbinder zwischen dem Basisabschnitt und dem Abutmenthalteabschnitt einen zylinderförmigen Schaftabschnitt aufweist. Somit kann der

Einheitsverbinder als eine Art Stehbolzen mit je einem Gewinde an jedem Ende hergestellt werden. Der Schaftabschnitt begünstigt eine möglichst spielfreie Aufnahme des Einheitsverbinders sowohl im Basiskörper als auch im Abutment. Etwaige Querkräfte oder Momente können über möglichst mit geringem Spiel bzw. spielfrei dimensionierte Anlageflächen zwischen Schaftabschnitt und Basiskörper einerseits sowie zwischen Schaftabschnitt und Abutment andererseits übertragen werden, was dabei hilft, die Robustheit und Langlebigkeit des gesamten Dentalimplantats zu verbessern.

Gemäss einer weiteren Ausführungsform weist der Schaftabschnitt wenigstens teilweise einen grösseren Durchmesser als der Basisabschnitt auf. Im Bereich der Durchmesseränderung kann ein Anschlag bzw. eine Abstufung gebildet sein, welcher hilft, einen Einsetzweg des Einheitsverbinders in Einsetzrichtung zu begrenzen. Darüber hinaus ermöglicht diese Ausführungsform, den Schaftabschnitt derart stabil auszugestalten, dass in Querrichtung bzw. radial zur Mittelachse des Schaftabschnittes bzw. Einheitsverbinders wirkende Kräfte sicher aufgenommen und abgetragen werden können. Im Gegensatz dazu können Gewinde im Basisabschnitt und im Abutmenthalteabschnitt zur Aufnahme von parallel zur Einsetzrichtung wirkenden Zugkräften ausgestaltet sein, was dabei hilft, die Abmasse der einzelnen Bestandteile des Dentalimplantates zu optimieren. Des Weiteren bietet diese Ausführungsform den Vorteil, dass ein Kontakt zwischen Basisabschnitt und der Innenwand der Bohrung des Basiskörpers bei der Einführung des Einheitsverbinders in die Bohrung des Basiskörpers minimiert werden kann. Bei einem Gewinde im Basisabschnitt kann zum Beispiel ein Kontakt zwischen dem Gewinde und der Innenwand der Bohrung des Basiskörpers bei der Einführung des Einheitsverbinders zu Beschädigungen führen, was insbesondere für Basiskörper aus Keramik kritisch sein kann. Durch eine Abstufung kann somit vorteilhafterweise eine Führung des Einheitsverbinders durch den Schaft sichergestellt und eine nachteilhafte Beschädigung des Basiskörpers durch Kontakt der Innenwand mit dem Basisabschnitt minimiert werden. Vorzugsweise weist die Bohrung des Basiskörpers im unteren Bereich anschliessend eine dem ersten Endbereich des Einheitsverbinders entsprechende verengte Bohrung auf, in welche der Basisabschnitt des Einheitsverbinders eingreifen bzw. möglichst bündig damit abschliessend eingesetzt werden kann.

Gemäss einer weiteren Ausführungsform ist ein mit den Abutmenthalteabschnitt umgreifendes Halteelement vorgesehen, das dazu ausgestaltet ist, zum Halten des Abutments mit dem Abutmenthalteabschnitt zusammenzuwirken. Das Halteelement kann in den wenigstens zwei Haltepositionen am Einheitsverbinder fixierbar bzw. arretierbar ausgestaltet sein oder zumindest derart mit dem Einheitsverbinder zusammenwirken, dass es im Wesentlichen parallel zur Einsetzrichtung wirkende Kräfte vom Einheitsverbinder aufnehmen und an diesen übertragen kann. Verschiedene Halteelemente können mit jeweils dem gleichen Einheitsverbinder kombiniert werden, um diesen mit verschiedenartigen Basiskörpern und/oder Abutments zusammen verwenden zu können.

Gemäss einer weiteren Ausführungsform des Einheitsverbinders ist vorgesehen, dass das Halteelement wenigstens eine zumindest teilweise entgegen der Einsetzrichtung weisende Haltefläche zum Halten des Abutments aufweist. Die Haltefläche kann den jeweiligen Anforderungen gemäss ausgestaltet sein, um im Wesentlichen parallel zur Einsetzrichtung wirkende Kräfte zu übertragen. Die Ausgestaltung der Haltefläche kann für den jeweiligen Basiskörper bzw. das jeweilige Abutment optimiert sein.

Gemäss einer weiteren Ausführungsform des Einheitsverbinders ist vorgesehen, dass der Abutmenthalteabschnitt mit wenigstens einem Haltegewinde zum form- und kraftschlüssigen Zusammenwirken mit dem Halteelement versehen ist. Somit kann das Halteelement einfach am Haltegewinde auf den Einheitsverbinder geschraubt werden. Das Halteelement ist mit einem entsprechenden Gewinde ausgestattet, dass komplementär zum Haltegewinde ausgestaltet ist. Dies ermöglicht es, eine Vielzahl weitestgehend frei variabel wähl und justierbare Haltepositionen bereitzustellen. Sobald der Einheitsverbinder ordnungsgemäss in den Basiskörper eingesetzt ist, kann das Abutment mit Hilfe des Halteelements einfach in gewünschter Position am Basiskörper fixiert werden, indem das Halteelement mit einem angemessenen Drehmoment auf das Haltegewinde des Einheitsverbinders geschraubt wird. Vorteilhafterweise können somit auch insbesondere im Bereich des Basisabschnitts bzw. der Verbindung zwischen Basiskörper und Einheitsverbinder auftretende Fertigungs- und Montagetoleranzen ausgeglichen und eine möglichst bündige, stabile und abgedichtete Verbindung zwischen Abutment und Basiskörper hergestellt werden.

Gemäss einer weiteren Ausführungsform ist das Halteelement hülsenartig mit einer im Wesentlichen zylinderförmigen Aussenkontur ausgestaltet. Über eine derartige Hülse ist der Einheitsverbinder mit dem Abutment zur formschlüssig abgedichteten Verbindung des Abutments und des Basiskörpers auf einfache und effektive Art und Weise verbindbar. In einer vorteilhaften Ausgestaltung wird die Hülse in den Abutmenthalteabschnitt eingreifend über diesen geschoben und drückt beim Eingreifen das Abutment formschlüssig abdichtend gegen den Basiskörper. Unter Schieben versteht der Fachmann in diesem Zusammenhang nicht nur eine transversale Geleitsbewegung, sondern im Allgemeinen eine Positionierung, wobei ein Bestandteil in oder an einem anderen aufgenommen wird. Ein Verschieben kann daher auch ein Verschrauben umfassen bzw. eine Kombination zwischen transversale Geleitbewegung und Verschraubung darstellen, wenn die Hülse zum Beispiel zuerst auf den Abutmenthalteabschnitt gesteckt und nach dem Eingreifen in ein daran vorgesehenes Haltegewinde geschraubt wird.

In der Regel ist die Hülse in einen Hülsenaufnahmebereich der Bohrung des Abutments einführbar und bündig mit diesem abschliessend ausgestaltet. In einer Ausgestaltung beträgt eine im Wesentlichen parallel zur Einsteckrichtung gemessene Länge der Hülse mindestens 50%, vorzugsweise mindestens 75%, besonders vorzugsweise mindestens 85%, der ebenfalls im Wesentlichen parallel zur Einsteckrichtung gemessenen Länge eines Hülsenaufnahmebereichs der Durchgangsbohrung des Abutments. In einer alternativen Ausführung kann die Hülse auch länger als der Hülsenaufnahmebereich der Durchgangsbohrung des Abutments ausgeführt sein. Die Hülse steht dann über das Abutment raus, was eine zusätzliche Stabilität erzeugt.

Gemäss einerweiteren Ausführungsform ist wenigstens ein den Abutmenthalteabschnitt umgreifendes Zusatzhalteelement vorgesehen, das dazu ausgestaltet ist, zum Halten des Abutments mit dem Abutmenthalteabschnitt zusammenzuwirken. Das Zusatzhalteelement kann dazu dienen, das Halteelemente bzw. dessen Wirkbereich zu verlängern bzw. es zu stabilisieren oder kontern. Insbesondere kann das Zusatzhalteelement zusätzlich zum Halteelemente Stützfunktionen ausüben. Somit hilft das Zusatzhalteelement dabei, den Einheitsverbinder noch flexibler in Verbindung mit verschiedenen Basiskörpern und/oder Abutments einzusetzen.

Ein Zusatzhalteelement bietet für Ausgestaltungen mit Abutments, welche eine Bohrung mit einem Halteelement bzw. Hülsenaufnahmebereich aufweisen, welcher wesentlich länger (z.B. mehr als doppelt so lang) als das Halteelement ist, den Vorteil, dass nach Einsetzen des Halteelementes der verbliebene Zwischenraum zwischen dem Abutmenthalteabschnitt und der Innenwand des Halteelements bzw. Hülsenaufnahmebereichs der Bohrung des Abutments durch das Zusatzhalteelement besetzt werden kann. Dadurch kann die Stabilität des Dentalimplantats erhöht werden, da die Abstützfläche zwischen Abutment und Einheitsverbinder vergrössert wird.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass das Halteelement und/oder das Zusatzhalteelement als eine Art Rundmutter mit einem inneren Gewinde versehen sind bzw. ist. Das innere Gewinde ist jeweils komplementär zum am Abutmenthalteabschnitt ausgeformten Gewinde ausgestaltet. Somit lassen sich Halteelement und Zusatzhalteelement einfach auf den Abutmenthalteabschnitt aufschrauben.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass das Halteelement und/oder das Zusatzhalteelement ein Eingriffsmittel aufweisen bzw. aufweist, an dem ein Werkzeug zum betätigen des Halteelements und/oder des Zusatzhalteelements abstützbar ist. Insbesondere kann das Eingriffsmittel komplementär zu einem Gegeneingriffsmittel eines Spezialwerkzeugs ausgestaltet sein, mit welchem Halteelement bzw. Zusatzhalteelement betätigbar sind. Bei auf den Abutmenthalteabschnitt aufschraubbarem Halteelement bzw. Zusatzhalteelement ist das Eingriffsmittel so ausgestaltet, dass ein Drehmoment zum Aufschrauben von Halteelement bzw. Zusatzhalteelement auf diese übertragbar ist. Eingriffsmittel können in einer Ausgestaltung an einem Ende des Halteelementes bzw. Zusatzhalteelements, vorzugsweise axialsymmetrisch daran angeordnete und ausgeformte Nuten sein.

Gemäss einer zusätzlichen Ausführungsform ist vorgesehen, dass eine im Wesentlichen parallel zur Einsetzrichtung gemessene Länge des Einheitsverbinders veränderbar ist. Dies bietet den Vorteil, dass der Einheitsverbinder bei verschieden grossen Dentalimplantaten mit einer für den Einheitsverbinder zu grossen oder zu kleinen Länge gekürzt bzw. verlängert werden kann.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Einheitsverbinder in Abhängigkeit der Grösse des Dentalimplantats an vorgegebenen Ablängmarkierungen ablängbar ausgestaltet ist. Die Ablängmarkierungen erlauben es, den Einheitsverbinder vor, während oder nach seinem Einsetzen auf die gewünschte Länge präzise abzulängen. Insbesondere bietet dies den Vorteil, dass der Einheitsverbinder für kleine Dentalimplantate, für welche der Basiskörper kurz ist, angepasst werden kann, indem die Länge des Einheitsverbinders gekürzt wird. Bevorzugt ist der Basisabschnitt und/oder der Abutmenthalteabschnitt von einer ausreichenden Länge, so dass nach einer Kürzung des Einheitsverbinders der Basisabschnitt und/oder der Abutmenthalteabschnitt noch eine ausreichende Länge aufweisen, um eine Verbindung mit dem Basiskörper und/oder eine Wirkverbindung mit dem Abutment sicherzustellen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Ablängmarkierungen als Sollbruchstellen ausgeformt sind. Die Sollbruchstellen vereinfachen ein präzises Ablängen des Einheitsverbinders und verhindern unerwünschte Beschädigungen beim Ablängen. In Ausgestaltungen, bei welchen der Basisabschnitt und/oder der Abutmenthalteabschnitt ein Gewinde aufweisen, erstreckt sich das Gewinde vorteilhafterweise über eine derart ausreichende Länge entlang der Einsetzrichtung, dass auch nach einer Kürzung ein ausreichendes Gewindestück verbleibt, um eine Verbindung mit dem Basiskörper und/oder mit dem Abutment sicherzustellen. In einer besonders vorteilhaften Ausgestaltung ist der Abutmenthalteabschnitt länger als der Basisabschnitt. Wenn dann der Einheitsverbinder im Bereich des Abutmenthalteabschnitts abgelängt wird, bleiben Basisabschnitt und Basiskörper davon unberührt.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass der Abutmenthalteabschnitt und/oder der Basisabschnitt mit einer Verbinderverlängerung, vorzugsweise in Form einer Bolzenverlängerung oder Schraubenverlängerung, in Eingriff bringbar ausgestaltet ist. Vorzugsweise kann zum Verlängern eine Bolzenverlängerung oder Schraubenverlängerung vorgesehen sein, die einen Aussendurchmesser aufweist, welcher mit dem Aussendurchmesser des Einheitsverbinders übereinstimmt, so dass sich bezüglich der Führung des Abutments und/oder eines Halteelementes und der radialen Positionierung des Einheitsverbinders in der Durchgangsbohrung des Abutments keine Änderungen ergeben. Bei Ausgestaltungen mit einem Aussengewinde im Basisabschnitt und einem Haltegewinde

im Abutmenthalteabschnitt bietet die Verbinderverlängerung den Vorteil, dass der Einheitsverbinder auf flexible Weise je nach Erfordernis an beiden Enden verlängert werden kann. Bei Ausgestaltungen mit einem zylinderförmigen Schaftabschnitt ist der Aussendurchmesser der Rundmutter vorteilhafterweise gleich dem Aussendurchmesser des Schaftabschnittes, so dass ein stufenloser Übergang zwischen Schaftabschnitt und der Verbinderverlängerung ermöglicht wird. Ausserdem kann der Einheitsverbinder bei grossen Dentalimplantaten mit einer ansonsten für den Einheitsverbinder zu grossen Länge angepasst bzw. verlängert werden kann. Vorzugsweise weist die Bolzenverlängerung oder Schraubenverlängerung einen Aussendurchmesser auf, welche mit dem Aussendurchmesser des Einheitsverbinders übereinstimmt, so dass sich bezüglich der Führung des Einheitsverbinders und der radialen Positionierung in der Bohrung des Basiskörpers keine Änderungen ergeben.

Ein erfindungsgemässer Einheitsverbinder samt etwaigen Halte und/oder Verlängerungselementen kann gemäss einer weiteren Ausführungsform wendbar ausgestaltet sein, sodass die Funktion von Basis und Abutmenthalteabschnitt den jeweiligen Anforderungen gemäss beliebig miteinander getauscht werden kann. Die Dimensionen von Basis und Abutmenthalteabschnitt können so auf verschiedenartigen Basiskörper bzw. Abutments abgestimmt sein, dass beispielsweise für gewisse Grössen und Typen der Basiskörper der Basisabschnitt und bei anderen Grössen und Typen der Abutmenthalteabschnitt darin eingesetzt und somit zum Basishalteabschnitt wird, während dieser dann die Funktion des Abutmenthalteabschnitt erfüllt. Durch eine derartige Wendefunktion lässt sich die Variabilität des Einheitsverbinders erhöhen.

Beim erfindungsgemässen Einheitsverbindungssystem kann die erfindungsgemässe Lösung dadurch weiter verbessert werden, dass das Einheitsverbindungssystem des Weiteren wenigstens einen in einen Kieferknochen einsetzbaren Basiskörper und/oder wenigstens ein Abutmenthalteabschnitt umfasst, die dazu ausgestaltet sind, mit dem Einheitsverbinder zusammenzuwirken. Einen in einen Kieferknochen einsetzbaren Basiskörper, ein mit dem Basiskörper formschlüssig verbindbares Abutment, und einen Einheitsverbinder gemäss der vorliegenden Offenbarung erlauben es, besonders kostengünstig flexibel einsetzbare Serien von Dentalimplantaten bereitzustellen, die modulartig miteinander kombinierbare Bestandteile umfassen.

Gemäss einer weiteren Ausführungsform eines erfindungsgemässen Einheitsverbindungssystems ist vorgesehen, dass der Basiskörper eine Bohrung zur Aufnahme des Einheitsverbinders aufweist bzw. dass das Abutment eine im Wesentlichen parallel zur Einsetzrichtung verlaufende Durchgangsbohrung aufweist, in der wenigstens eine Schulter angeordnet ist, die einen entgegen der Einsetzrichtung weisenden Anschlag für den Einheitsverbinder ausbildet. Das Abutment weist also in der Regel eine durchgehende Bohrung und auf der Innenseite der Bohrung eine Schulter, beispielsweise in Form einer Abstufung, auf, über welche das Abutment an den Basiskörper abdichtend anpressbar ist.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Bohrung des Basiskörpers in einer Abutment abgewandten Hälfte des Basiskörpers ein mit dem Basisabschnitt in Eingriff bringbares Innengewinde aufweist. Somit kann der Einheitsverbinder einfach in den Basiskörper eingeschraubt werden. Die Anordnung des Innengewindes in der vom Abutment abgewandten Hälfte des Basiskörpers ermöglicht es bei gleichzeitiger seitlicher AbStützung des Einheitsverbinders in oberhalb des Innengewindes liegenden Abschnitten des Basiskörpers, im Wesentlichen lediglich parallel zur Einsetzrichtung verlaufende Zug oder Druckkräfte am Innengewinde vorliegen zu haben, wodurch die Gefahr von Beschädigungen, beispielsweise Brüchen oder Rissen, im Bereich des Innengewindes vermieden werden, die insbesondere dann auftreten können, wenn Gewindegänge und ungünstige Krafteinleitungen zu unerwünschten Kerbwirkungen führen.

Mit anderen Worten bietet eine Anordnung des Innengewindes in der dem Abutment abgewandten Hälfte des Basiskörpers den Vorteil, dass die auftretenden Kräfte am Innengewinde in den unteren Bereich des Basiskörpers geleitet und daher vom Kontaktbereich zum Abutment entfernt gehalten werden können. Dies führt vorteilhafterweise dazu, dass Zug und Scherspannungen im Kontaktbereich zwischen Abutment und Basiskörper, insbesondere an Auflageflächen, im Wesentlichen vermieden werden können. Vorteilhafterweise verbleiben im Kontaktbereich hauptsächlich Druckspannungen, was insbesondere für Keramikbestandteile vorteilhaft ist, da das Keramikmaterial zwar druckkraftstabil, aber eher zugkraftinstabil ist. Diese Anordnung bietet daher den Vorteil, dass die Stabilität und somit der Langzeiterfolg des Dentalimplantats erhöht werden kann.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass ein grösster Aussendurchmesser des Einheitsverbinders zumindest in einer unteren Hälfte des Einheitsverbinders derart auf einen kleinsten Innendurchmesser der Bohrung des Basiskörpers abgestimmt ist, dass der Einheitsverbinder beim Einsetzen in die Bohrung im Wesentlichen spielfrei im Basiskörper geführt ist. Die spielfreie Führung hilft dabei, den Einbau des Einheitsverbinders zu vereinfachen und die Langzeitstabilität des gesamten Implantats zu erhöhen.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass ein kleinster Innendurchmesser der Durchgangsbohrung des Abutments derart auf einen grössten Aussendurchmesser des Halteelementes und/oder des Zusatzhalteelements abgestimmt ist, dass das Halteelement und/oder das Zusatzhalteelement im Wesentlichen spielfrei im Abutment geführt sind bzw. ist. Bevorzugt weist die Bohrung des Abutments einen dem Basiskörper zugewandten unteren Bereich mit einem kleineren Durchmesser als dem Durchmesser eines dem Basiskörper abgewandten oberen Bereichs der Bohrung des Abutments auf, welcher einen Aufnahmebereich für das Halteelement und/oder das Zusatzhalteelement bildet, wobei die beiden Bereiche über die Abstufung so aneinander angrenzen, dass das Abutment durch Anschlag der Hülse an der Abstufung in axialer Richtung des Dentalimplantats in den Basiskörper formschlüssig abdichtend anpressbar ist. In Ausgestaltungen des Abutments mit einer Abstufung beträgt die Länge der Hülse vorzugsweise mindestens 50%, besonders vorzugsweise mindestens 75%, ganz besonders vorzugsweise mindestens 85%, der Länge des oberen Bereichs, bzw. des Hülsenaufnahmebereichs, der Bohrung des Abutments.

Gemäss einer weiteren Ausführungsform ist vorgesehen, dass die Bohrung im Basiskörper als eine durchgehende Bohrung ausgestaltet ist und am unteren Ende eine Kappe aufweist, welche die Bohrung wenigstens teilweise abdeckt und welche mit einem Teil des Basisabschnitts des Einheitsverbinders in Eingriff bringbar und beim Einsetzen des Einheitsverbinders vom Basiskörper derart abtrennbar ausgestaltet ist, dass in einem vollständig in den Kieferknochen eingesetzten Zustand von Basiskörper und Einheitsverbinder das untere Ende des Einheitsverbinders die Kappe in den Kieferknochen presst. Mit der vom Basiskörper trennbaren Kappe kann vorteilhafterweise die Flexibilität des Dentalimplantats weiter erhöht werden. Bei einem zu langen Einheitsverbinder in Bezug auf den Basiskörper kann der Einheitsverbinder

so weit in den Basiskörper eingeführt, bzw. eingeschraubt (in Ausgestaltungen mit einem ersten Gewinde im ersten Endbereich) werden, bis der Einheitsverbinder an der Kappe anschlägt, die Kappe schliesslich vom Basiskörper trennt und weiter in den Kieferknochen presst. Die Stabilität der Verankerung des Dentalimplantats kann mit der weiter in den Kieferknochen gepressten Kappe mit Vorteil erhöht werden. Mit Vorteil kann die durch die getrennte Kappe entstehende zusätzliche Fläche den Osseointegrationsgrad erhöhen helfen.

Alternativ ist die Bohrung des Basiskörpers als Sackloch ausgebildet. Bevorzugt beträgt die Länge des Sackloches mindestens 80%, besonders bevorzugt mindestens 90% der Gesamtlänge des Basiskörpers. Dies bietet den Vorteil, dass die gesamte Länge des Basiskörpers zur Aufnahme von Kräften, z.B. Schraubkräften, bei der Verbindung des Einheitsverbinders mit dem Basiskörper dienen kann.

Gemäss einerweiteren Ausführungsform ist vorgesehen, dass zwischen einem grössten Aussendurchmesser des Halteelementes und/oder des Zusatzhalteelementes und dem kleinsten Innendurchmesser der Durchgangsbohrung des Abutments ein Spalt gebildet ist, dessen Breite vorzugsweise zwischen 0.001 mm und 0.1 mm beträgt. Der Spalt dient dazu, ein ausreichendes Spiel in radialer Richtung zwischen der Hülse und dem Abutment bereitzustellen, so dass eine Überbestimmung vermieden werden kann. Das Spiel ist mit Vorteil aber ausreichend klein, dass die Hülse die Stabilität dadurch erhöhen kann, dass sich das Abutment bei auftretenden Querkräften an der Hülse abstützen kann.

In einer Ausgestaltung ist der Basiskörper aus Keramik, vorzugsweise Zirkoniumoxid oder auf Zirkoniumoxid-Basis, gefertigt. In einer Ausgestaltung ist das Abutment aus Keramik, vorzugsweise aus Zirkoniumoxid oder auf Zirkoniumoxid-Basis, gefertigt. Bevorzugt werden der Basiskörper und/oder das Abutment in Ausgestaltungen aus Keramik durch Pulverspritzgiessverfahren hergestellt. Dies bietet den Vorteil einer kostengünstigen Herstellung. Das Keramikmaterial bietet den Vorteil einer hohen Biokompatibilität sowie eines hohen Osseointegrationsgrads. Weiter bietet das Keramikmaterial im Vergleich zu Titan einen kosmetischen Vorteil bei Zahnfleischrückgang, was bei Dentalimplantaten oft eintritt.

In Ausgestaltungen des Basiskörpers aus Keramik und mit einem Innengewinde ist das Innengewinde vorzugsweise als Rundgewinde ausgebildet. In einer vorteilhaften Variante weist in diesen Ausgestaltungen der erste Endbereich des Einheitsverbinders ein Trapezgewinde auf. Dies bietet den Vorteil, dass die Gewindegänge des Innengewindes beim Einschrauben des Einheitsverbinders geschont werden können. Im Vergleich zu Spitzgewinden, welche sich in das Innengewinde schneiden und somit das Keramikmaterial beschädigen können, kann ein solcher Einheitsverbinder mit einem Trapezgewinde daher den Langzeiterfolg des Dentalimplantats erhöhen.

In einer Ausgestaltung ist der Einheitsverbinder aus Metall, vorzugsweise aus rostfreiem Stahl und/oder Titan, gefertigt.

In einer Ausgestaltung entspricht der grösste Querdurchmesser des Einheitsverbinders in der unteren Hälfte des Einheitsverbinders dem grössten Querdurchmesser der Bohrung des Basiskörpers derart, dass der Einheitsverbinder bei der Aufnahme in die Bohrung führbar ist.

Optional besteht zwischen dem Bereich des Einheitsverbinders, welcher sich nach dem Einsetzen im Basiskörper befindet, und der Innenwand der Bohrung des Basiskörpers ein Spiel, so dass bei der Einführung des Einheitsverbinders in den Basiskörper Beschädigungen aufgrund von Reibung minimiert werden können. Das Spiel ist vorteilhafterweise aber so klein, dass eine zuverlässige Führung bzw. Zentrierung des Einheitsverbinders bereitgestellt wird.

In einer Ausgestaltung entspricht ein Querdurchmesser des Einheitsverbinders dem kleinsten Querdurchmesser der Bohrung des Abutments derart, dass das Abutment beim Einsetzen auf den Basiskörper durch den Einheitsverbinder führbar ist.

Der Einheitsverbinder bietet daher den Vorteil, dass das Abutment beim Positionieren auf den Basiskörper geführt bzw. zentriert werden kann. Vorzugsweise besteht zwischen dem Einheitsverbinder und der Innenwand der Bohrung des Abutments ein Spiel, so dass bei der Positionierung des Abutments auf den Basiskörper Beschädigungen aufgrund von Reibung minimiert werden können. Das Spiel ist vorteilhafterweise aber so klein, dass eine zuverlässige Führung bzw. Zentrierung des Abutments bereitgestellt wird.

In einer Ausgestaltung entspricht der grösste Querdurchmesser der Bohrung des Abutments dem Querdurchmesser der Hülse derart, dass das Abutment in Querrichtung an der Hülse abstützbar ist.

In Ausgestaltungen mit einer abgestuften Bohrung des Abutments und einem Einheitsverbinder mit einem zylindrischen Schaft und einer Hülse entspricht mit Vorteil der kleinere Durchmesser der Bohrung im dem Basiskörper zugewandten unteren Bereich des Abutments dem Aussendurchmesser des zylindrischen Schafts des Einheitsverbinders. Der grössere Durchmesser der Bohrung im dem Basiskörper abgewandten oberen Bereich des Abutments, welcher den Hülsenaufnahmebereich bildet, entspricht mit Vorteil dem Aussendurchmesser der Hülse, so dass sich das Abutment an der Hülse abstützen kann und bei auftretenden Querkräften die Stabilität des Dentalimplantats erhöht werden kann. Im unteren Bereich der Bohrung des Abutments kann sich das Abutment bei auftretenden Querkräften mit Vorteil am zylindrischen Schaft oder teilweise am zweiten Endbereich des Einheitsverbinders abstützen.

In einer Ausgestaltung weist das Abutment einen Fortsatz und der Basiskörper eine Aussparung auf, wobei der Fortsatz in die Aussparung einsteckbar ist. Bevorzugt wird durch den Fortsatz des Abutments und der Aussparung des Basiskörpers ein verdrehsicherer Formschluss bereitgestellt. In einer Variante wird der verdrehsichere Formschluss durch eine radial ungleichmässige Struktur des Fortsatzes (d.h. in tangentialer Richtung) bereitgestellt. In einerweiteren Variante weist der Fortsatz radiale Vorsprünge auf, welche in tangentialer Richtung weisende Anlageflächen ausbilden und in radiale Nuten der Aussparung des Basiskörpers eingreifen können.

Figurenbeschrieb

Die Erfindung soll nachfolgend anhand von Ausführungsbeispielen im Zusammenhang mit den Figuren und der dazugehörigen Beschreibung näher erläutert werden. Es zeigen:

Fig. 1 eine Schnittdarstellung einer ersten Ausführungsform eines erfindungsgemässen Einheitsverbinders;

Fig. 2 eine Schnittdarstellung einer zweiten Ausführungsform eines erfindungsgemässen Einheitsverbinders;

Fig. 3 eine Schnittdarstellung eines Dentalimplantats mit einer ersten Ausführungsform eines erfindungsgemässen Einheitsverbindungssystems;

Fig. 4 eine Schnittdarstellung eines Dentalimplantats mit einer zweiten Ausführungsform eines erfindungsgemässen Einheitsverbindungssystems;

Fig. 5 eine Schnittdarstellung des in Fig. 3 gezeigten Dentalimplantats entlang der in Fig. 3 eingezeichneten Schnittlinie A-A;

Fig. 6 eine schematische Explosionsdarstellung einer weiteren Ausführungsform eines erfindungsgemässen Dentalimplantats;

Fig. 7 eine schematische Querschnittsansicht entlang einer Längsachse des in Fig. 6 gezeigten Dentalimplantates in einem Vormontagezustand;

Fig. 8 eine schematische Querschnittsansicht entlang der Längsachse des in Figs. 6 und 7 gezeigten Dentalimplantates in einem Endmontagezustand;

Fig. 9 eine schematische Explosionsdarstellung einer zusätzlichen Ausführungsform eines erfindungsgemässen Dentalimplantats;

Fig. 10 ein Detail IX des in Fig. 9 gezeigten Dentalimplantates;

Fig. 11 eine schematische Querschnittsansicht entlang einer Längsachse des in Fig. 9 und 10 gezeigten Dentalimplantates in einem Vormontagezustand;

Fig. 12 ein Detail XI des in Figs. 9 bis 11 gezeigten Dentalimplantates; und

Fig. 13 eine schematische Querschnittsansicht entlang der Längsachse des in Figs. 9 bis 12 gezeigten Dentalimplantates in einem Endmontagezustand.

Ausführung der Erfindung

Im Folgenden ist die Erfindung beispielhaft anhand möglicher Ausführungsformen mit Bezug auf die beigefügten Zeichnungen genauer beschrieben. Die bei diesen Ausführungsformen dargestellten Merkmalskombinationen dienen lediglich Anschauungszwecken. Einzelne Merkmale können nach Massgabe ihrer oben beschriebenen Vorteile auch weggelassen werden, wenn es bei bestimmten Anwendungen auf den Vorteil des jeweiligen Merkmals nicht ankommt. In der Beschreibung der Ausführungsformen sind der Einfachheit halber gleiche Merkmale und Elemente mit gleichen Bezugszeichen versehen. Bei unterschiedlichen Ausführungsformen können Merkmale und Elemente mit gleicher oder ähnlicher Funktion mit einem oder mehreren Apostrophen versehen sein, um sie darstellungshalber einer Ausführungsform zuzuordnen, wobei diese Zuordnung nicht als auf die jeweilige Ausführungsform einschränkend aufzufassen ist.

Figur 1 zeigt eine Schnittdarstellung einer ersten Ausführungsform eines erfindungsgemässen Einheitsverbinders 1. Der Einheitsverbinder 1 weist einen Basisabschnitt 11 mit einem ersten Aussengewinde 111 sowie einen Abutmenthalteabschnitt 12 mit einem Haltegewinde 121 auf. Zwischen den Abschnitten 11, 12 weist der Einheitsverbinder einen zylindrischen Schaftabschnitt 13 auf, so dass der Einheitsverbinder 1 die Form eines Stehbolzens mit einer Mittelachse M_1 aufweist, entlang welcher der Einheitsverbinders 1 in einer Einsetzrichtung I einzusetzen bzw. einzuschrauben ist.

Der Einheitsverbinder 1 besitzt eine parallel zur Einsetzrichtung I gemessene Gesamtlänge L_1. Der Basisabschnitt 11 und das Aussengewinde 111 besitzen eine parallel zur Einsetzrichtung I gemessene Länge L_{11} bzw. L_{111}, die das 0.2 bis 0.3-fache, vorzugsweise das 0.25-fache entsprechend einem Viertel der Gesamtlänge L_1 betragen. Der Abutmenthalteabschnitt 12 und das Haltegewinde 121 besitzen eine parallel zur Einsetzrichtung I gemessene Länge L_{12} bzw. Ln_2, die das 0.3 bis 0.6-fache, vorzugsweise das 0.4 bis 0.5-fache, höchst vorzugsweise das 0.416-fache entsprechend fünf Zwölftel der Gesamtlänge Li betragen. Der Schaftabschnitt 13 besitzt eine parallel zur Einsetzrichtung I gemessene Länge Li_3, die das 0.3 bis 0.4-fache, vorzugsweise das 0.333-fache entsprechend einem Drittel der Gesamtlänge Li beträgt.

Der Einheitsverbinder 1 ist beispielsweise aus rostfreiem Stahl, Titan und/oder Keramik gefertigt. In bestimmten Ausführungsformen kann es besonders vorteilhaft sein, den Einheitsverbinder aus rostfreiem Stahl und/oder Titan zu fertigen, insbesondere wenn er innerhalb eines ansonsten keramischen Implantats hermetisch abgeschlossen von Kiefer und Zahnfleisch isoliert aufgenommen ist, so dass die Frage der Biokompatibilität für den Einheitsverbinder 1 selber von eher zweitrangiger Bedeutung und einer Optimierung seiner mechanischen Eigenschaften nachstehen kann.

Figur 2 zeigt eine Schnittdarstellung einer zweiten Ausführungsform eines Einheitsverbinders 1' mit einem Basisabschnitt 11' und einem ersten Aussengewinde 111' sowie einem Abutmenthalteabschnitt 12' und einem Haltegewinde 121'. An den Basisabschnitt 11' anschliessend ist eine Bolzenverlängerung 14' in geeigneter weise angebracht. Beispielsweise kann die Bolzenverlängerung 14' mit dem Basisabschnitt 11' mittels einer Schraubverbindung in einer Ausnehmung an der Mittelachse des Basisabschnitts 11' oder mittels einer Klebeverbindung an dessen Stirnfläche verbunden sein. Die Bolzenverlängerung 14' weist ein Verlängerungsgewinde 141 auf, welche mit einem Innengewinde eines Basiskörpers eines Dentalimplantats in Eingriff bringbar ist. Mittels der Bolzenverlängerung 14' ist der Einheitsverbinder 1' verlängerbar und kann daher für lange Dentalimplantate verwendet werden. Alternativ oder zusätzlich kann die Bolzenverlängerung 14' in analoger Art und Weise auch am Abutmenthalteabschnitt 12' angebracht sein, um diesen zu verlängern.

Der Einheitsverbinder 1' besitzt ähnlich wie der Einheitsverbinder 1 eine parallel zur Einsetzrichtung I gemessene Gesamtlänge $L_{1'}$, die beispielsweise einer Summe der Gesamtlänge L_1 des Einheitsverbinders 1 zuzüglich einer parallel zur Einsetzrichtung I gemessenen Länge $L_{14'}$ der Bolzenverlängerung 14' betragen kann. Der Basisabschnitt 11' und das Aussengewinde 111' besitzen eine parallel zur Einsetzrichtung I gemessene Länge $L_{11'}$ bzw. $L_{111'}$, die ebenfalls das 0.2 bis 0.3-fache, vorzugsweise das 0.25-fache entsprechend einem Viertel der Gesamtlänge Li betragen. Der Abutmenthalteabschnitt 12' und das Haltegewinde 121' besitzen eine parallel zur Einsetzrichtung I gemessene Länge $L_{12'}$ bzw. $L_{112'}$, die das 0.3 bis 0.6-fache, vorzugsweise das 0.4 bis 0.5-fache, höchst vorzugsweise das 0.41 6-fache entsprechend fünf Zwölftel der Gesamtlänge Li betragen. Der Schaftabschnitt 13' besitzt eine parallel zur Einsetzrichtung I gemessene Länge $L_{13'}$, die das 0.3 bis 0.4-fache, vorzugsweise das 0.333-fache entsprechend einem Drittel der Gesamtlänge Li beträgt.

Mit Hilfe der Bolzenverlängerung 14' können die oben genannten vom Einheitsverbinder 1' abgeleiteten Längenverhältnisse zwischen den einzelnen Abschnitten des Einheitsverbinders 1' bezogen auf seine Gesamtlänge l_r den jeweiligen Anforderungen gemäss verschoben bzw. angepasst sein. Die Verschiebung bzw. Anpassung der Längenverhältnisse ergibt sich aus der Länge $L_{14'}$ der Bolzenverlängerung 14', wobei die Gesamtlänge L_1 des Einheitsverbinders 1 eine Art Grundlänge darstellt, die mit Hilfe verschiedener Typen der Bolzenverlängerung 14' variiert werden kann.

Im vorliegenden Ausführungsbeispiel des Einheitsverbinders 1' mit Bolzenverlängerung 14' beträgt die Länge $L_{14'}$ das 0.3 bis 0.4-fache, vorzugsweise das 0.333-fache entsprechend einem Drittel der Gesamtlänge L_i. Somit kann die Länge des Verlängerungsgewindes wiederum der Länge $L_{111'}$ des Aussengewindes entsprechen. Der Einheitsverbinder 1 bzw. 1' kann somit durch Bolzenverlängerungen 14' jeweils inkrementell um das 0.3 bis 0.4-fache, vorzugsweise das 0.333-fache entsprechend einem Drittel der Gesamtlänge L_i verlängert oder wahlweise verkürzt werden, wenn er ursprünglich mit wenigstens einer Bolzenverlängerung 14' versehen und durch ein Abnehmen der wenigstens einen Bolzenverlängerung 14' ablängbar ausgestaltet ist.

Figur 3 zeigt eine Schnittdarstellung eines Dentalimplantats 100 mit einer ersten Ausführungsform eines erfindungsgemässen Einheitsverbindungssystems. Das Dentalimplantat 100 umfasst einen Basiskörper 130, ein Abutment 120 und einen Zahnaufbau 110. Die Einsetzrichtung I des Dentalimplantats 100 ist mit einem Pfeil dargestellt. Der Basiskörper 130 und das Abutment 120 sind vorzugsweise aus einem Keramikmaterial gefertigt. Der Basiskörper 130 weist ein Aussengewinde 133 in Form eines Rundgewindes auf. Weiter weist der Basiskörper 130 eine Bohrung 131 in Form eines Sackloches auf, wobei die Bohrung 131 in der dem Abutment 120 abgewandten unteren Hälfte des Basiskörpers 130 ein Innengewinde 132 aufweist. Um die Angaben „oben" oder „unten" zu verdeutlichen, ist in der Figur das Koordinatensystem eingezeichnet. Das Innengewinde 132 ist mit einem ersten Aussengewinde 111" im Basisabschnitt 11" eines Einheitsverbinders 1", der in die Bohrung 131 eingeführt ist, in Eingriff gebracht.

Die Länge L_{111} des ersten Aussengewindes 111" unterschreitet geringfügig eine parallel zur Einsetzrichtung I gemessene Länge L_{132} des Innengewindes 132. Das Innengewinde 132 ist als Rundgewinde ausgebildet. Der Durchmesser der Bohrung 131 entspricht dem

Durchmesser des Einheitsverbinders 1", sodass der Einheitsverbinder 1" beim Einsetzen in den Basiskörper 130 geführt wird. Das Abutment 120 weist eine Durchgangsbohrung 1200 mit oberem Bereich 1201 und unterem Bereich 1202 auf, wobei der Durchmesser der Durchgangsbohrung 1200 im oberen Bereich 1201 grösser als der Durchmesser der Durchgangsbohrung 1200 im unteren Bereich 1202 ist. Der obere Bereich 1201 grenzt an den unteren Bereich 1202 über eine Schulter 1203 an.

Der Durchmesser der Durchgangsbohrung 1200 im unteren Bereich 1202 entspricht dem Durchmesser des zylindrischen Schaftabschnitts des Einheitsverbinders 1", so dass das Abutment 120 beim Aufsetzen auf den Basiskörper 130 durch den zylindrischen Schaftabschnitt 13" des Einheitsverbinders 1" geführt wird. Die Länge L_{13} des zylindrischen Schaftabschnitts 13" ist vorteilhafter Weise so bemessen, dass er sowohl das Abutment 120 als auch den Basiskörper optimal seitlich stützt und etwaige Quer und/oder Scherkräfte möglichst weit von Basisabschnitt 11" und Abutmenthalteabschnitt 12" entfernt aufnimmt sowie abgibt.

In die Durchgangsbohrung 1200 ist im oberen Bereich 1201 ein Halteelement 15 eingesetzt, welche mit dem Haltegewinde 121" im Abutmenthalteabschnitt 12" des Einheitsverbinders 1" in Eingriff gebracht ist, bzw. über ein Innengewinde 152 des Halteelements 15 aufgeschraubt ist. Der Abutmenthalteabschnitt 12" weist eine Länge L_{12} auf. Das Halteelement 15 ist ebenfalls aus rostfreiem Stahl, Titan und/oder Keramik gefertigt. Der Aussendurchmesser des Halteelements 15 entspricht dem Durchmesser des oberen Bereichs 1201 der Durchgangsbohrung 1200 des Abutments 120, welche den Hülsenaufnahmebereich bildet, so dass das Abutment 120 bei auftretenden Querkräften an das Halteelement 15 anliegen kann, was die Stabilität des Dentalimplantats 100 erhöht. Zwischen der seitlichen Aussenfläche des Halteelements 15 und der seitlichen Innenfläche des oberen Bereichs 1201 der Durchgangsbohrung 1200 besteht ein Spalt, welcher ein Spiel sicherstellt. Das Halteelement 15 weist Eingriffsmittel 151 in Form von Kerben auf, welche mit einem geeigneten Schlüssel (nicht gezeigt) in Eingriff gebracht werden können.

Mit dem geeigneten Werkzeug bzw. Schlüssel kann das Halteelement 15 mittels der Eingriffsmittel 151 auf den Abutmenthalteabschnitt 121" des Einheitsverbinders 1" aufgeschraubt werden. Das Halteelement 15 weist ein Innengewinde 152 auf, welche mit dem Haltegewinde 121" des Einheitsverbinders 1" in Eingriff gebracht ist. Durch das

Aufschrauben des Halteelements 15 wird eine Wirkverbindung zwischen dem Einheitsverbinder 1" und dem Abutment 120 derart hergestellt, dass das Abutment 120 durch das Halteelement 15 über die Schulter 1203 auf den Basiskörper 130 gepresst wird und so eine abgedichtete formschlüssige Verbindung zwischen dem Abutment 120 und dem Basiskörper 130 hergestellt wird. Beim Aufschrauben des Halteelements 15 liegt dabei die Kontaktfläche 125 des Abutments 120 auf der Kontaktfläche 134 des Basiskörpers 130 an.

Das Abutment 120 weist weiter einen Fortsatz 124 a,b auf, welcher in eine formpassende Aufnahme 135 in Form einer Vertiefung des Basiskörpers 130 aufgenommen ist. Der Fortsatz 124 a,b ist in radialer Richtung asymmetrisch ausgebildet, so dass ein verdrehsicherer Formschluss sichergestellt wird. In Querschnitt (in y-Richtung) weist der Fortsatz 124 a,b Vorsprünge auf, welche in Fig. 5 im Querschnitt gezeigt sind. In der Figur 3 oder 4 ist zu sehen, dass der Abutmenthalteabschnitt 12" des Einheitsverbinders 1" über das Abutment 120 hinausragt. Vor dem Aufsetzen des Zahnaufbaus 110 kann der Einheitsverbinder 1" bei Bedarf im Abutmenthalteabschnitt 12" abgelängt werden, falls der Überstand zu gross sein sollte. Alternativ oder in Ergänzung kann eine Ausnehmung 1101 im Zahnaufbau 110, wie in der Figur gezeigt, genutzt werden, welche den Überstand des Abutmenthalteabschnitts 12" aufnimmt.

Figur 4 zeigt eine zweite Ausführungsform eines erfindungsgemässen Dentalimplantats 100'. Im Unterschied zum in Figur 3 gezeigten Dentalimplantat 100 besitzt das Dentalimplantat 100' ein Abutment 120', dessen parallel zur Einsetzrichtung I gemessene Länge grösser ist als die parallel zur Einsetzrichtung I gemessene Länge des Abutments 120. Dementsprechend ragt ein oberes Ende eines Einheitsverbinders 1" des Dentalimplantats 100' weniger aus der Durchgangsbohrung 1200' heraus über dem oberen Rand des Abutments 120' hervor als beim Dentalimplantat 100.

Das Dentalimplantat 100' ist mit einem Zusatzhalteelement 16 versehen. Das Zusatzhalteelement 16 ist an das Halteelement 15' anliegend auf das Haltegewinde 121" des Einheitsverbinders 1" aufgeschraubt. Das Zusatzhalteelement 16 weist ein Innengewinde auf, welche mit dem Haltegewinde 121" des Einheitsverbinders 1" in Eingriff gebracht ist. Das Zusatzhalteelement 16 weist Eingriffsmittel 161 auf, mittels welchen das Zusatzhalteelement 16 auf das Haltegewinde 121" aufgeschraubt werden kann.

Das Zusatzhalteelement 16 erhöht die Stabilität des Dentalimplantats 100', da die Fläche, über welche das Abutment 120' abgestützt werden kann, erhöht wird. Die Länge des Halteelements 15' und die Länge des Zusatzhalteelements 16 entspricht fast der Länge des oberen Bereichs 1201' der Durchgangsbohrung 1200'. Somit kann das Abutment 120' bei auf das Zahnimplantat 100' einwirkenden Querkräften sowohl am vorzugsweise hülsenförmigen Halteelement 15' als auch am ebenfalls vorzugsweise hülsenförmigen Zusatzhalteelement 16 seitlich anliegen.

Illustrativ ist in der Figur 4 der Doppelpfeil F gezeigt, welcher auftretende Querkräfte darstellen soll. Die Kräfte F können zu Drehmomenten führen, welche ohne Halteelemente oder mit kurzen Halteelementen im Wesentlichen auf den unteren Bereich der Durchgangsbohrung 1200' des Abutments 120' konzentriert sein würden. Lange Halteelemente 15' oder Zusatzhalteelemente 16 ermöglichen bei Querkräften F ein seitliches Abstützen des Abutments 120', so dass die auftretenden Drehmomente im Wesentlichen entlang der gesamten Länge der Durchgangsbohrung 1200' verteilt und aufgenommen werden können.

Figur 5 zeigt das in der Figur 3 gezeigte Dentalimplantat 100 in einer schematischen Querschnittsansicht entlang der in Figur 3 eingezeichneten Schnittlinie A-A in einem Bereich, in welchem der Fortsatz 124 a, b in die Aufnahme 135 eingreift. Am Fortsatz 124 a, b aussen sind sich radial vom Fortsatz 124 a, b weg erstreckende vorsprungartige Positivelemente 126 ausgeformt, die parallel zur Einsetzrichtung I verlaufen. Die Aufnahme 135 ist mit ebenfalls parallel zur Einsetzrichtung I verlaufenen Negativelementen 136 versehen, die komplementär zu den Positivelementen 126 ausgestaltet sind.

Die Positivelemente 126 wirken derart formschlüssig mit den Negativelementen 136 zusammen, dass im zusammengesetzten Zustand Relativbewegungen, insbesondere Drehbewegungen, des Abutments 120 gegenüber dem Basiskörper 130 unterbunden sind. Zugleich definieren Positivelemente 126 und Negativelemente 136 gemeinsam ein kreisförmiges Raster von Drehpositionen, entlang denen eine Rotationsausrichtung von Abutment 120 und Basiskörper 130 vor dem Zusammensetzen relativ zueinander in inkrementellen Schritten frei gewählt werden kann.

Entsprechend der Beschaffenheit der Haltegewinde 121, 121' als solche sowie durch Ihre variable Positionierbarkeit entlang der Einsetzrichtung I dank der beschriebenen Verlänger- und/oder Verkürzbarkeit stellen erfindungsgemässe Einheitsverbinder 1, 1' eine Vielzahl von entlang der Einsetzrichtung I voneinander beabstandeten Haltepositionen für das Abutment 120, 120' bereit.

Fig. 6 zeigt eine schematische Explosionsdarstellung einer weiteren Ausführungsform eines erfindungsgemässen Dentalimplantats 200. Das Dentalimplantat 200 umfasst einen vorzugsweise aus einem Metall oder einer Metalllegierung, wie beispielsweise Titan oder einer Titanlegierung gefertigten Verbinder 2, eine vorzugsweise aus Keramik, wie beispielsweise Zirkoniumoxid gefertigte Prothetik 220, hier beispielsweise in Form eines Kopfes einer Einheilschraube, und einen vorzugsweise ebenfalls aus Keramik, wie beispielsweise Zirkoniumoxid, gefertigten Basiskörper 230. Verbinder 2, Prothetik 220 und Basiskörper 230 sind konzentrisch zu einer parallel zur Einsetzrichtung I verlaufenden Mittelachse M des Dentalimplantats 200 angeordnet.

Der Verbinder 2 besitzt einen Basisabschnitt 21, einen Halteabschnitt 22 und einen Schaftabschnitt 23. Am Basisabschnitt 21 ist ein Basisgewinde 211 ausgeformt, das dazu ausgestaltet ist, in Einsetzrichtung I in den Basiskörper 230 eingeschraubt zu werden. Um den Halteabschnitt 22 ist wie beim Abutmenthalteabschnitt 12, 12', 12" ein Haltegewinde 221 ausgeformt (s. Figuren 1 bis 3). Das Haltegewinde 221 ist dazu ausgestaltet, entgegen der Einsetzrichtung I in die Prothetik 220 eingeschraubt zu werden sowie mit dem Halteelement 15, 15' zusammenzuwirken (s. Figuren. 3 und 4). Der Schaftabschnitt 23 ist zylinderförmig ausgestaltet sowie rotationssymmetrisch zur Mittelachse angeordnet und bietet durch seine zylindrische Aussenumfangsfläche eine Stützfläche 27, die in eine radial von der Mittelachse M weg verlaufenden radialen Richtung R des Verbinders 2 weist.

Ein Ringbund 28 des Verbinders 2 ist ebenfalls zylinderförmig ausgestaltet und zwischen dem Halteabschnitt 22 und dem Schaftabschnitt 23 liegend rotationssymmetrisch zur Mittelachse M angeordnet. Ein parallel zur radialen Richtung R gemessener Durchmesser des Ringbundes 28 ist grösser als ein ebenfalls parallel zur radialen Richtung R gemessener Durchmesser des Schaftabschnittes 23. Somit überragt der Ringbund 28 den Schaftabschnitt 23 in radialer Richtung R und bildet ein in

Einsetzrichtung I weisendes Schulterelement 28a und ein entgegen der Einsetzrichtung I weisendes Schulterelement 28b.

Des Weiteren ist der Verbinder 2 mit Ringnuten 29 versehen, die jeweils zwischen Basisabschnitt 21 bzw. Basisgewinde 211 und Schaftabschnitt 23, zwischen Schaftabschnitt 23 und Ringbund 28 sowie zwischen Ringbund 28 und Halteabschnitt 22 bzw. Haltegewinde 221 angeordnet sind. An den Ringnuten 29 ist der Verbinder 2 verjüngt bzw. eingeschnürt, sodass ein parallel zur radialen Richtung R gemessener Durchmesser des Verbinders 2 wenigstens am Boden der Ringnuten 29 kleiner ist als der entsprechende Durchmesser der jeweils an die Ringnuten 29 angrenzenden Abschnitte des Verbinders 2.

Ferner ist ein oberer, vom Halteabschnitt 22 entgegen der Einsetzrichtung I Weg verlaufender Endabschnitt des Verbinders 2 als Eingriffsmittel 251 ausgeformt, an dem mit einem Werkzeug (nicht gezeigt) ein um die Mittelachse M wirkendes Drehmoment auf den Verbinder 2 übertragen werden kann. Ein parallel zur radialen Richtung R gemessener Durchmesser des Eingriffsmittel 251 ist kleiner als eine in radialer Richtung R gemessener Durchmesser des Haltegewindes 221 . Im vorliegenden Beispiel weist das Eingriffsmittel 251 an seinem äusseren Umfang eine Aussenkontur auf, die im vorliegenden Ausführungsbeispiel als Sechskant ausgestaltet ist.

Die Prothetik 220 ist beispielsweise rotationssymmetrisch zur Mittelachse M ausgestaltet und besitzt einen Fortsatz 224, eine Kontaktfläche 225, einen kegelstumpfförmigen Übergangsabschnitt 227, einen Kopfteil 228 und ein Eingriffselement 229. Alternativ kann die Prothetik 220 auch asymmetrisch zur Mittelachse M ausgestaltet sein. Der Fortsatz besitzt einen parallel zur radialen Richtung R gemessenen Durchmesser, der kleiner als der ebenfalls parallel zur radialen Richtung R gemessene Durchmesser des Übergangsabschnittes 227, wodurch zwischen Fortsatz 224 und Übergangsabschnitt 227 die in Einsetzrichtung I weisende Kontaktfläche 225 ausgebildet ist. Das im Kopfteil 228 ausgeformte Eingriffselement 229 ist beispielsweise als Innensechskant oder wie vorliegend als Innensechsrund ausgestaltet und erlaubt, mit Hilfe eines Werkzeugs (nicht gezeigt) ein um die Mittelachse M wirkendes Drehmoment auf die Prothetik 220 zu übertragen.

Der Basiskörper 230 besitzt wie der Basiskörper 130 eine Bohrung 231, in der ein Innengewinde 232 (s. Fig. 7) ausgeformt ist. Aussenumfangsseitig ist der Basiskörper 230 wie der Basiskörper 130 mit einem Aussengewinde 233 versehen. Ebenfalls ist am Basiskörper 230 wie am Basiskörper 130 eine entgegen der Einsetzrichtung I weisende Kontaktfläche 234 ausgeformt, welche die Bohrung 231 bzw. deren Öffnung umgibt. Ein oberer Teil der Bohrung 231 dient als Aufnahme 235 für den Fortsatz 224 der Prothetik 220.

Fig. 7 zeigt eine schematische Querschnittsansicht entlang der Mittelachse M des Dentalimplantates 200 in einem Vormontagezustand V. Im Vormontagezustand V ist der Verbinder 2 in den Basiskörper 230 eingesetzt, wobei der Basisabschnitt 21 mit dem Basisgewinde 211 in einem unteren Bereich der Bohrung 231 angeordnet ist, wo in dieser das Innengewinde 232 ausgeformt ist. Oberhalb des Innengewindes 232 des Basiskörpers 230 ist der Schaftabschnitt 23 des Verbinders 2 angeordnet. Zwischen der Stützfläche 27 des Schaftabschnitts 23 und dem Innenumfang des den Schaftabschnitt 23 umgebenden Teils der Bohrung 231 befindet sich ein möglichst geringes bis vorzugsweise kaum oder kein Spiel, beispielsweise indem Schaftabschnitt 23 und Bohrung 231 in diesem Bereich mit einer Spielpassung oder Übergangspassung ausgelegt sind. Somit stützt der Schaftabschnitt 23 den Verbinder 2 in der Bohrung 231 oberhalb des Innengewindes 232 vorzugsweise ringsherum ab, was dabei hilft, in radialer Richtung R wirkende Querkräfte sowie Biegemomente vom Innengewinde 232 fernzuhalten, sodass dort im Wesentlichen lediglich in Richtung der Mittelachse M wirkende Normalkräfte auftreten.

Der Ringbund 28 bzw. das von ihm bereitgestellte Schulterelement 28a liegt auf einem Gegenschulterelement 236 auf, das in der Bohrung 231 ausgeformt ist. Das Gegenschulterelement 236 ist zwischen dem unteren Teil der Bohrung 231 und der Aufnahme 235 gebildet und begrenzt die Aufnahme 235 in Einsetzrichtung I. Mit anderen Worten ist ein parallel zur radialen Richtung R gemessener Durchmesser des unteren Teils der Bohrung 231 kleiner als ein parallel zur radialen Richtung R gemessener Durchmesser der Aufnahme 235. Der Halteabschnitt 22 mit dem Haltegewinde 221 ist vollständig innerhalb der Aufnahme 235 angeordnet. Das Eingriffsmittel 251 ragt entgegen der Einsetzrichtung I über die Kontaktfläche 234 hinweg aus der Aufnahme 235 hinaus und steht somit vom Dentalimplantat 200 im Vormontagezustand V vor, sodass das Eingriffsmittel 251 für ein Werkzeug einfach zugänglich angeordnet ist.

Fig. 8 zeigt eine schematische Querschnittsansicht entlang der Mittelachse des Dentalimplantates 200 in einem Endmontagezustand E. Das Dentalimplantat 200 ist vom Vormontagezustand V in den Endmontagezustand E zu überführen, indem die Prothetik 220 in Einsetzrichtung I auf den Verbinder 2 geschraubt wird. Dazu ist die Prothetik 220 analog zur Bohrung 231 des Basiskörpers 230 mit einer konzentrisch zur Mittelachse M angeordneten sacklochartigen Ausnehmung 2101. In einem unteren Teil der Ausnehmung 2101, der sich im Wesentlichen in Einsetzrichtung I entlang des Fortsatzes 224 erstreckt, ist die Ausnehmung 2101 mit einem Gegenhaltegewinde 2102 versehen, das sich im Eingriff mit dem Haltegewinde 221 befindet. Das Eingriffsmittel 251 ist unter einem gewissen radialen Spiel gegenüber der Ausnehmung 2101 in der Ausnehmung 2101 aufgenommen und darin vom Kopfteil 228 umschlossen.

Im Endmontagezustand E liegt die Kontaktfläche 225 der Prothetik 2 auf der Kontaktfläche 234 des Basiskörpers 230 bündig abdichtend auf. Folglich ist die Aufnahme 235 hermetisch abgedichtet. Somit kann sichergestellt werden, dass der Verbinder 2 nicht in Kontakt mit dem Zahnfleisch gelangt bzw. vom gesamten Mundraum abgeschirmt ist. Der Fortsatz 224 ragt in Einsetzrichtung I in die Aufnahme 235, wobei zwischen einem Aussenumfang des Fortsatzes 224 und einem Innenumfang der Aufnahme 235 vorzugsweise ein möglichst geringes bis vorzugsweise kaum oder kein Spiel vorhanden ist, beispielsweise indem Fortsatz 224 und Aufnahme 235 in diesem Bereich mit einer Spielpassung oder Übergangspassung ausgelegt sind. In radialer Richtung R überdecken sich eine die Aufnahme 235 bildende Wandung des Basiskörpers 230 mit Prothetik 220 und Verbinder 2, wodurch sie einen kompakte und hochstabile Baugruppe bilden. Eine in Einsetzrichtung I weisende Stirnseite 240 am Fortsatz der Prothetik 220 ist am Fortsatz 224 gebildet und von dem Schulterelement 28b in Einsetzrichtung I beabstandet angeordnet.

Fig. 9 zeigt eine schematische Explosionsdarstellung einer zusätzlichen Ausführungsform eines erfindungsgemässen Dentalimplantats 300. Das Dentalimplantat 300 umfasst wie das Dentalimplantat 200 einen vorzugsweise aus einem Metall oder einer Metalllegierung, wie beispielsweise Titan oder einer Titanlegierung, gefertigten Verbinder 3, eine vorzugsweise aus Keramik, wie beispielsweise Zirkoniumoxid gefertigte Prothetik 320, auch hier beispielsweise in Form eines Kopfes einer Einheilschraube, und einen vorzugsweise ebenfalls aus Keramik, wie beispielsweise Zirkoniumoxid, gefertigten Basiskörper 330, der im vorliegenden Beispiel

identisch zum Basiskörper 230 ausgeformt ist. Verbinder 3, Prothetik 320 und Basiskörper 330 sind konzentrisch zu Mittelachse M des Dentalimplantats 300 angeordnet. Im Folgenden wird der Kürze halber hauptsächlich auf die Unterschiede zwischen dem Dentalimplantat 300 und dem Dentalimplantat 200 eingegangen.

Der Verbinder 3 besitzt einen Basisabschnitt 31, einen Halteabschnitt 32 und einen Schaftabschnitt 33. Am Basisabschnitt 31 ist ein Basisgewinde 311 ausgeformt, das dazu ausgestaltet ist, in Einsetzrichtung I in den Basiskörper 330 eingeschraubt zu werden. Am Halteabschnitt 32 ist wie beim Abutmenthalteabschnitt 12, 12', 12", 22 ein Haltegewinde 321 ausgeformt. Das Haltegewinde 321 ist dazu ausgestaltet, entgegen der Einsetzrichtung I in die Prothetik 320 eingeschraubt zu werden sowie mit dem Halteelement 15, 15' zusammenzuwirken (s. Figuren. 3 und 4). Der Schaftabschnitt 33 ist zylinderförmig ausgestaltet sowie rotationssymmetrisch zur Mittelachse M angeordnet und bietet somit durch seine zylindrische Aussenumfangsfläche eine Stützfläche 37.

Ein Ringbund 38 des Verbinders 3 ist zwischen dem Halteabschnitt 32 und dem Schaftabschnitt 33 liegend rotationssymmetrisch zur Mittelachse M angeordnet und zumindest abschnittsweise als Eingriffsmittel 351 ausgeformt. Das Eingriffsmittel 351 besitzt ähnlich wie das Eingriffsmittel 251 des Verbinders 2 eine Außenkontur, die dazu ausgestaltet ist, mit einem Werkzeug zusammen zu wirken, um mit Hilfe des Werkzeugs ein Drehmoment auf den Verbinder 3 zu übertragen. Vorzugsweise ist das Eingriffsmittel 351 als Aussensechskant ausgestaltet. Ein parallel zur radialen Richtung R gemessener Durchmesser von Ringbund 38 samt Eingriffsmittel 351 ist größer als ein ebenfalls parallel zur radialen Richtung R gemessener Durchmesser des Schaftabschnittes 33. Somit überragt der Ringbund 38 den Schaftabschnitt 33 und bietet daher ein entgegen der Einsetzrichtung I weisendes Schulterelement 38b.

Des Weiteren ist der Verbinder 3 mit Ringnuten 39 versehen, die jeweils zwischen Basisabschnitt 31 bzw. Basisgewinde 311 und Schaftabschnitt 33, zwischen Schaftabschnitt 33 und Ringbund 38 sowie zwischen Ringbund 38 und Halteabschnitt 32 bzw. Haltegewinde 321 angeordnet sind. An den Ringnuten 39 ist der Verbinder 3 verjüngt bzw. eingeschnürt, sodass ein parallel zur radialen Richtung R gemessener Durchmesser des Verbinders 3 am Boden der Ringnuten 39 kleiner ist als ein Durchmesser jeweils an die Ringnuten 39 angrenzender Abschnitte des Verbinders 3.

Die Prothetik 320 ist rotationssymmetrisch zur Mittelachse M ausgestaltet und besitzt ähnlich wie die Prothetik 220 einen Fortsatz 324, eine Kontaktfläche 325, einen kegelstumpfförmigen Übergangsabschnitt 327, einen Kopfteil 328 und ein Eingriffselement 329 (siehe Fig. 11). Der Fortsatz 324 besitzt einen parallel zur radialen Richtung R gemessenen Durchmesser, der kleiner als der ebenfalls parallel zur radialen Richtung R gemessene Durchmesser des Übergangsabschnittes 327 ist, wodurch zwischen Fortsatz 324 und Übergangsabschnitt 327 die in Einsetzrichtung I weisende Kontaktfläche 325 ausgebildet ist. Das im Kopfteil 328 ausgeformte Eingriffselement 329 ist beispielsweise als Innensechskant oder wie vorliegend als Innensechsrund ausgestaltet und erlaubt, mit Hilfe eines Werkzeugs (nicht gezeigt) ein um die Mittelachse M wirkendes Drehmoment auf die Prothetik 320 zu übertragen. Im Unterschied zur Prothetik 220 besitzt die Prothetik 330 eine spezielle ausgeformte Stirnseite 340, auf die weiter unten im Detail eingegangen wird.

Der Basiskörper 330 besitzt wie die Basiskörper 130 und 230 eine Bohrung 331, in der ein Innengewinde 332 (s. Fig. 13) ausgeformt ist. Aussenumfangsseitig ist der Basiskörper 330 wie die Basiskörper 130 und 230 mit einem Aussengewinde 333 versehen. Ebenfalls ist am Basiskörper 330 wie an den Basiskörpern 130 und 230 eine entgegen der Einsetzrichtung I weisende Kontaktfläche 334 ausgeformt, welche die Bohrung 331 umgibt. Ein oberer Teil der Bohrung 331 dient als Aufnahme 335 für den Fortsatz 324 der Prothetik 320 (s. Fig. 13).

Fig. 10 zeigt ein Detail IX des in Fig. 9 gezeigten Dentalimplantats 300, insbesondere die Stirnseite 340 der Prothetik 320. Die Stirnseite 340 bildet einen ringförmigen Rand um eine Ausnehmung 3101 der Prothetik 320, die ähnlich wie die Ausnehmung 2101 der Prothetik 220 ausgebildet und mit einem Gegenhaltegewinde 3102 versehen ist. An der Stirnseite 340 ist eine Verzahnung 341 ausgeformt. Die Verzahnung 341 ist aus einer Vielzahl von Zähnen 342 gebildet, welche die Ausnehmung 3101 kranzartig umgeben.

Die Zähne 342 ragen ähnlich wie bei einer sogenannten Hirth-Verzahnung in Einsetzrichtung I von der Stirnseite 340 vor. Zahnspitzen 343 der Zähne 342 bilden im Wesentlichen parallel zur radialen Richtung R verlaufende Kanten aus. Die Zähne 342 sind entgegen einer in einer Projektion entlang der Einsetzrichtung I im Uhrzeigersinn um die Mittelachse herum verlaufende Schraubrichtung S der Prothetik 320 geneigt. Durch die Neigung weisen die Zähne 342 jeweils eine in Schraubrichtung S weisende

flache Zahnflanke 344 und eine entgegen der Schraubrichtung S weisende steile Zahnflanke 345 auf.

Fig. 11 zeigt eine schematische Querschnittsansicht entlang einer Mittelachse M des in Fig. 9 und 10 gezeigten Dentalimplantates 300 in einem weiteren Vormontagezustand V. Im weiteren Vormontagezustand V ist die Prothetik 320 mit dem in ihrer Ausnehmung 3101 ausgeformten Gegenhaltegewinde 3102 in Einsetzrichtung I auf das Haltegewinde 321 des Halteabschnitts 32 des Verbinders 3 geschraubt. Die Stirnseite 340 der Prothetik 320 ist in Kontakt mit dem Schulterelement 38b gebracht. Im Bereich der zwischen dem Haltebereich 32 und dem Ringbund 38 angeordneten Ringnut 39 ist eine Kavität 50 gebildet. Die Kavität 50 kann zum Beispiel mindestens teilweise mit einem Klebstoff 51 gefüllt sein.

Fig. 12 zeigt ein Detail XI des in Figs. 9 bis 11 gezeigten Dentalimplantates 300. Hier wird deutlich, dass die Zähne 342 beim Aufschrauben der Prothetik 320 auf den Verbinder 3 dessen Material verdrängt haben und somit ein Formschluss zwischen Prothetik 320 und Verbinder 3 herbeigeführt ist. Durch die Neigung der Zähne 342 entgegen der Schraubrichtung S ist dieser Formschluss insbesondere bei entgegen der Schraubrichtung S auf die Prothetik 320 relativ zum Verbinder 3 wirkenden Drehmomente um die Mittelachse M wirksam, sodass eine innige Verbindung zwischen Prothetik 320 und Verbinder 3 besteht.

Die flachen Zahnflanken 344 begünstigen eine Relativbewegung zwischen Prothetik 320 und Verbinder 3 beim Aufschrauben der Prothetik 320, wenn die Stirnseite 340 auf das Schulterelement 38b trifft. Die steilen Zahnflanken 345, die beispielsweise im Wesentlichen parallel zur Einsetzrichtung I verlaufen oder sogar einen Hinterschnitt aufweisen können, verhindern hingegen ein Lösen der Verschraubung zwischen Prothetik 320 und Verbinder 3, indem sie sich beim Versuch, die Prothetik 320 entgegen der Schraubrichtung S relativ zum Verbinder 3 zu drehen in dessen Material graben und somit die Relativdrehung hemmen oder bestenfalls Prothetik 320 und Verbinder 3 gegeneinander sperren.

Der Klebstoff 51 begünstigt eine innige Verbindung zwischen Prothetik 320 und Verbinder 3 und kann beispielsweise auf Haltegewinde 321 und/oder Gegenhaltegewinde 3102 aufgetragen und/oder, wie gezeigt, in der Kavität 50

angeordnet sein. Verzahnung 341 und/oder Klebstoff 51 können also erfindungsgemäß dazu genutzt werden, um die Prothetik 320 hochfest bzw. möglichst unlösbar mit dem Verbinder 3 zu verbinden. Verzahnung 341 und/oder Klebstoff 51 helfen somit, eine hybride Implantatschraube 4 zu bilden, die wenigstens eine metallische Komponente, wie den Verbinder 3, und wenigstens eine keramische Komponente, wie die Prothetik 320 umfasst.

Fig. 13 zeigt eine schematische Querschnittsansicht entlang der Längsachse des in Figs. 9 bis 12 gezeigten Dentalimplantates in einem weiteren Endmontagezustand E'. Im Endmontagezustand E' sind Verbinder 3 und Prothetik 320 gemeinsam bzw. als hybride Implantatschraube 4 in den Basiskörper 330 eingesetzt. Zum Einsetzen ist der Basisabschnitt 31 mit dem Basisgewinde 311 des Verbinders 3 bzw. der hybriden Implantatschraube 4 unter Verwendung des Eingriffselements 329 der Prothetik zum Ansetzen eines Werkzeugs (nicht gezeigt) in das Innengewinde 332 des Basiskörpers 330 eingeschraubt. Der Schaftabschnitt 33 des Verbinders 3 bzw. der hybriden Implantatschraube 4 ist in einem oberhalb des Innengewindes 332 angeordneten Abschnitt der Bohrung 331 aufgenommen.

Zwischen der Stützfläche 37 des Schaftabschnitts 33 und dem Innenumfang der Bohrung 331 befindet sich ein möglichst geringes bis vorzugsweise kaum oder kein Spiel, beispielsweise indem Schaftabschnitt 33 und Bohrung 331 in diesem Bereich mit einer Spielpassung oder Übergangspassung ausgelegt sind. Somit stützt der Schaftabschnitt 33 den Verbinder 3 in der Bohrung 331 oberhalb des Innengewindes 332 ab, was dabei hilft, in radialer Richtung R wirkende Querkräfte sowie Biegemomente vom Innengewinde 332 fernzuhalten, sodass dort im Wesentlichen lediglich in Richtung entlang der Mittelachse M wirkende Normalkräfte auftreten.

Im Endmontagezustand E' liegt die Kontaktfläche 325 der Prothetik 320 auf der Kontaktfläche 334 des Basiskörpers 330 bündig abdichtend auf, wodurch die Aufnahme 335 hermetisch abgedichtet ist. Somit kann sichergestellt werden, dass der Verbinder 3 nicht in Kontakt mit dem Zahnfleisch gelangt bzw. vom gesamten Mundraum abgeschirmt ist. Der Fortsatz 324 ragt in Einsetzrichtung I in die Aufnahme 335, wobei zwischen einem Außenumfang des Fortsatzes 324 und einem Innenumfang der Aufnahme 335 vorzugsweise ein möglichst geringes bis vorzugsweise kaum oder kein Spiel vorhanden ist, beispielsweise indem Fortsatz 324 und Aufnahme 335 in diesem

Bereich mit einer Spielpassung oder Übergangspassung ausgelegt sind. In radialer Richtung R überdecken sich eine die Aufnahme 335 bildende Wandung des Basiskörpers 330 mit Prothetik 320 und Verbinder 3, wodurch sie einen kompakte und hochstabile Baugruppe bilden. Durch die Verwendung von Prothetik 320 und Verbinder 3 als hybride Implantatschraube 4 ist das Dentalimplantat 300 wie ein zweiteiliges Dentalimplantat handhabbar.

Bezugszeichenliste

1, *V*, 1", 2, 3	Einheitsverbinder oder Verbinder
4	hybride Implantatschraube
I I , 11', 11", 21, 31	Basisabschnitt
I I I , 111', 111", 211, 311	Basisgewinde / unteres Aussengewinde
12, 12', 12", 22, 32	Abutmenthalteabschnitt/Halteabschnitt
121 , 121', 121 ", 221 , 321	Haltegewinde / oberes Aussengewinde)
13, 13', 13", 23, 33	Schaftabschnitt
14'	Bolzenverlängerung
141	Verlängerungsgewinde
100, 100', 200, 300	Dentalimplantat
110	Zahnaufbau
1101, 2101, 3101	Ausnehmung
2102, 3102	Gegenhaltegewinde
120, 120', 220, 320	Abutment / Prothetik
1200, 1200'	Durchgangsbohrung
1201 , 1201 '	oberer Bereich der Durchgangsbohrung
1202	unterer Bereich der Durchgangsbohrung
1203	Schulter
124a, b, 224	Fortsatz
125, 225	Kontaktfläche
126	Positivelement
130, 230, 330	Basiskörper
131 , 231 , 331	Bohrung
132, 232, 332	Innengewinde
133, 233, 333	Aussengewinde
134, 234, 334	Kontaktfläche
135, 235, 335	Aufnahme
236, 336	Gegenschulterelement
136	Negativelement
227, 327	Übergangsabschnitt
228, 328	Kopfteil
229, 329	Eingriffselement
240, 340	Stirnseite
341	Verzahnung
342	Zahn
343	Zahnspitzen
344	flache Zahnflanke

345	steile Zahnflanke
15, 15'	Halteelement
151 , 151', 251 , 351	Eingriffsmittel
152, 152'	Innengewinde
153	Haltefläche
16	Zusatzhalteelement
161	Eingriffsmittel
27, 37	Stützfläche
28, 38	Ringbund
28a, 28b, 38b	Schulterelement
29, 39	Ringnut
50	Kavität
51	Klebstoff
E	Endmontagezustand
I	Einsetzrichtung
L_{11}, $L_{11'}$	Länge des Basisabschnitts
L_{12}, $L_{12'}$	Länge des Abutmenthalteabschnitts
L_{13}, $L_{13'}$	Länge des Schaftabschnitts
$L_{14''}$	Länge der Bolzenverlängerung
L_{ni}, L_{iii-}	Länge des ersten Aussengewindes
L_{112}, $L_{112'}$	Länge des Abutmenthalteabschnitts
L_{132}	Länge des Innengewindes
L_{141}	Länge des Verlängerungsgewindes
M	Mittelachse
S	Schraubrichtung
R	radiale Richtung
V, V	Vormontagezustand

Patentansprüche

1. Verbinder (1, 1', 1", 2, 3) zum Verbinden keramischer Komponenten eines Dentalimplantats (100, 100', 200, 300),

mit einem Basisabschnitt (11, 11', 11", 21, 31), an dem ein Basisgewinde (111, 111', 111", 211, 311) zum Einschrauben des Verbinders (1, 1', 1", 2, 3) in einen Basiskörper (130, 230, 330) des Dentalimplantats (100, 100', 200, 300) ausgeformt ist, und

mit einem Halteabschnitt (12, 12', 12", 22, 32), an dem ein Haltegewinde (121, 131, 131', 221, 321) zum Aufschrauben einer Prothetik (120, 120', 220, 320) des Dentalimplantats (100, 100', 200, 300) auf den Verbinder (1, 1', 1", 2, 3) ausgeformt ist.

2. Verbinder (1, 1', 1", 2, 3) nach Anspruch 1, **dadurch gekennzeichnet, dass** der Verbinder (1, 1', 1", 2, 3) aus einem Metall oder einer Metalllegierung gefertigt ist.

3. Verbinder (1, 1', 1", 2, 3) nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** der Verbinder (1, 1', 1", 2, 3) zwischen dem Basisabschnitt (11, 11', 11", 21, 31) und dem Halteabschnitt (12, 12', 12", 22, 32) wenigstens ein Schulterelement (28a, 28b, 38b) aufweist, das zumindest abschnittsweise über einen Aussenumfang des Basisabschnitts (11, 11', 11", 21, 31) und/oder des Halteabschnitts (12, 12', 12", 22, 32) in einer radialen Richtung (R) des Verbinders (1, 1', 1", 2, 3) hinweg ragt.

4. Verbinder (1, 1', 1", 2, 3) nach Anspruch 3, **dadurch gekennzeichnet, dass** das wenigstens eine Schulterelement (28a, 28b, 38b) an einem Ringbund (28, 38) ausgeformt ist, dessen Aussendurchmesser grösser ist als ein Aussendurchmesser des Basisabschnitts (11, 11', 11", 21, 31) und/oder des Halteabschnitts (12, 12', 12", 22, 32).

5. Verbinder (1, 1', 1", 2, 3) nach wenigstens einem der oben genannten Ansprüche, **dadurch gekennzeichnet, dass** das am Verbinder (1, 1', 1", 2, 3) wenigstens ein Eingriffsmittel (251, 351) ausgeformt ist zum Betätigen des Verbinders (1, 1', 1", 2, 3) mit einem Werkzeug.

6. Verbinder (1, 1', 1", 2, 3) nach Anspruch 5, **dadurch gekennzeichnet, dass** das wenigstens eine Eingriffsmittel (251, 351) zumindest abschnittsweise mit einer Aussenprofilierung versehen ist.

7. Verbinder (1, 1', 1", 2, 3) nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** ein Kopfende des Verbinders (1, 1', 1", 2, 3) als das wenigstens eine Eingriffsmittel (251, 351) ausgestaltet ist.

8. Verbinder (1, 1', 1", 2, 3) nach wenigstens einem der oben genannten Ansprüche, **dadurch gekennzeichnet, dass** das wenigstens eine Ringnut (29, 39) zwischen dem Basisabschnitt (11, 11', 11", 21, 31) und dem Halteabschnitt (12, 12', 12", 22, 32) ausgeformt ist, an der sich der Aussenumfang des Verbinders (1, 1', 1", 2, 3) gegenüber den jeweils umliegenden Abschnitten verjüngt.

9. Verbinder (1, 1', 1", 2, 3) nach wenigstens einem der oben genannten Ansprüche, **dadurch gekennzeichnet, dass** das Basisgewinde (111, 111', 111", 211, 311) und/oder das Haltegewinde (121, 131, 131', 221, 321) als Linksgewinde ausgestaltet sind bzw. ist.

10. Prothetik (120, 120', 220, 320) für ein Dentalimplantat (100, 100', 200, 300), mit einem Gegenhaltegewinde (2102, 3102) zum Aufschrauben der Prothetik (120, 120', 220, 320) auf einen Verbinder (1, 1', 1", 2, 3) des Dentalimplantats (100, 100', 200, 300).

11. Prothetik (120, 120', 220, 320) nach Anspruch 10, **dadurch gekennzeichnet, dass** die Prothetik (120, 120', 220, 320) mit einem Sackloch versehen ist, in dem das Gegenhaltegewinde (2102, 3102) angeordnet ist.

12. Prothetik (120, 120', 220, 320) nach Anspruch 10 oder 11, **dadurch gekennzeichnet, dass** das Gegenhaltegewinde (2102, 3102) zumindest abschnittsweise entlang eines Fortsatzes (224, 324) der Prothetik (120, 120', 220, 320) verläuft, der dazu ausgestaltet ist, in eine Aufnahme (135, 235, 335) eines Basiskörpers (130, 230, 330) des Dentalimplantats (100, 100', 200, 300) einzugreifen.

13. Basiskörper (130, 230, 330) für ein Dentalimplantat (100, 100', 200, 300), mit einem Innengewinde (132, 232, 332), das komplementär zu einem Basisgewinde (111, 111', 111", 211, 311) eines Verbinders (1, 1', 1", 2, 3) nach wenigstens einem der Ansprüche 1 bis 9 ausgestaltet ist und/oder mit einer Aufnahme (135, 235, 335), die komplementär zu einer Prothetik (120, 120', 220, 320) nach einem der Ansprüche 10 bis 12 ausgestaltet ist.

14. Verbindungssystem für ein Dentalimplantat (100, 100', 200, 300), mit wenigstens einem Verbinder (1, 1', 1", 2, 3) nach einem der Ansprüche 1 bis 9 und/oder mit wenigstens einer Prothetik (120, 120', 220, 320) nach einem der Ansprüche 10 bis 12 und/oder mit wenigstens einem Basiskörper (130, 230, 330) nach Anspruch 13.

15. Verbindungssystem für ein Dentalimplantat (100, 100', 200, 300), **dadurch gekennzeichnet, dass** in einem Endmontagezustand (E, E') des Dentalimplantats (100, 100', 200, 300) der Verbinder (1, 1', 1", 2, 3) in einem von Prothetik (120, 120', 220, 320) und Basiskörper (130, 230, 330) umschlossenen Innenraum des Dentalimplantats (100, 100', 200, 300) aufgenommen ist.

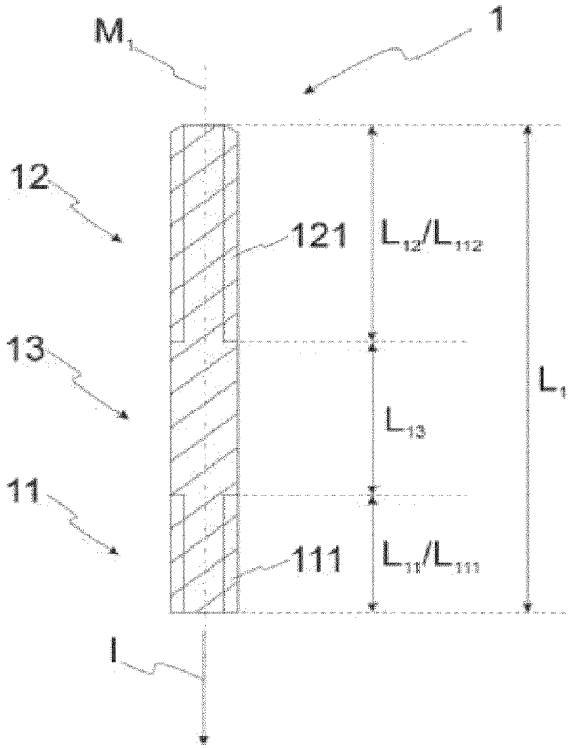

M1
1
12
121
L12/L112
13
L13
L1
11
111
L11/L111
I

Fig. 1

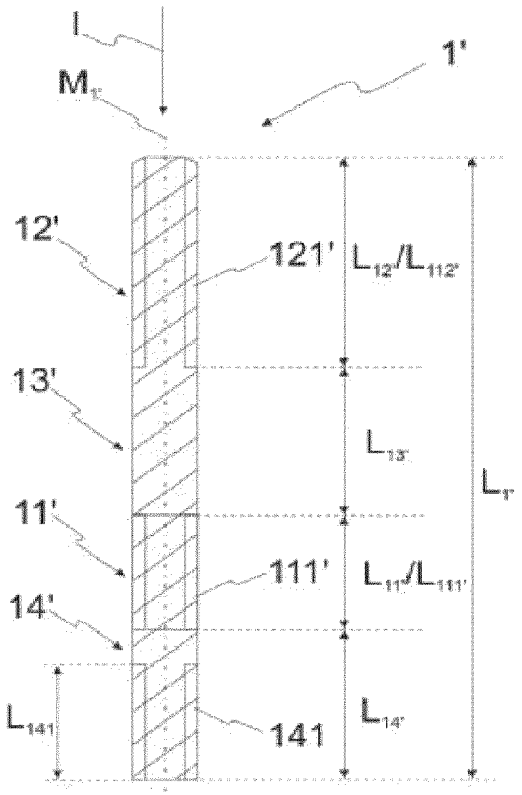

I
M1'
1'
12'
121'
L12/L112'
13'
L13'
L1'
11'
111'
L11/L111'
14'
L141
141
L14'

Fig. 2

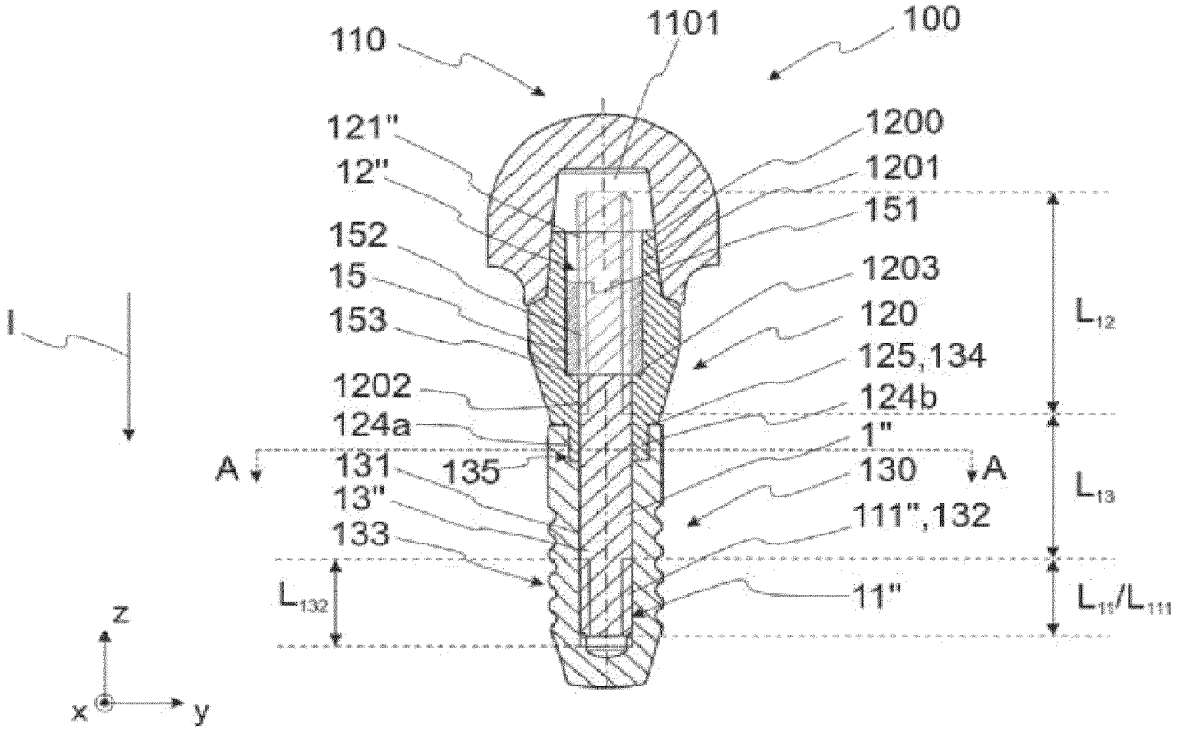

110
1101
100
121"
12"
152
15
153
1202
124a
131
135
13"
133
1200
1201
151
1203
120
125,134
124b
1"
130
111",132
11"
A
A
I
L_{12}
L_{13}
L_{11}/L_{111}
L_{132}
z
x
y

Fig. 3

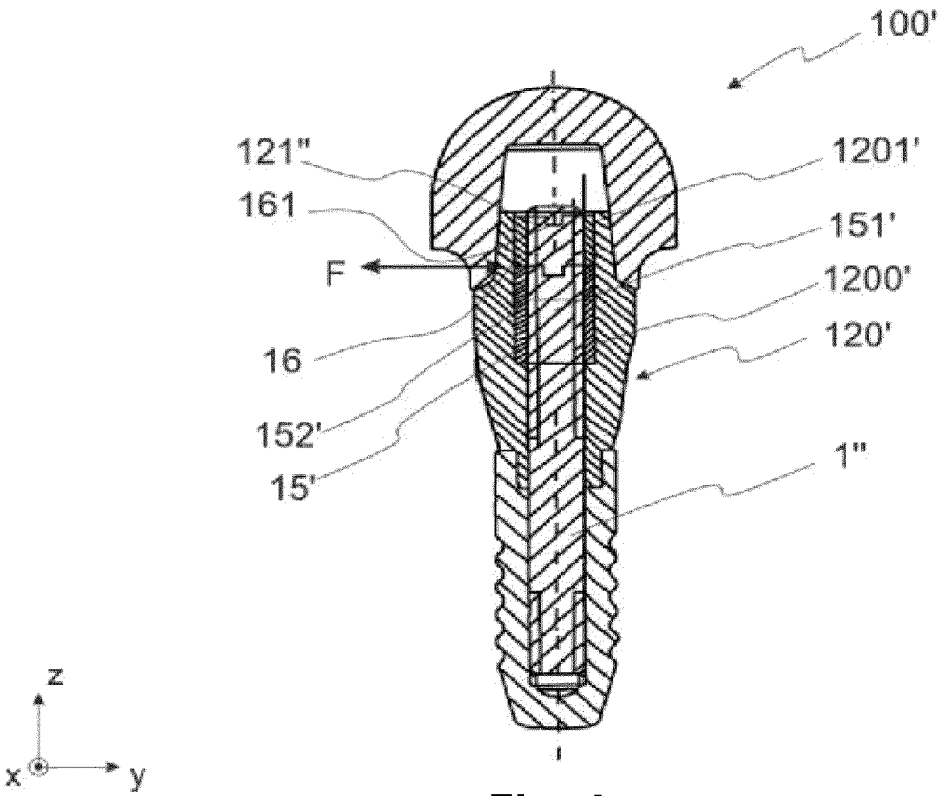

100'
121"
161
F
16
152'
15'
1201'
151'
1200'
120'
1"
z
x
y

Fig. 4

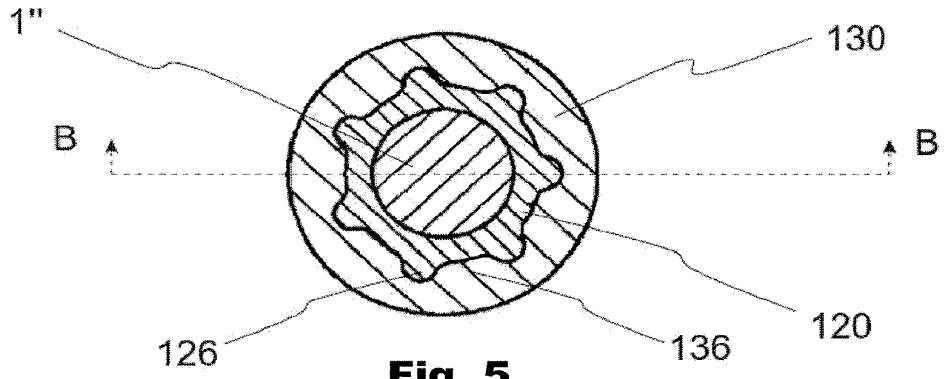

1"
130
B
B
120
126
136

Fig. 5

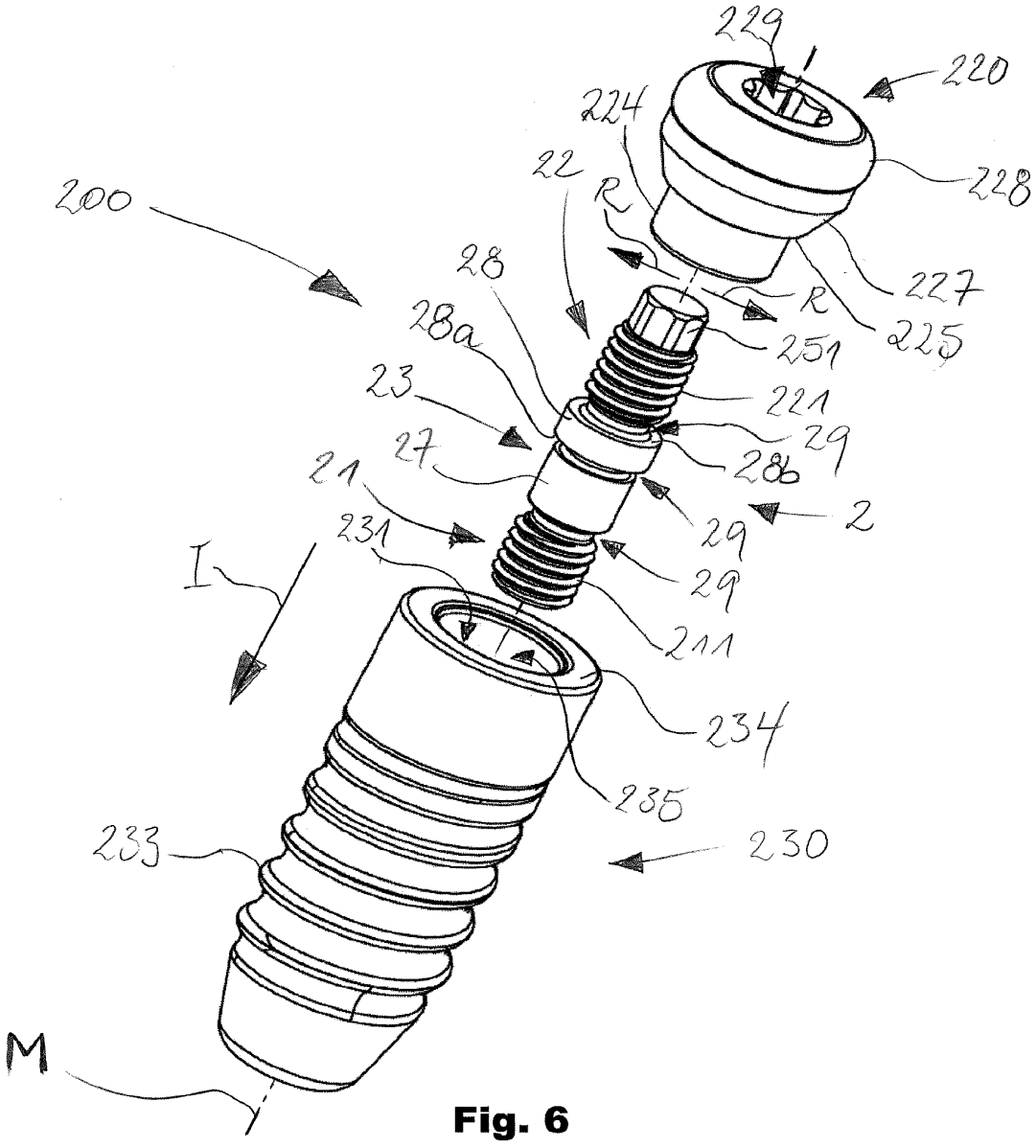

229
220
224
228
22
R
200
28
227
R
28a
251
225
23
221
29
27
286
21
29
2
231
I
29
211
234
235
233
230
M

Fig. 6

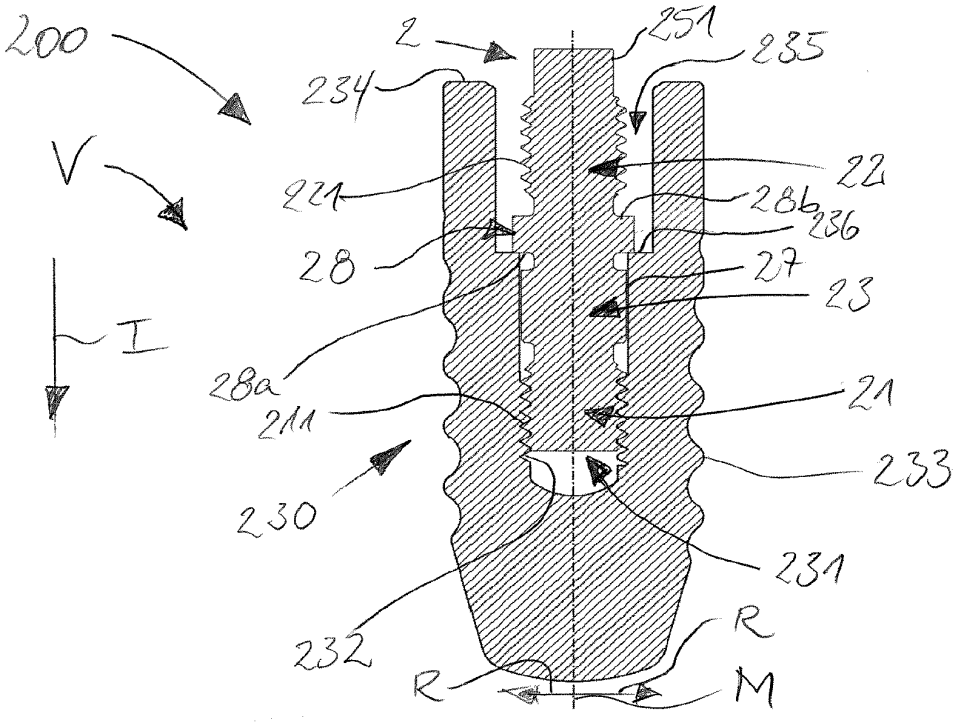

200
V
I
2
251
235
234
22
221
286
236
28
27
23
28a
211
21
230
233
231
232
R
R
M

Fig. 7

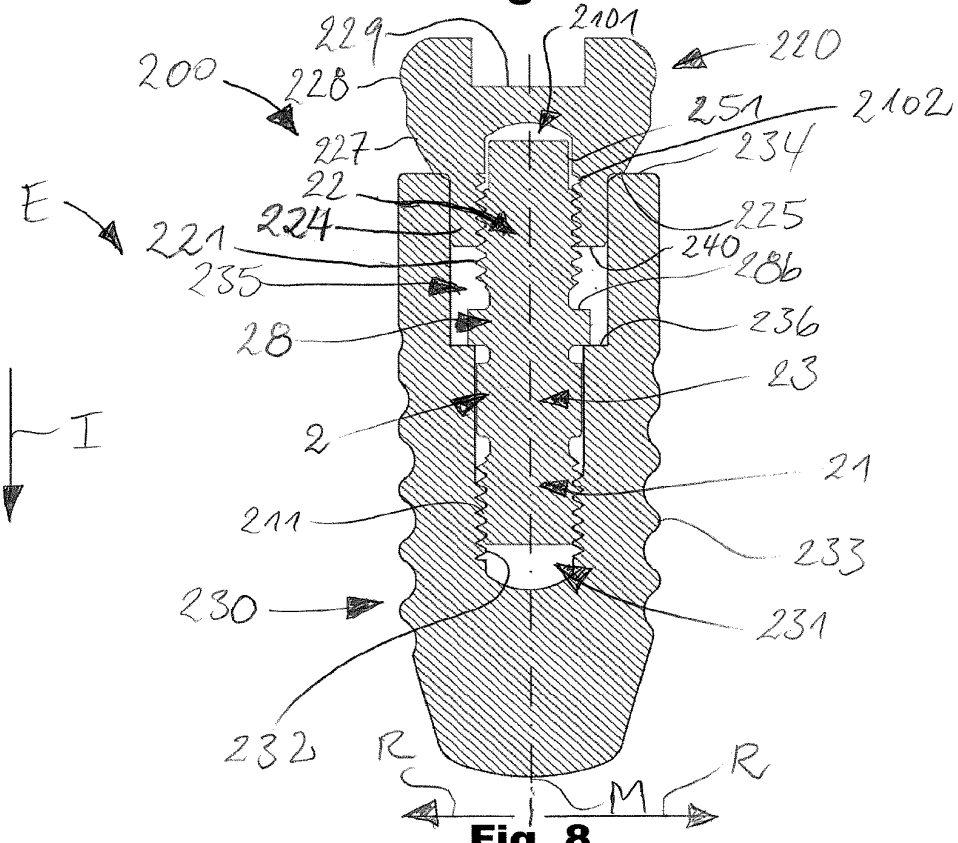

229
2101
220
200
228
251
2102
227
234
E
22
225
221
224
240
286
235
236
28
23
I
2
21
211
233
230
231
232
R
R
M

Fig. 8

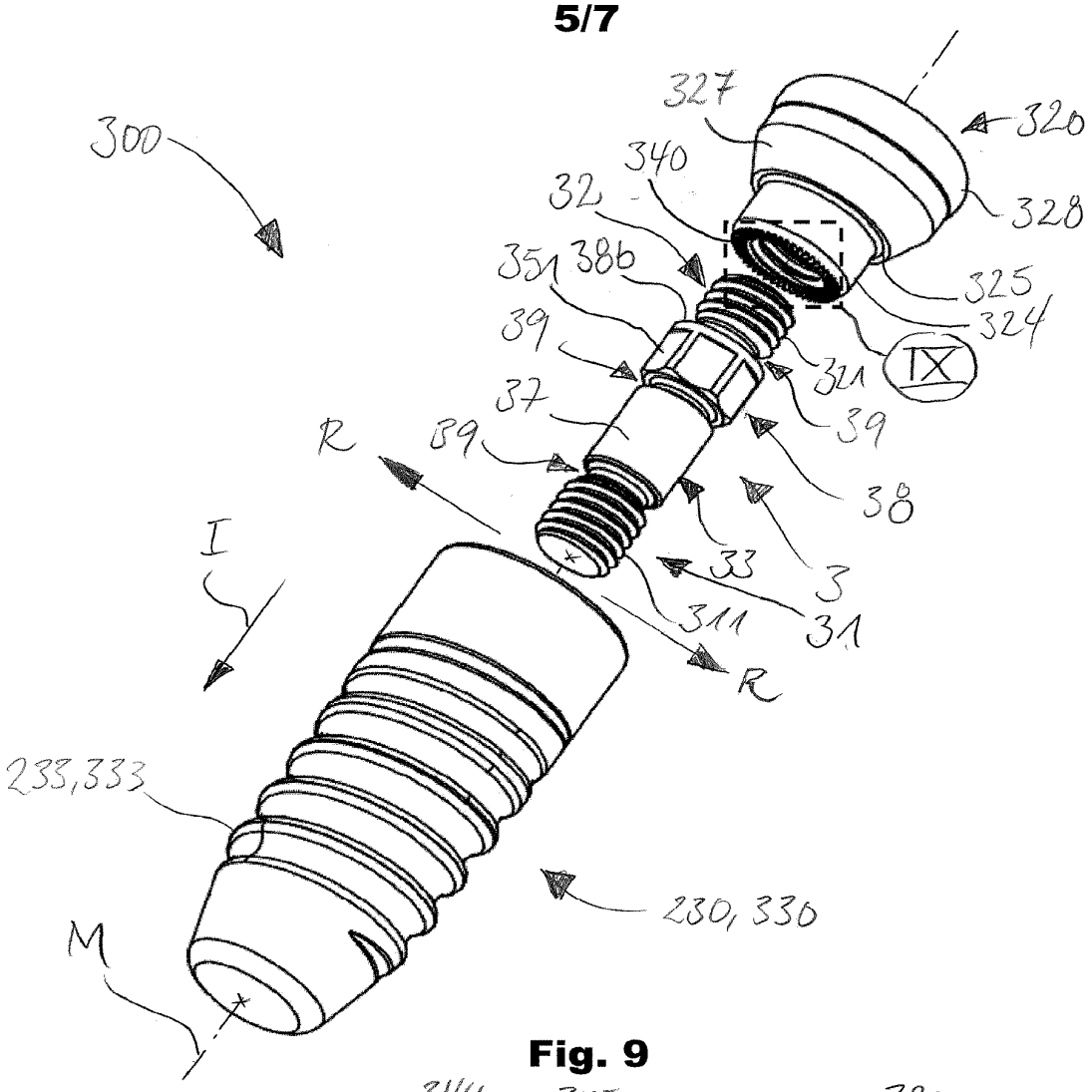

300
327
320
340
32
328
351
386
325
39
324
IX
321
37
39
R
89
38
I
33
3
311
31
R
233,333
230, 330
M

Fig. 9

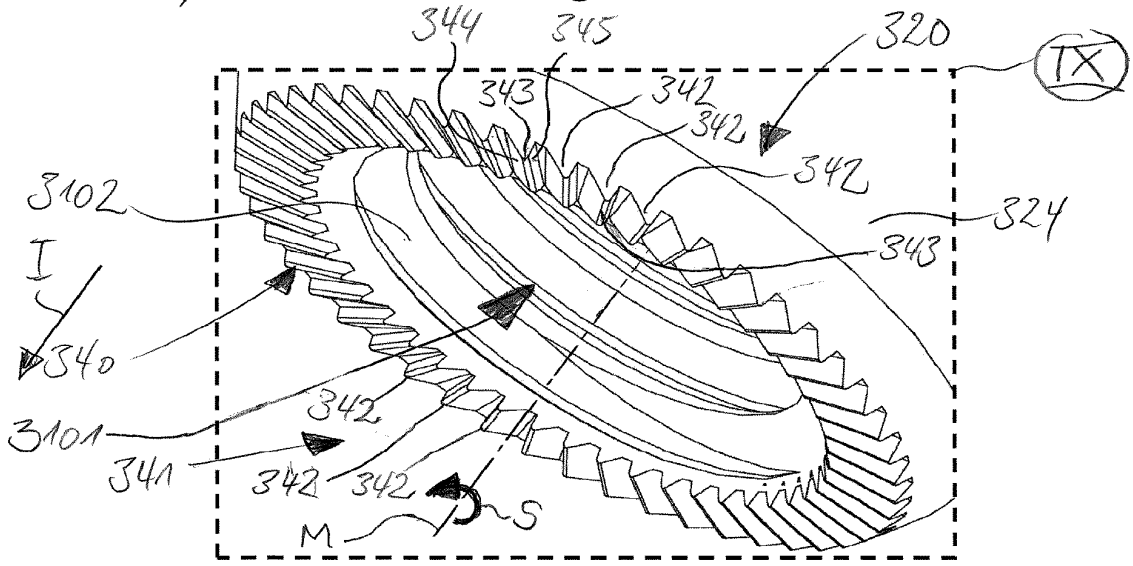

344
345
320
IX
343
341
342
342
3102
342
324
I
343
340
342
3101
341
342
342
M
S

Fig. 10

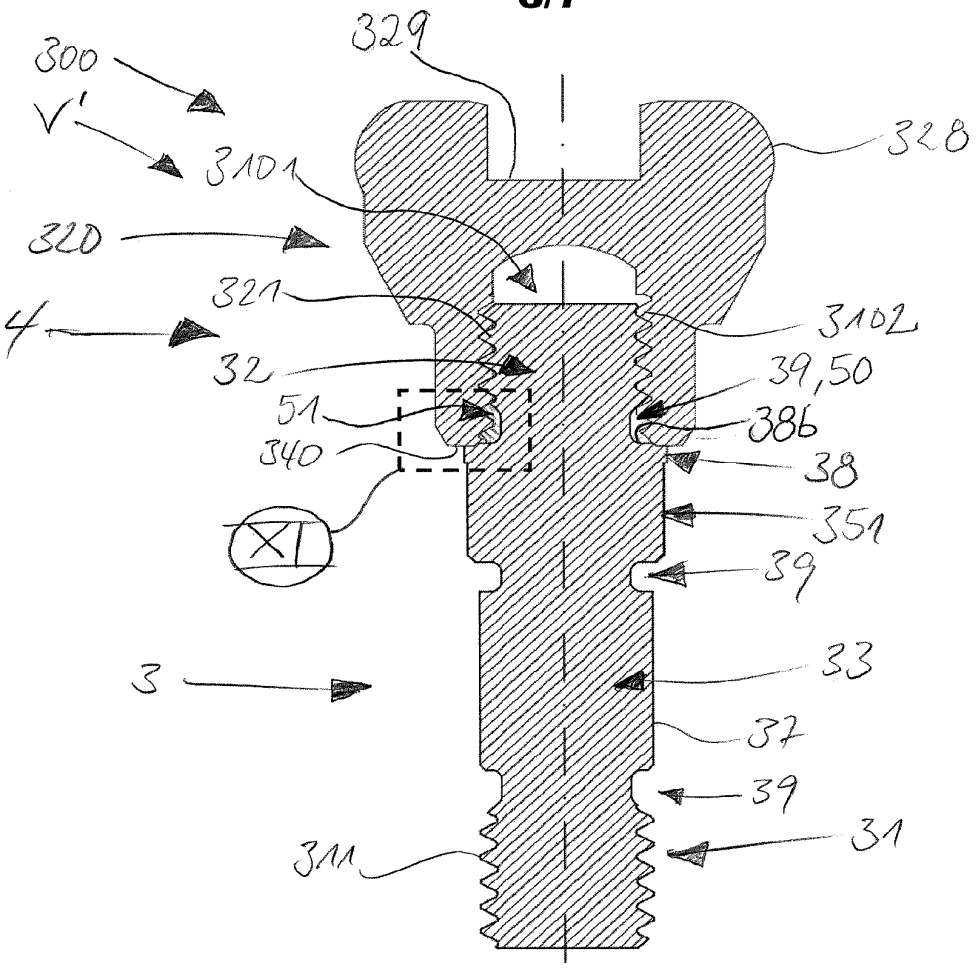

329
300
V'
328
3101
320
321
4
3102
32
39,50
51
386
340
38
XI
351
39
3
33
37
39
311
31

Fig. 11

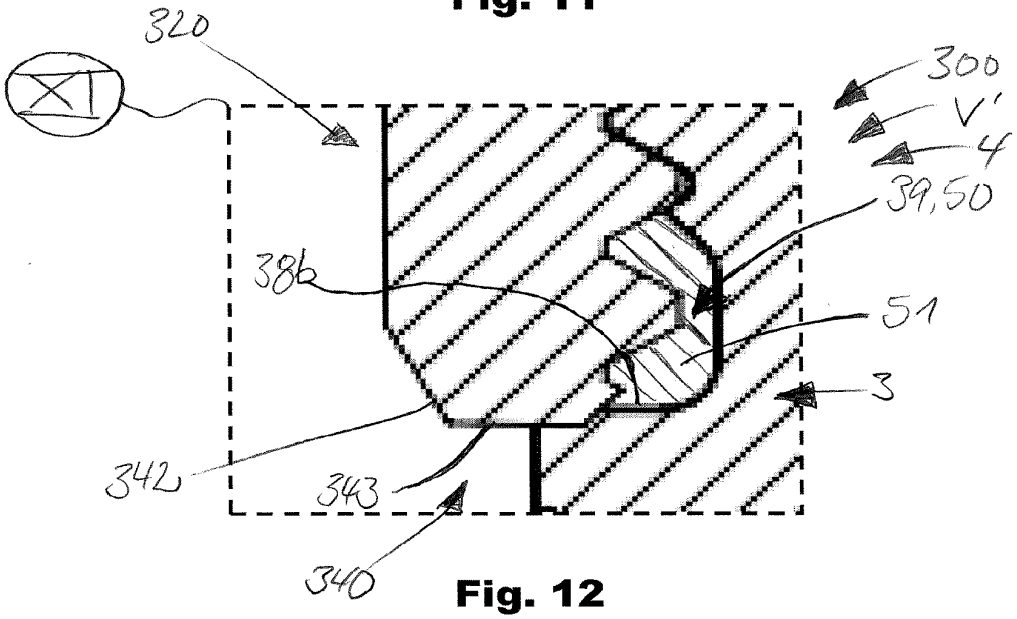

320
XI
300
V'
4
39,50
386
51
3
342
343
340

Fig. 12

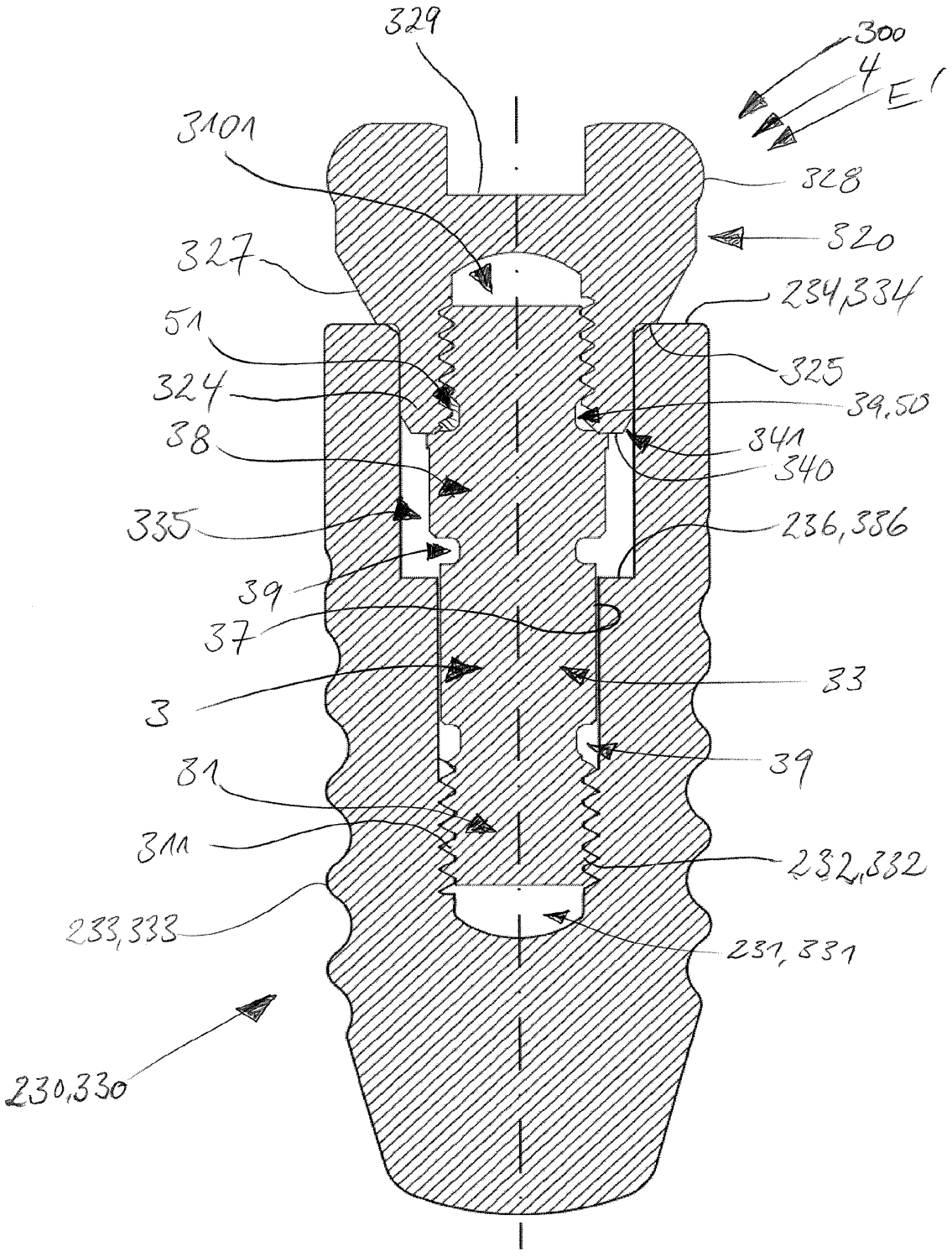

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300
4
E1
3101
328
320
327
234,334
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325
324
39,50
38
341
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236,336
39
37
33
3
39
31
311
232,332
233,333
231,331
230,330

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2017/054916

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61C8/00
ADD.

According to International Patent Classification (IPC) orto both national Classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (Classification System followed by Classification Symbols)
A61C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
X Y	US 2008/233538 Al (HUG THOMAS SI LVAN [CH] ET AL) 25 September 2008 (2008-09-25) page 1, paragraph 33 - page 3, paragraph 35; figures 1-3D	1-8, 10-15 9

X A	DE 28 36 152 Al (LEITZ ERNST GMBH) 28 February 1980 (1980-02-28) page 13 - page 27; figures 1, 2, 11, 12	1-7,10, 13,14 8,9,11, 12,15

X A	DE 44 43 051 Al (SCHMITT FRI EDRICH [DE]; MOHR PETER DR [DE]) 2 October 1996 (1996-10-02) column 1 - column 4; figure 1	1,5-7, 10,11, 13-15 2-4,8,9, 12

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 September 2017	11/10/2017

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Wirth , Christian

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INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
Y	JP 2015 146927 A (IKASHIKA SOLUTIONS CO LTD) 20 August 2015 (2015-08-20)	9
A	Paragraph [0032]	1-8, 10-15

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SDC001745

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2017/054916

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2008233538 A1	25-09-2008	EP 1972297 A1	24-09-2008
		ES 2557555 T3	27-01-2016
		US 2008233538 A1	25-09-2008
DE 2836152 A1	28-02-1980	NONE	
DE 4443051 A1	02-10-1996	NONE	
JP 2015146927 A	20-08-2015	JP 6124815 B2	10-05-2017
		JP 2015146927 A	20-08-2015

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/IB2017/054916

A. KLASSIFIZIERUNG DES ANMELDUNGSGEGENSTANDES
INV. A61C8/00
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B. RECHERCHIERTE GEBIETE

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A61C

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EPO-Internal , WPI Data

C. ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
X Y	US 2008/233538 AI (HUG THOMAS SI LVAN [CH] ET AL) 25. September 2008 (2008-09-25) Seite 1, Absatz 33 - Seite 3, Absatz 35; Abbi ldungen 1-3D	1-8, 10-15 9

X A	DE 28 36 152 AI (LEITZ ERNST GMBH) 28. Februar 1980 (1980-02-28) Seite 13 - Seite 27; Abbi ldungen 1, 2, 11, 12	1-7,10, 13,14 8,9 ,11, 12,15

X A	DE 44 43 051 AI (SCHMITT FRI EDRICH [DE] ; MOHR PETER DR [DE]) 2. Oktober 1996 (1996-10-02) Spalte 1 - Spalte 4; Abbi ldung 1	1,5-7 , 10, 11, 13-15 2-4,8,9 , 12

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[X] Weitere Veröffentlichungen sind der Fortsetzung von Feld C zu entnehmen [X] Siehe Anhang Patentfamilie

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Datum des Abschlusses der internationalen Recherche	Absendedatum des internationalen Recherchenberichts
29. September 2017	11/10/2017

Name und Postanschrift der Internationalen Recherchenbehörde	Bevollmächtigter Bediensteter
Europäisches Patentamt, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Wi rth , Chri sti an

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INTERNATIONALER RECHERCHENBERICHT

Internationales Aktenzeichen
PCT/IB2017/054916

C. (Fortsetzung) ALS WESENTLICH ANGESEHENE UNTERLAGEN

Kategorie*	Bezeichnung der Veröffentlichung, soweit erforderlich unter Angabe der in Betracht kommenden Teile	Betr. Anspruch Nr.
Y	JP 2015 146927 A (IKASHIKA SOLUTIONS CO LTD) 20. August 2015 (2015-08-20)	9
A	Absatz [0032]	1-8, 10-15

2

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SDC001748

Page 545 of 1175

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INTERNATIONALER RECHERCHENBERICHT

Angaben zu Veröffentlichungen, die zur selben Patentfamilie gehören

Internationales Aktenzeichen
PCT/IB2017/054916

Im Recherchenbericht angeführtes Patentdokument	Datum der Veröffentlichung	Mitglied(er) der Patentfamilie	Datum der Veröffentlichung
US 2008233538 A1	25-09-2008	EP 1972297 A1 ES 2557555 T3 US 2008233538 A1	24-09-2008 27-01-2016 25-09-2008
DE 2836152 A1	28-02-1980	KEINE	
DE 4443051 A1	02-10-1996	KEINE	
JP 2015146927 A	20-08-2015	JP 6124815 B2 JP 2015146927 A	10-05-2017 20-08-2015

Formblatt PCT/ISA/210 (Anhang Patentfamilie) (April 2005)



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CHAPTER

1

Basic Biology of Oral Microbes

1.1 CYTOLOGICAL BASIS OF MICROORGANISMS

The cell is the fundamental unit of all living organisms. Various subunit structures and chemical substances found on and inside the cell make complex cellular functions possible. Microbes can be divided into three major groups according to their morphological structure, degree of differentiation, and chemical composition: eukaryote, prokaryote, and acellular microorganisms (Figure 1.1(A)–(D)).

1.2 MICROBIAL MORPHOLOGY

Microorganisms, also known as microbes, are tiny organisms that are only visible under an optical microscope or an electron microscope. They are small in size and simple in structure. Microbes reproduce quickly, can tolerate a wide range of environmental conditions, are widely distributed, highly variable, and tend to congregate.

1.2.1 Microbial Size

As many types of microbes exist, they vary widely in size. Generally, the units used to measure microbes are μm and nm. Most cocci are 1 μm in diameter. Bacilli can be further divided into coccobacilli, brevibacteria, and long bacilli, and measure approximately 1–10 μm in length and 0.3–1 μm in width. Spirochetes measure approximately 6–20 μm in length and 0.1–0.2 μm in width. Fungi are several times larger than bacteria. Most viruses are smaller than 150 nm and are only visible under the electron microscope. The same microbes can change in size depending on their environment or age (Figure 1.2).

1.2.2 Microbial Morphology

Different types of microbes have different, but characteristic, shapes. Under suitable conditions, the shape and size of microbes are relatively stable. It is important to know the morphological structure of microbes, as it provides us with a better understanding of microbial physiology, pathogenic mechanisms, antigenic features, and allows us to identify them by species. In addition, knowledge of microbial morphology can be helpful in diagnosing disease and in preventing microbial infections.

1. Bacteria are complex and highly variable microbes. They come in four basic shapes: spherical (cocci), rod-shaped (bacilli), arc-shaped (vibrio), and spiral (spirochete) (Figure 1.3(A)).
2. Fungi are divided into unicellular and multicellular according to the number of cells that make up the organism. Unicellular fungi, such as *Saccharomyces* and other yeast-like fungi, are usually round or oval. Multicellular fungi have hyphae and spores. The hyphae and spores of different fungi are shaped differently (Figure 1.3(B) and (C)).
3. Many viruses are spherical or almost spherical, some are rod-shaped (often seen in plant viruses), filamentous (e.g., freshly isolated influenza virus), bullet-shaped (e.g., rabies virus), brick-shaped (e.g., poxvirus), and tadpole-shaped (e.g., bacteriophage) (Figure 1.3(D)).

1.3 MICROBIAL CELL STRUCTURE

Although different microbes possess different cellular structures, there are certain commonalities within groups of microbes.

1.3.1 Basic Bacterial Structures

The architecture of bacterial cells consists of basic and special structures. Basic structures include the cell wall, cell membrane, cytoplasm, nuclear material, ribosome, plasmid, etc. Special structures, which are only found in some bacteria, include the flagellum, pilus, capsule, spore, etc. (Figure 1.4).

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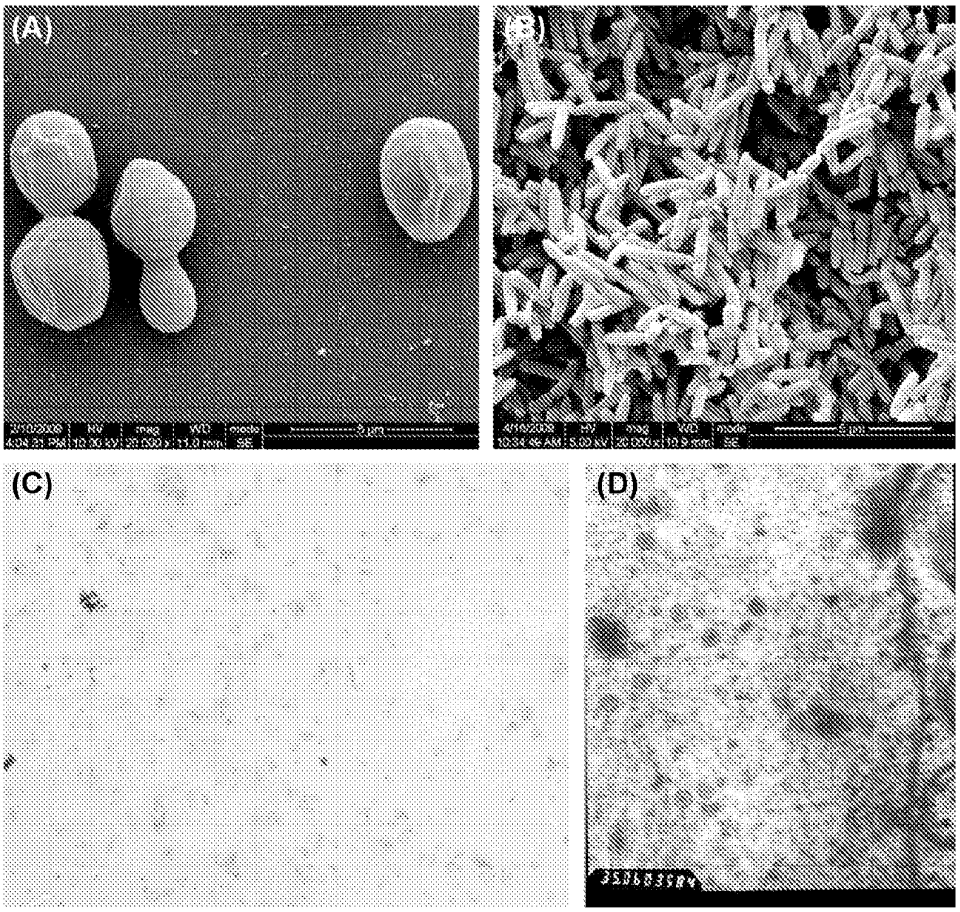


FIGURE 1.1 (A) Eukaryotic microbes (*Saccharomyces*, SEM): The eukaryotic cell has a high degree of nuclear differentiation. It has a nuclear membrane, nucleoli, and chromosomes. There is a complete complement of structured organelles in the cytoplasm and cellular reproduction takes place by mitosis. Examples include fungi and algae. (B) Prokaryotic microbes (bacteria). (C) Prokaryotic microbes (mycoplasma): The prokaryotic cell has a primitive nucleoplasm and cell membrane; it has no nuclear membrane, nucleolus, or organelles. Prokaryotes include bacteria such as *Mycoplasma*, *Chlamydia*, and *Rickettsia*. (D) Acellular microorganisms (herpes simplex virus): Acellular microorganisms are the smallest microorganism with no typical cell structure and no enzymatic energy-production system. They consist merely of a nucleic acid genome (DNA/RNA) and a protein coat (the capsid). Acellular microorganisms can only reproduce inside a living cell. Examples include viruses and subviral agents.

1.3.1.1 Cell Wall

The cell wall is the outermost structure of the bacterial cell and is located outside the cell membrane. It is transparent, tough, and flexible. The average thickness ranges from 15 to 30 nm. It mainly consists of peptidoglycan, also called mucopeptide, glycopeptide, or murein. Bacteria are classified into gram-positive and gram-negative based on the appearance of the cells after Gram stain. The peptidoglycan of gram-positive bacteria is composed of a glycan backbone, tetrapeptide side chains, and a pentapeptide cross-linking bridge (Figure 1.5(A)). The peptidoglycan of gram-negative bacteria is composed of a glycan backbone and a tetrapeptide side chain (Figure 1.5(B)).

Gram-positive and gram-negative bacteria have unique structures other than peptidoglycan in their cell walls (Figure 1.5(C) and (D)). Other substances, such as compound polysaccharide, surface protein, proteins M and G of *Streptococcus*, protein A of *Staphylococcus aureus*, etc. are found on the outer layer of the cell wall of some gram-positive bacteria.

1.3.1.2 Cell Wall-Deficient Bacteria (Bacterial L Form)

Cell wall-deficient bacteria are strains of bacteria that lack cell walls. The peptidoglycan that makes up the cell wall can be destroyed or inhibited by physical, chemical, or biological factors. When gram-positive bacteria lack a cell wall, the cytoplasm is surrounded by the cell membrane, and the entire structure is known as a protoplast. When gram-negative bacteria do not have a cell wall, the cytoplasm is protected by the outer membrane, and the entire structure is called a spheroplast. Bacteria

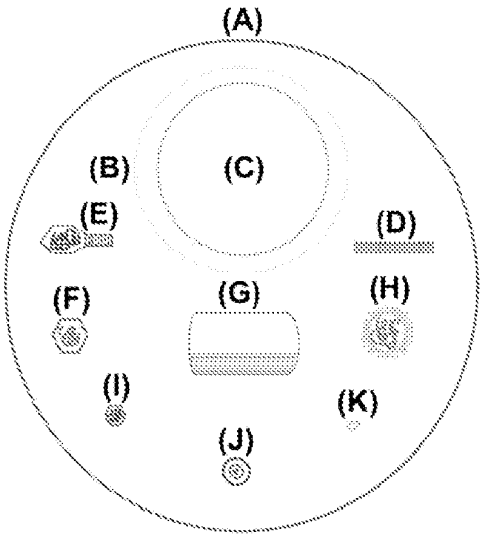


FIGURE 1.2 Microbial size. (A) *Staphylococcus* 1000 nm. (B) *Rickettsia* 450 nm. (C) *Chlamydia* 390 nm. (D) Tobacco mosaic virus 300 × 15 nm. (E) *Escherichia coli* bacteriophages, head 65 × 95 nm, tail 12 × 100 nm. (F) Adenovirus 70 nm. (G) Poxvirus 300 × 230 nm. (H) Influenza virus 100 nm. (I) Poliovirus 30 nm. (J) Japanese encephalitis virus 40 nm. (K) Molecule of egg protein 10 nm.

that have lost their cell wall are still capable of growing and dividing as cell wall-deficient bacteria. Examples of these were first isolated in 1935 by Emmy Klieneberger-Nobel, who named them "l-forms" after the Lister Institute in London where she was working at the time. l-form bacteria give rise to a variety of cell morphologies and sizes and can be spherical, rod-shaped, filiform, etc. The rate of growth and division of l-form bacteria is slow. They also form distinctive bacterial colonies when plated on agar. Some l-form strains have a tendency to revert to the normal phenotype when the conditions that were used to produce the cell wall deficiency are reduced. l-form bacteria are difficult to stain or stain unevenly. In a Gram stain test, l-form bacteria always show up as gram-negative, due to the lack of a cell wall.

1.3.1.3 Cell Membrane

The cell membrane is a selectively permeable biological membrane found inside the cell wall and surrounding the cytoplasm. It is made of a lipid bilayer. The cell membrane is compact and flexible, and measures approximately 7.5 nm in thickness. It accounts for 10–30% of the bacterial cell dry weight. The structure of the bacterial cell membrane resembles that of eukaryotic cell membranes, except it is deficient in cholesterol. The lipid bilayer is embedded with carrier proteins and zymoprotein, which possess specific functions.

The cell membrane of some bacteria can form invaginations into the cytoplasm called mesosomes.

1.3.1.4 Cytoplasm

The cytoplasm is the gel-like substance enclosed within the cell membrane, which is made up of water, proteins, lipids, nucleic acids, inorganic salts, etc. Most metabolic activities take place within the cytoplasm, and subcellular structures, such as ribosomes, plasmids, and cytoplasmic granules, are located in the cytoplasm.

Ribosomes are found in cytoplasm. They are approximately 15–20 nm in diameter and are composed of a small (30S) and a large (50S) subunit. The association between subunits requires the presence of Mg^{2+}. Ribosomes are made up of 30% ribosomal proteins and 70% ribosomal RNA.

Plasmids are small, circular, double-stranded DNA molecules and are extrachromosomal genetic material. They can replicate independently of chromosomal DNA and transmit genes encoding drug resistance, bacteriocins, toxins, and more from one bacterium to another via conjugation and transduction.

Cytoplasmic granules is a general term referring to many types of cytoplasmic inclusion granules. They are an intracytoplasmic (inside the cytoplasm of a cell) form of storing nutrients and energy and include molecules such as polysaccharides, lipids, phosphates, etc. They are not essential or permanent structures in cells. Cytoplasmic granules are also known as metachromatic granules because they may stain into different colors than other bacterial cell structures.

1.3.1.5 Nuclear Material

The bacterial nuclear material is also called the nucleoid. It is a piece of double-stranded DNA devoid of nuclear membrane, nucleolus, or histones and is the bacterial equivalent of chromatin. The function of the nucleoid is similar to that of the nucleus in eukaryotic cells and encodes genes necessary for activities and traits such as growth, metabolism, reproduction, heredity, mutation, etc.

1.3.2 Special Bacterial Structures

1.3.2.1 Capsule

The capsule is a layer of slime that lies outside the bacterial cell wall. It is secreted by bacteria and diffuses into the surrounding medium. Based on its appearance when examined by light microscope, the bacterial capsule is classified into two types: microcapsule, which is less than 0.2 μm in thickness and escapes optical detection; and capsule or large capsule, which is over 0.2 μm in thickness, binds tightly to the cell wall, and presents an obvious

boundary under optical microscope. The capsule shows up as negatively stained when ordinary

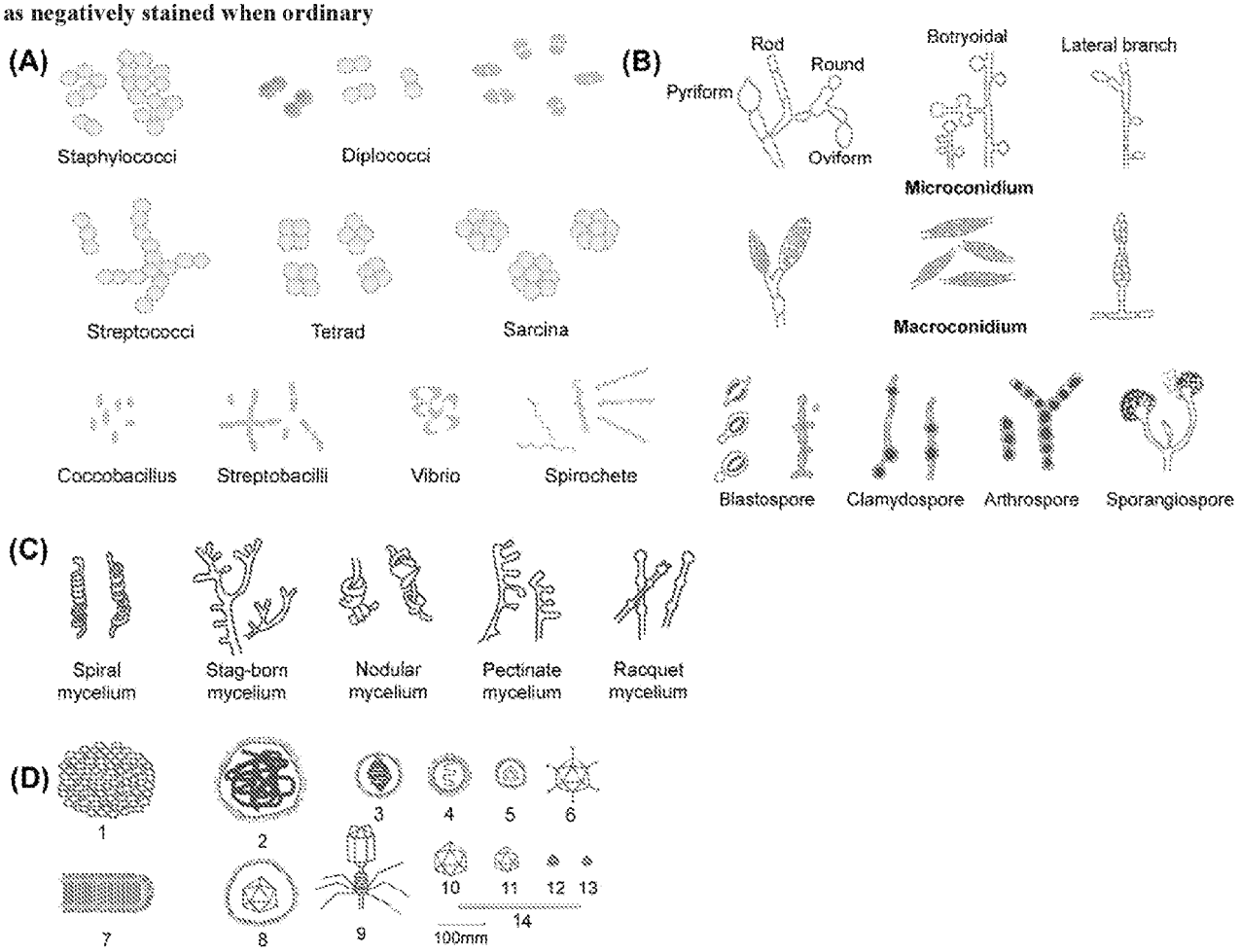


FIGURE 1.3 (A) Basic shape of bacteria. (B) Fungal spores. (C) Fungal hyphae. (D) Morphology and structure of viruses: 1. Poxvirus, 2. Paramyxovirus, 3. Orthomyxovirus, 4. Coronavirus, 5. Togaviridae, 6. Adenovirus, 7. Bullet-shaped virus, 8. Herpes virus, 9. T2 bacteriophage, 10. Reovirus, 11. Papovavirus, 12. Picornavirus, 13. Picodnavirus, 14. Tobacco mosaic virus.

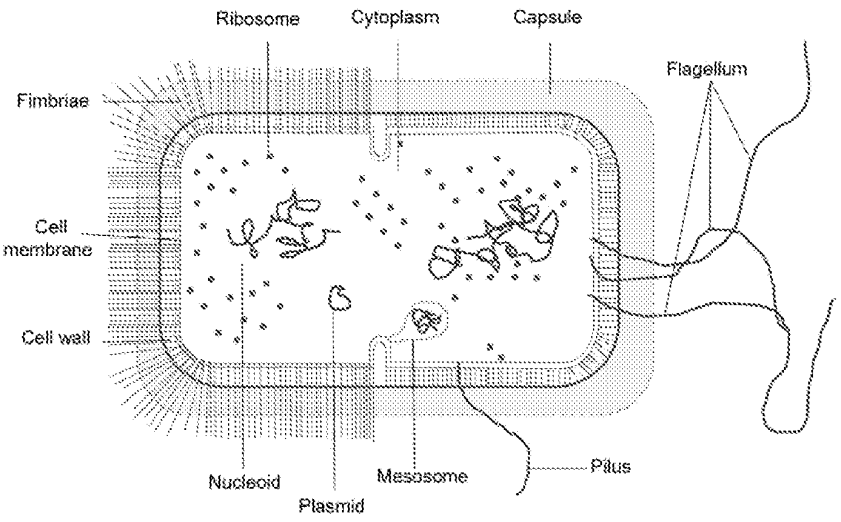


FIGURE 1.4 **Schematic representation of bacterial cell structure.**

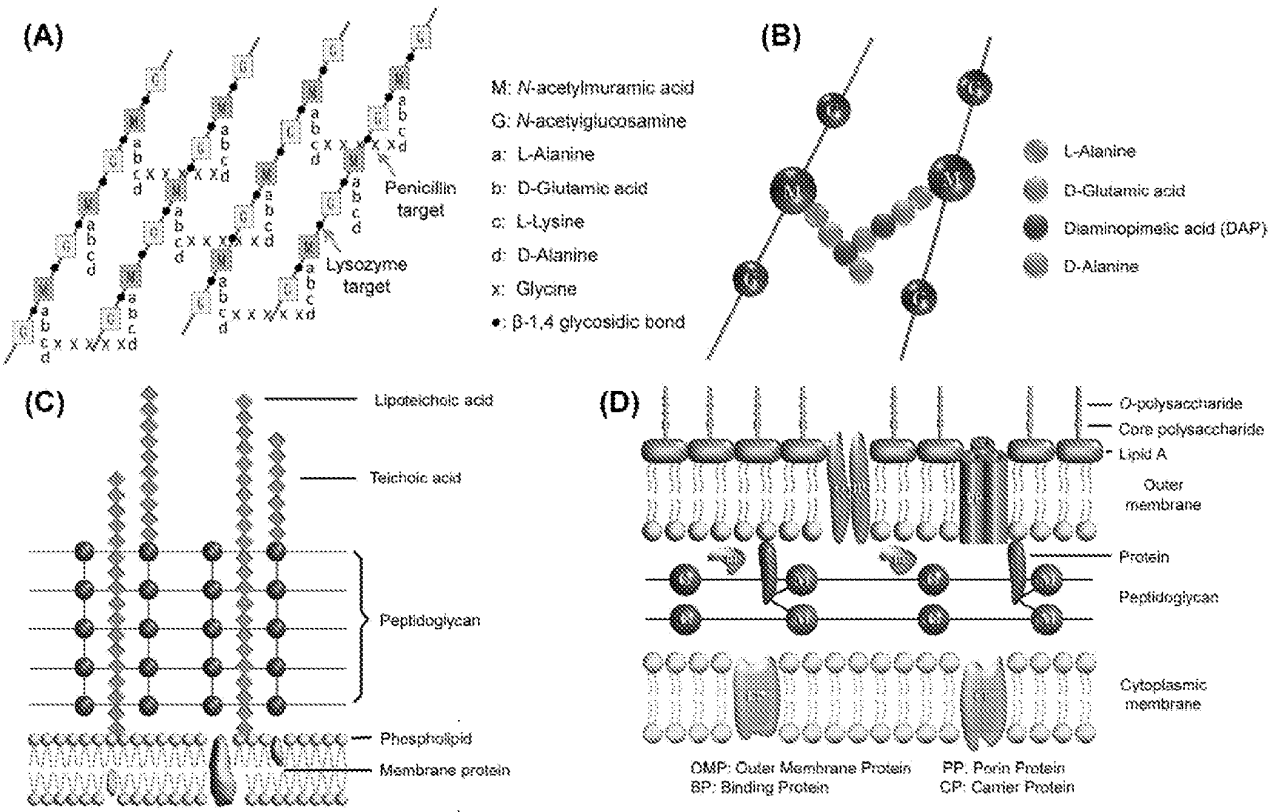


FIGURE 1.5 **(A) Schematic representation of *Staphylococcus aureus* cell wall peptidoglycan. M: *N*-Acetylmuramic acid, G: *N*-acetylglucosamine, O: β-1,4 glycosidic bond, a: l-alanine, b: d-aspartic acid, c: l-lysine, d: d-aspartic acid, x: glycine. (B) Schematic representation of *Escherichia coli* cell wall peptidoglycan. M: *N*-Acetylmuramic acid, G: *N*-acetylglucosamine, Ala: alanine, Glu: glutamic acid, DAP: diaminopimelic acid. (C) Schematic of gram-positive bacteria cell wall. Gram-positive bacteria have a thick (20–80 nm) cell wall composed of 15–50 layers of peptidoglycan, many teichoic acids, and some teichuroic acid. Teichoic acids are unique to gram-positive bacterial cell walls and constitute a class of important antigens related to the serotype classification of certain bacterial species. Teichoic acid accounts for about 50% of the dry weight of the cell wall. It is a polymer consisting of ribitol or glycerin residues that are bound by phosphodiester bonds into a long chain, which is then anchored in peptidoglycan. Teichoic acids are classified into cell wall teichoic acids and membrane teichoic acids (also known as lipoteichoic acid, LTA) according to the cellular structure to which they are anchored. (D) Schematic representation of the cell wall of gram-negative bacteria. Gram-negative bacteria have a comparatively thin cell wall,**

approximately 10–15 nm in thickness. It is made up of one to two layers of peptidoglycan and other complex structures. On the outside of the peptidoglycan is the outer membrane, which is the main component of the gram-negative bacteria cell wall and accounts for approximately 80% of the dry weight of the cell wall. The outer membrane is composed of three layers: lipoprotein, lipid bilayer, and lipopolysaccharide (LPS) ordered from the interior to the exterior. OMP: outer membrane protein, PP: porin, BP: nutrient binding protein, CP: carrier protein, M: *N*-acetylmuramic acid, G: *N*-acetylglucosamine.

staining techniques are used. It appears as a clear halo around the bacterium when stained samples are examined by light microscope. Using special staining, the capsule can be stained differently from the bacterial cell (Figure 1.6). Most bacterial capsules are composed of polysaccharides, but a few capsules are made of polypeptides.

Capsular polysaccharides are highly hydrated molecules in which water accounts for more than 95% of the composition. They bind to phospholipids or lipid A on the cell surface through covalent bonds. The capsule is considered as an important virulence factor because it protects bacteria from engulfment by eukaryotic immune cells, desiccation, and helps bacteria adhere to surfaces.

1.3.2.2 Flagellum

The flagellum is a lash-like appendage that protrudes from the cell body and usually measures 5–20 μm in length and 10–30 nm in diameter. It is the locomotive organelle of motile bacteria such as *Selenomonas* and *Wolinella succinogenes*. The flagellum is composed of three parts: basal body, hook, and filament (Figure 1.7(A)). Different bacteria can have anywhere from one or two flagella to hundreds of flagella (Figure 1.7(B)). Flagella can only be observed directly by electronic microscope or by light microscope after special staining (Figure 1.7(C)). The flagellum is involved in the pathogenesis of some diseases and is antigenic (for example, antigen H). Examples of flagellate bacteria include *Vibrio cholerae*

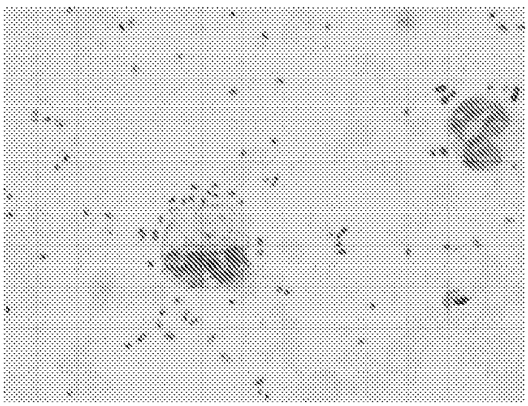


FIGURE 1.6 Capsule of *S. pneumoniae* (Murs staining method). Bacterial cells are stained red and the capsule around the cell appears as blue transparent circles.

and *Campylobacter jejuni*, which use multiple flagella to propel themselves through the mucus lining of the small intestine to reach the epithelium and produce toxin.

Flagella can be classified as monotrichous, amphi trichous, lophotrichous, and peritrichous according to their number and location.

1.3.2.3 Pilus

The pilus is a hair-like structure associated with bacterial adhesion and related to bacterial colonization and infection. Pili are primarily composed of oligomeric pilin proteins, which arrange helically to form a cylinder. New pilin protein molecules insert into the base of the pilus. Pili are antigenic, and genes encoding pili can be located in the bacterial chromosome or in plasmids. Pili are not locomotive structures. They are classified into ordinary

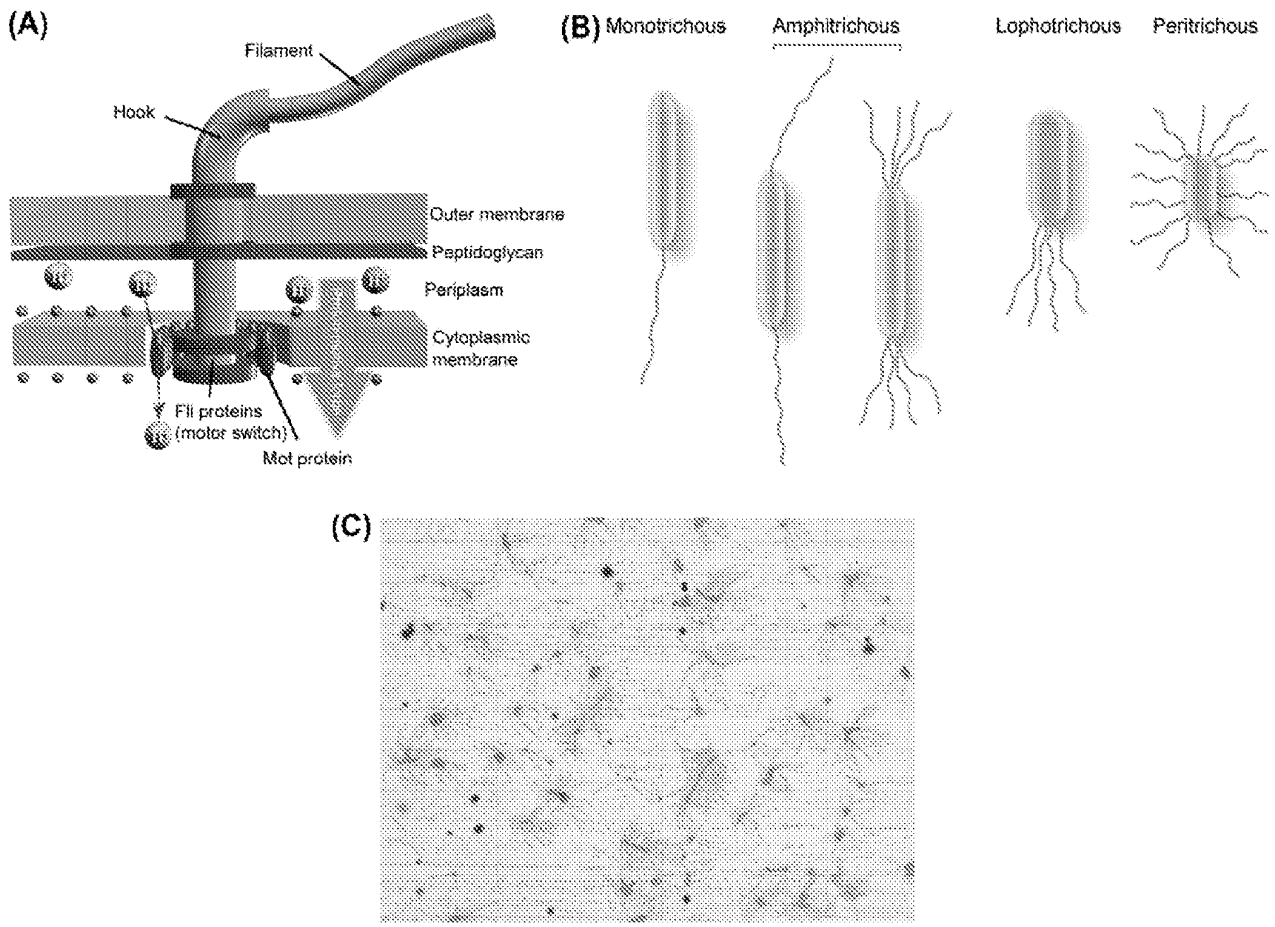


FIGURE 1.7 **(A) Schematic of *E. coli* flagellum. Basal body: Located at the base of the flagellum. The basal body, embedded in the cell wall and cell membrane, is the output device. It acts as an engine to provide energy for locomotion. The nearby switch determines the direction of rotation. Hook: This structure points directly away from the cell and has a sharp bend (about 90°) from which filaments protrude. Filament: This filiform structure protrudes from the bacterial cell. It is a hollow tube made of the protein flagellin. Its acts like a ship's or plane's propeller to move the bacterial cell. (B) Examples of bacterial flagellar arrangement. (C) Periplasmic flagella (flagella staining). The bacterial cell is stained red and the flagella are stained light red around the bacterial cell.**

pilus or sex pilus according to their morphology, distribution, and function.

The pilus is found on the surface of many grampositive bacteria and some gram-negative bacteria. It is thinner and shorter than the flagellum. Ordinary pili are 0.3–1.0 μm in length and about 7 nm in diameter and are distributed all over the bacterial cell surface. Sex pili can be found in a handful of gram-negative bacteria. These pili are longer and thicker than ordinary pili, and each bacterial cell can have from one to four sex pili.

1.3.2.4 Spore

The spore is a small round or oval body that forms in bacteria due to cytoplasmic dehydration under unfavorable conditions (Figure 1.8(A)). It is surrounded by multiple membrane layers and has low permeability. Only gram-positive bacteria can form spores, including species such as *Bacillus subtilis*, *Clostridium tetani* (Figure 1.8(B)), etc. The spore contains a complete karyoplasm and enzymatic system and can maintain all the essential activities for the bacteria to remain alive.

The multiple membrane layers of the spore are, from the exterior to the interior, as follows: spore coating, spore shell, outer membrane, cortex, cell wall of spore, and inner membrane, which surrounds the nucleus of the spore.

Spores are difficult to stain due to their thick cell wall. Special staining is required to stain the spore and distinguish it from the bacterial cell (Figure 1.8(B)).

The size, morphology, and location of the spore differ between bacterial species and can be used to help identify bacteria (Figure 1.8(C)). For example, the *C. tetani* spore is round and larger than the transverse diameter of the bacterial cell, forming a drumstick-like structure, as the spore is located at the tip of the bacterial cell (Figure 1.8(B)).

1.3.3 Basic Structure of Virus

Viruses are a kind of acellular microbe consisting mainly of nucleic acid and proteins. Some viruses are composed of a small amount of lipids and polysaccharides. The basic structure of viruses is made up by the

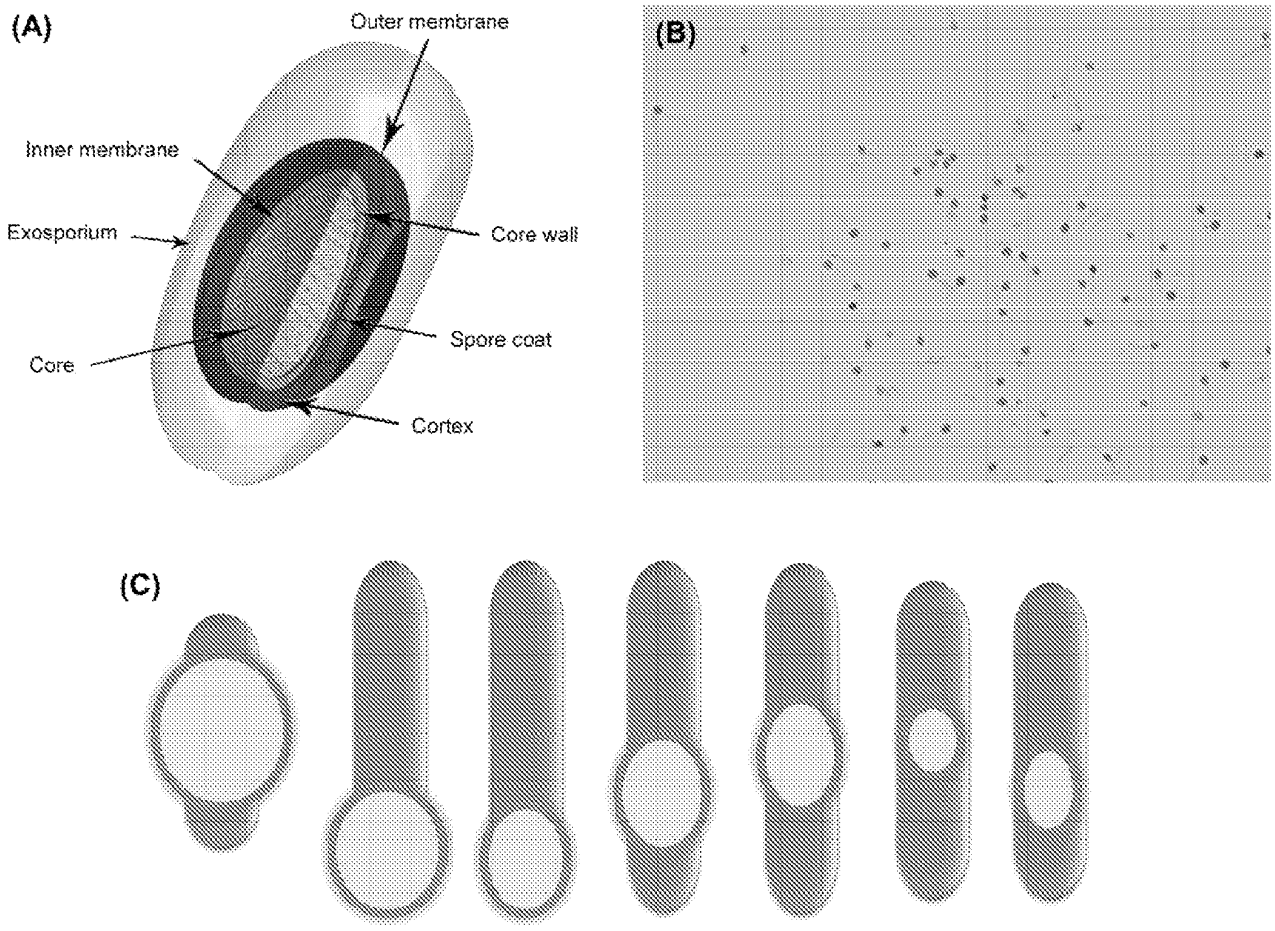


FIGURE 1.8 (A) Schematic representation of the bacterial spore. (B) Spore stain of *C. tetani* (fuchsin-methylene blue stain). (C) Size, morphology, and location of bacterial spores.

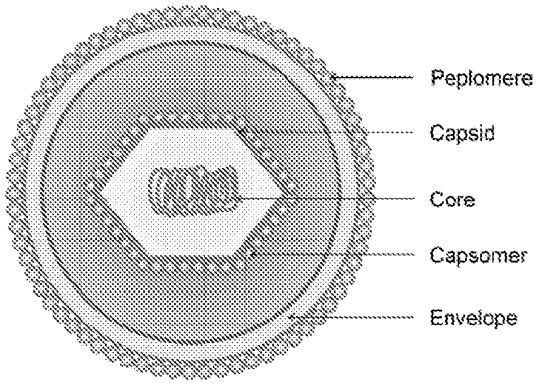


FIGURE 1.9 Basic structure of a virus.

viral core, viral capsid, as well as a membrane envelope in some viruses (Figure 1.9). The size, morphology, and structure of viruses play important roles in viral taxonomy and in diagnosing viral infections.

1. Viral core: namely the nucleic acid component, which makes up the genome of the virus. The viral core provides genetic information that determines pathogenicity, antigenicity, proliferation, heredity, variation, etc. The chemical components of the viral core are DNA or RNA, based on whether the virus is classified as a DNA virus or an RNA virus. Nucleic acid can be single or double stranded. The relative molecular mass of the viral core is 2–160 × 10^6.
2. Viral capsid: it is a protein shell that surrounds and protects the nucleic acid of the virus. The viral capsid is sometimes associated with the viral nucleic acid, and this structure is known as the nucleocapsid. In virions without an envelope, the nucleocapsid makes up the entirety of the virus. The viral capsid is composed of repeated protein subunits known as capsomeres, which are made of one or more proteins known as the chemical subunit or structural subunit.
3. Envelope: this is the one or two layers of membrane that surround the capsid of some viruses, which is a structure unique to the class of viruses known as enveloped viruses. The envelope is formed during the maturation process when certain viruses bud out from the cell membrane. Therefore, the envelope can be composed of the host cell membrane and/or the nuclear membrane. The surface of some viral envelopes carries protein protrusions called peplomers or spikes.

1.4 MICROBIAL PHYSIOLOGY

Bacterial cells are synthesis machines that multiply themselves. The growth and division of bacteria include approximately 2000 different types of biochemical reactions that mediate energy conversion or enzymatic biosynthesis.

1.4.1 Binary Fission Reproduction

Binary fission is a process by which many prokaryotes reproduce from a single cell into two new cells (Figure 1.10(A)). Bacteria reproduce asexually by binary fission. Cocci can divide from different planes to form different arrangements. Bacilli divide along their horizontal axis; however, some bacterial species such as *Mycobacterium tuberculosis* occasionally spilt by branching.

During cell division, the cell volume increases and a diaphragm is generated where the cell division is to take place. Then, a single cell will divide into two cells (Figure 1.10(B) and (C)). Under suitable conditions, the majority of bacteria divide quickly, about 20–30 min for one division. However, the growth of some b acterial species can be relatively slow. For example, *M. tuberculosis* takes 18–20 h to complete one round of division.

1.4.2 Bacterial Growth

Mastering the fundamentals of bacterial growth allows the researcher to change culture conditions artificially, adjust the bacterial phases of growth and reproduction, and use beneficial bacteria more efficiently. Bacterial growth involves inoculating a certain number of bacteria into a suitable liquid medium and checking the number of viable cells at different time intervals. With the collected information, it is possible to generate a growth curve using culture time as the horizontal axis and the logarithmic number of viable cells in the culture as the vertical axis (Figure 1.11). Growth curves can generally be divided into four major sections.

1. Lag phase: During this process, the bacteria are adapting to their new environment. The volume of bacterial cells increases and their metabolism is active, but cell division is slow and reproduction is minimal.
2. Logarithmic phase: In this period, bacteria grow rapidly and divide and reproduce at a constant speed. The number of bacteria increases exponentially and the number of viable cells increases logarithmically.
3. Stationary phase: The bacterial growth rate gradually decreases, and the number of dead bacteria increases. The number of newly produced bacteria is approximately equal to the number of dying bacteria, and the number of viable cells remains relatively stable.
4. Decline phase: Bacterial growth rate slows and stops, and the number of dead bacteria is higher than that

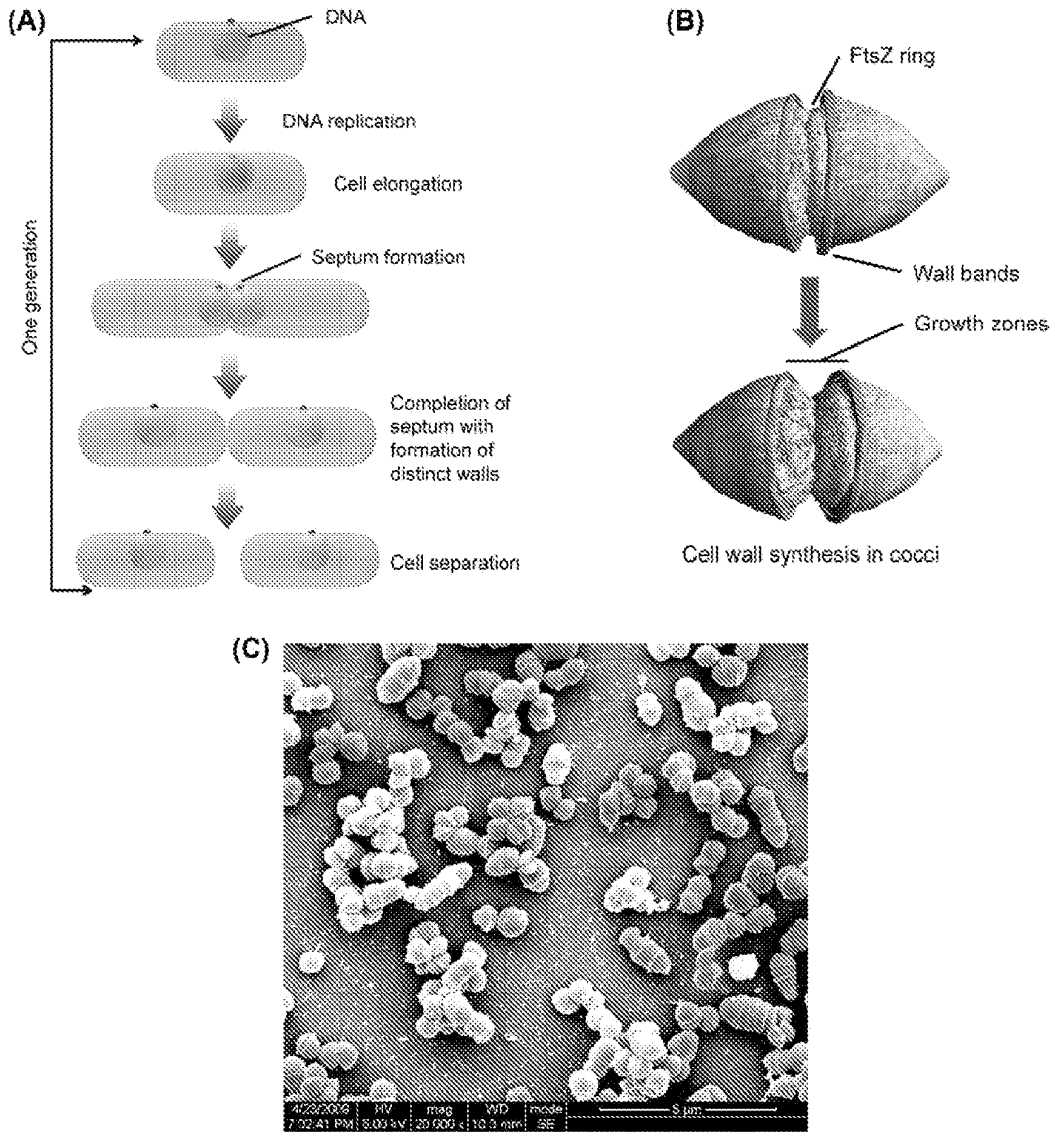


FIGURE 1.10 (A) Binary fission in bacilli. (B) Synthesis of gram-positive bacterial cell wall. During cell division, the volume of the cell increases and a new cell wall is formed. New cell wall materials are added to the preexisting cell wall to maintain structural integrity. (C) Division of gram-positive bacteria (SEM). Cell division in *Streptococcus gordonii*, showing a clear division.

of viable cells. Cells become polymorphic, showing morphologies such as cell deformation, swelling, or autolysis.

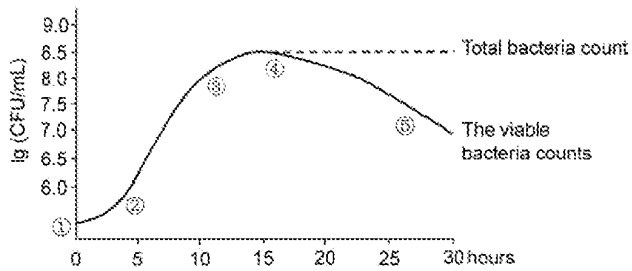


FIGURE 1.11 The growth curve of *E. coli*.

1.5 MICROBIAL GENETICS

Like the other living organisms, microorganisms have heredity and variable characteristics. Heredity keeps microbial genetic traits relatively stable to ensure the reproduction of the species, while variations produce changes in the microorganisms that are useful for

microbial survival and evolution and ultimately lead to the generation of new species.

1.5.1 Heredity

Heredity is the similarity in biological traits between offspring and its parent. Cells can be considered as a chemical plant in which information can be stored and transformed into a useful product. Enzymes are the molecular machines that catalyze specific chemical reactions. The information is stored DNA, which exists in the cell as two long molecular coiled chains (DNA double helix). The intracellular genetic information is replicated, transcribed, and translated by enzymes, which then leads to protein synthesis (Figure 1.12).

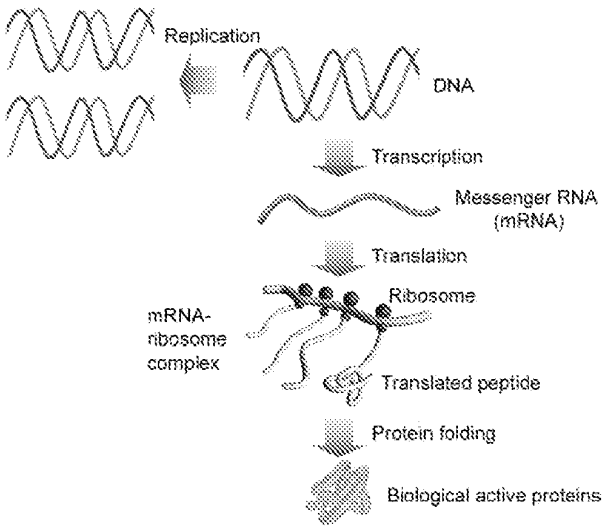


FIGURE 1.12 The processes of replication, transcription, translation of intracellular genetic information and protein synthesis.

1.5.2 Variation

Variation refers to the differences between offspring and its parent under certain conditions, including variations in morphology and structure, virulence, drug resistance, and so on. The variability of microorganisms is divided into genetic variation and nongenetic variation. The former is due to changes in bacterial gene structure. The new characteristics can be stably transmitted to future generations, which is why this type of variation is called genotype variation, as the change is mostly irreversible (Figure 1.13). The latter is caused by the influence of certain environmental conditions that do not change the genetic structure of bacteria. The change is not transmitted to the offspring and is therefore called a phenotypic variation. Genetic variation is rarely influenced by external environmental factors. Therefore, genetic variation tends to occur in individual bacterial cells, while phenotypic variation tends to occur in a bacterial flora due to the effect of environmental factors. These variations can revert with the removal of the stimulating environmental factors.

1.5.3 Genetic Material of Bacteria

Nucleic acids are the basis of organismal heredity. Two types of nucleic acid exist: DNA and RNA. DNA is the genetic material in prokaryotic and eukaryotic organisms, while the genetic material in viruses is DNA and RNA. The genetic material found in microorganisms includes chromosomes, plasmids, bacteriophages, and transposable elements.

Bacteriophages are viruses that infect bacteria, fungi, actinomycetes, mycoplasmas, and spirochetes. They inject their genetic material into the infected host cell and can

induce bacterial cell lysis under certain conditions. Bacteriophages, known as phages, can only reproduce in specific host strains and have high specificity for

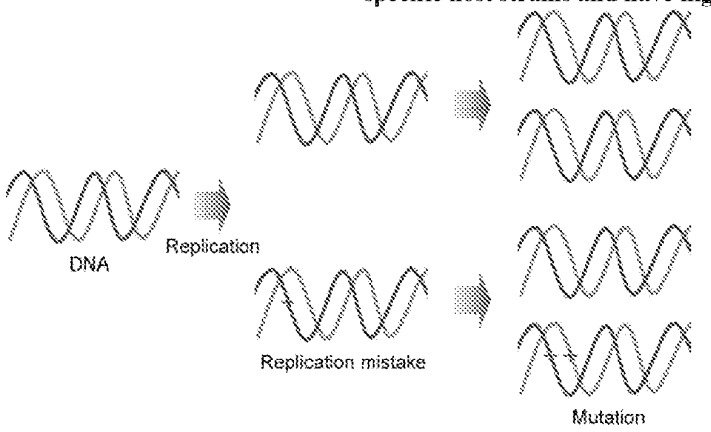


FIGURE 1.13 DNA mutation.

their host. The specificity is related to phage cell binding molecules and the structure and complementarity of the host bacterial strain's surface receptor molecules.

Since phages are small, they can only be observed under electron microscope. They can be divided into three basic morphologies: tadpole-shaped, spherical, and rod-shaped. Most phages are tadpole-shaped and consist of a head and a tail (Figure 1.14(A)).

The relationship between the phage life cycle and its host bacteria is shown in Figure 1.14(B). Phages that infect bacteria can produce two outcomes. The first, observed in virulent phage, involves phage multiplication resulting in the production of many progeny phages, bacterial cell lysis, and cell death. This cycle is known as the lytic cycle. The second outcome is lysogeny, observed in temperate phages. It involves the integration of phage nucleic acid with the bacterial chromosome, resulting in the formation of a prophage. The phage genetic material is reproduced when the bacterial cell divides.

1.5.4 Mechanism of Microbial Variation

Genetic variation in microorganisms has its basis in mutations caused by changes in their genetic sequence. These changes are stable and heritable. Mutations can generally be classified as gene mutations and chromosomal aberrations. The spontaneity and randomness of microbial mutations can be tested by using fluctuation test or replica plating (Figure 1.15(A) and (B)).

1.5.5 Gene Transfer and Recombination

Gene transfer is a process by which exogenous genetic material from a donor cell is transferred to the receptor cell. However, simply the process of transferring genetic material is not enough, as the recipient cell must be able to accommodate exogenous genes. Integration between the transferred gene and the DNA of the recipient cell is a process known as recombination, whereby the recipient cell acquires certain characteristics of the donor strain. Gene transfer and recombination in bacteria can take place through processes such as transformation, conjugation, transduction, cell fusion, and lysogenic conversion.

1.5.5.1 Transformation

Transformation takes place when donor bacteria DNA is cleaved and free DNA fragments are directly taken up by receptors. As a result, recipient cells acquire certain genetic traits from the donor cell. This phenomenon was confirmed in *Streptococcus pneumoniae*, *Staphylococci*, and *Haemophilus influenzae*. Griffith first showed that bacterial transformation takes place by infecting mice with *S. pneumoniae* in 1928. An outline of the experiment is shown in Figure 1.16.

1.5.5.2 Conjugation

Conjugation is the method by which bacteria physically connect with one another through their pilus to transfer genetic material (mainly plasmid DNA). Plasmid transfer from the donor to the recipient cell results in the recipient cell acquiring some of the genetic traits of the donor cell. Plasmids that can be transferred through conjugation are called conjugative plasmids, which include the F, R, Col, and virulence plasmids. The F plasmid encodes the pilus, controls pilus formation and whether or not the pilus enables conjugation (Figure 1.17(A)).

Plasmids that cannot be transferred between bacteria through a pilus are called nonconjugative plasmids.

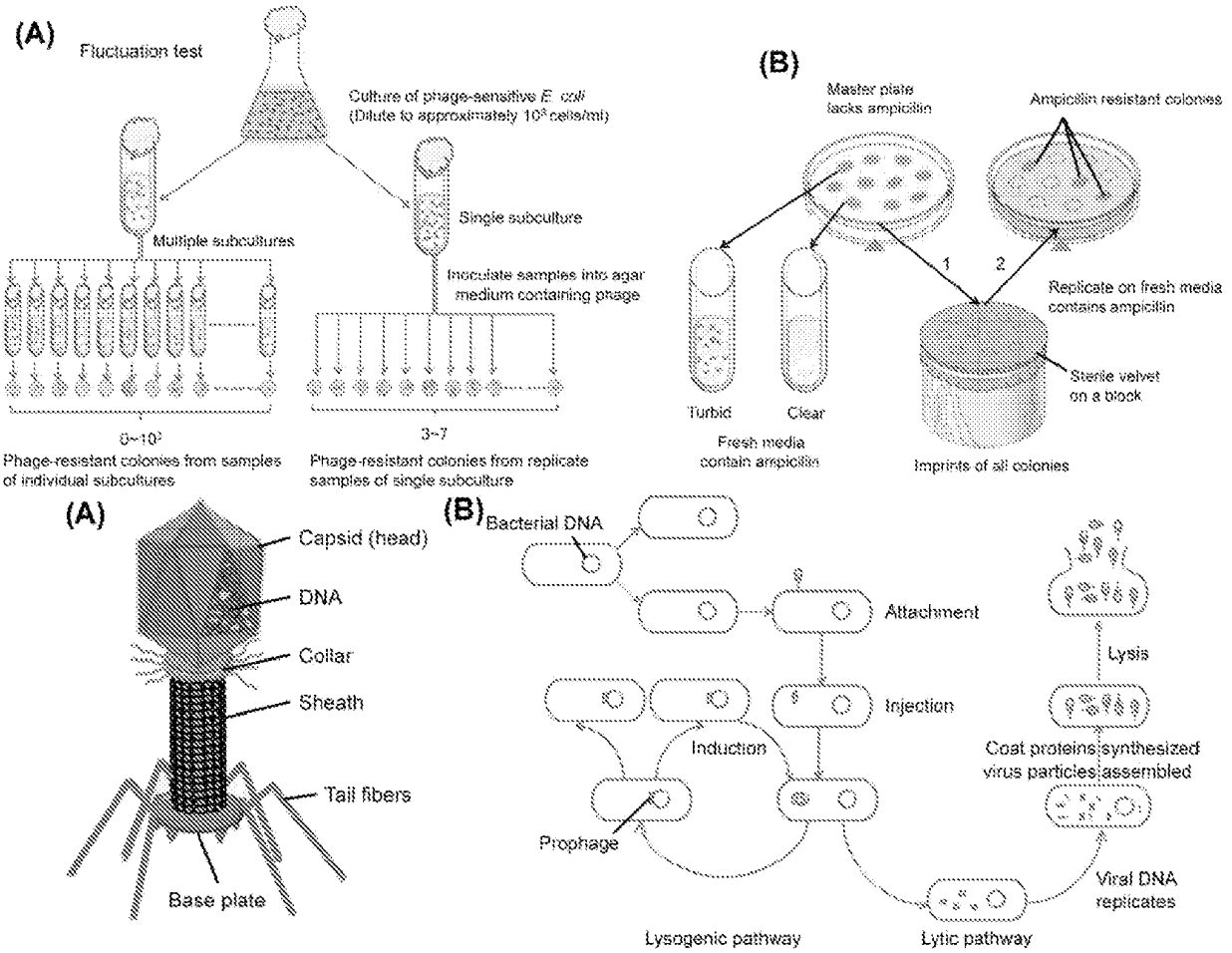


FIGURE 1.14 (A) The structural model of a phage. The phage head is icosahedral and is approximately 80 × 100 nm in size. It consists of the capsid protein that surrounds the internal nucleic acid. The tail is a tubular structure composed of protein, including the tail whiskers, tail collar, tail tube, tail sheath, tail fibers, and tail baseplate. (B) Lysogenic and lytic cycles of lysogenic phage.

FIGURE 1.15 (A) Fluctuation test: The fluctuation test shows that mutations preexist in a population of bacteria in the absence of selection. This was tested by Luria and Delbruck using naturally existing phage-resistant mutations in bacterial populations. A given concentration (10^3/ ml) of *Escherichia coli* sensitive to specific phages was inoculated in two equal volumes (10 ml) of broth medium. One inoculum was concentrated in a large test tube and the other was evenly distributed into 50 small test tubes. After 24–36 h incubation under the same conditions, the bacterial cultures from the large and small tubes were plated onto phage-containing plates, and the number of colonies was measured. The results typically showed that of 50 phage-coated plates inoculated with bacteria from the large test tube, the fluctuation in the colony number was small (3–7). On the other hand, when the 50 small tubes were plated onto 50 plates, the number of the colonies tended to fluctuate significantly, from zero colonies to several hundreds. (B) Replica plating: Replica plating (Lederberg et al., 1952) involves plating antibiotic-susceptible strains on agar plates in the absence of antibiotics until scattered single colonies grow. Using a block covered with sterile velvet, gently press the velvet onto the surface of the agar plates so that bacterial colonies are imprinted onto the sticky velvet surface. Then, press the velvet surface onto an agar plate containing antibiotics. After an appropriate culture time, bacteria susceptible to the antibiotics are completely suppressed, but drug-resistant colonies will be visible on the plate. We can find colonies corresponding to drug-resistant colonies on the original plates lacking antibiotics. The drug-resistant colonies can then be transplanted to culture broth containing the appropriate antibiotics to observe bacterial growth. Although the bacterial colonies on the original agar plate have never been in contact with antibiotics, they are nonetheless resistant to antibiotic drugs.

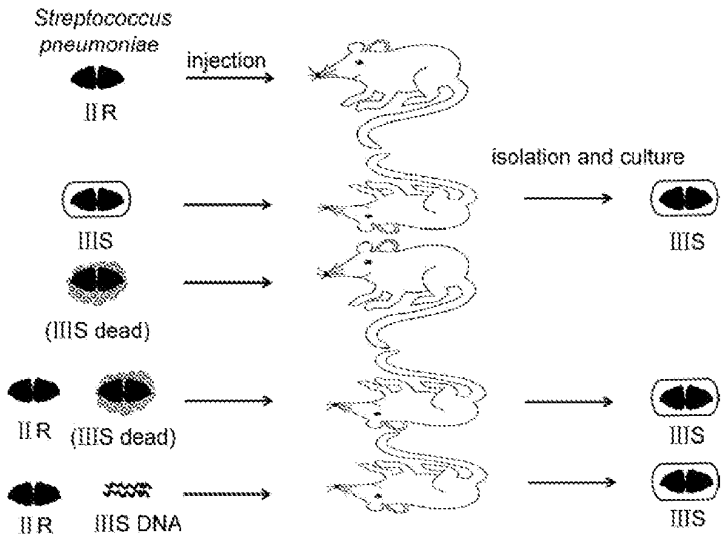
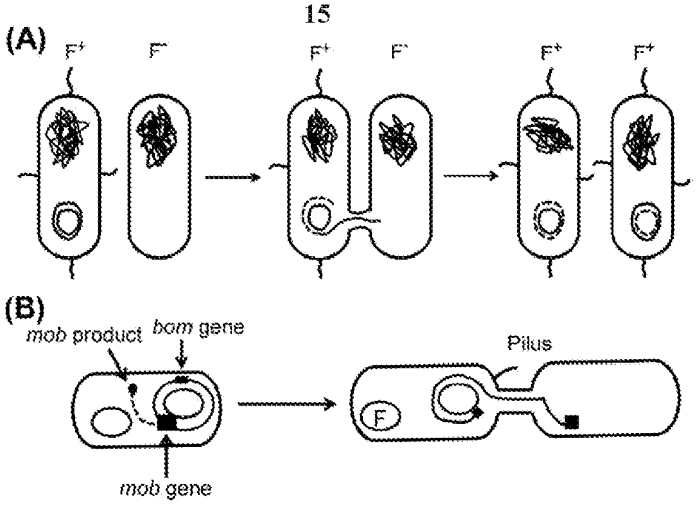


FIGURE 1.16 ***Streptococcus pneumoniae*** **transformation in mice.** *S. pneumoniae* **with a polysaccharide capsule belong to the virulent type III strain. These colonies are smooth (S) in appearance.** *S. pneumoniae* **without the polysaccharide capsule belong to the avirulent type II strain and appear as rough (R) type colonies. In the classic Griffith experiment, type II-R bacteria and type III-S bacteria were injected into mice. Mice that received the type II-R bacteria survived, and those that received the type III-S bacteria died. The type III-S bacteria were isolated from the blood of the dead mice and were heated until they were no longer active. These dead type III-S bacteria were injected into mice, and the mice survived. However, when dead type III-S bacteria and live type II-R bacteria were both injected into the same mice, the mice died, and type III-S bacteria were isolated from their blood. This experiment showed that the live type II R-type bacteria were able to obtain genetic material from dead type III-S bacteria that transformed them from an avirulent strain to a virulent one. It also suggests that the genetic material encoded the capsule virulence factor from type III-S bacteria.**

FIGURE 1.17 **(A) The transfer and replication of the F plasmid during conjugation. Bacteria possessing the F plasmid and F-pili are the male equivalent strain (F^+), while bacteria lacking the F plasmid and F-pili are the female equivalent strain (F^-). When the F^+ and F^- strains are present in the same environment, the F-pilus from the F^+ bacterial cell conjugates to the F^- surface receptor. The F-pilus gradually shortens so that the two cells are pulled close to each other and a channel is formed. Plasmid DNA from the F^+ bacteria breaks at the origin of transfer (*oriT*) and the 5′ end extends through the channel into the F^- bacteria. Single-stranded DNA in both bacterial cells replicate by rolling circle replication, and each cell forms a complete F plasmid. Therefore, the donor cell has not lost its F plasmid after the transfer, and the recipient cell becomes F^+ strain bacteria after receiving the F plasmid. (B) Nonconjugative plasmid (ColE1) induced to transfer by F plasmid. The ColE1 plasmid can be induced to transfer from a donor to a recipient cell. This process requires two genes encoded on the ColE1 plasmid: the specific site *bom* on ColE1 DNA (also known as the *nic* locus) and the nuclease encoded by the *mobA* gene. When both F and ColE1 plasmids are present in the same bacterial cell, the *mobA* gene is transcribed and its product creates a single strand break at the *bom* locus to form a gap. As a result, the ColE1 plasmid goes from a supercoiled plasmid to an open loop.**

The nonconjugative plasmid ColE1 is relatively low in molecular mass and does not encode the necessary gene required for it to be transferred from one cell to another. However, if there is another conjugative plasmid in the host



cell, ColE1 can tag along and be transferred from one cell to another. For example, the F plasmid that encodes the genes necessary for pilus formation can help ColE1 transfer from one cell to another (Figure 1.17(B)).

Conjugation is widespread in gram-negative bacteria and can be observed in almost all members of the *Enterobacteriaceae*. Some gram-positive bacteria have been reported to conjugate (e.g., *Streptococcus*, *Bacillus subtilis*), and the phenomenon has also been observed in *Streptomyces*.

1.5.5.3 Transduction

Transduction uses a temperate phage as the vehicle by which DNA from a donor cell is transferred into a recipient cell. Transduction can transfer larger fragments of DNA than transformation. According to the genes involved in transduction, the process can be divided into generalized transduction and restricted transduction (Figure 1.18(A) and (B)).

Generalized transduction can transfer plasmids. The transduction of plasmid R in *S. aureus* is a very important clinical feature.

In generalized transduction, the packaged DNA can be from any part of the donor strain chromosome. When phages exit the lysogenic phase, the prophage will excise

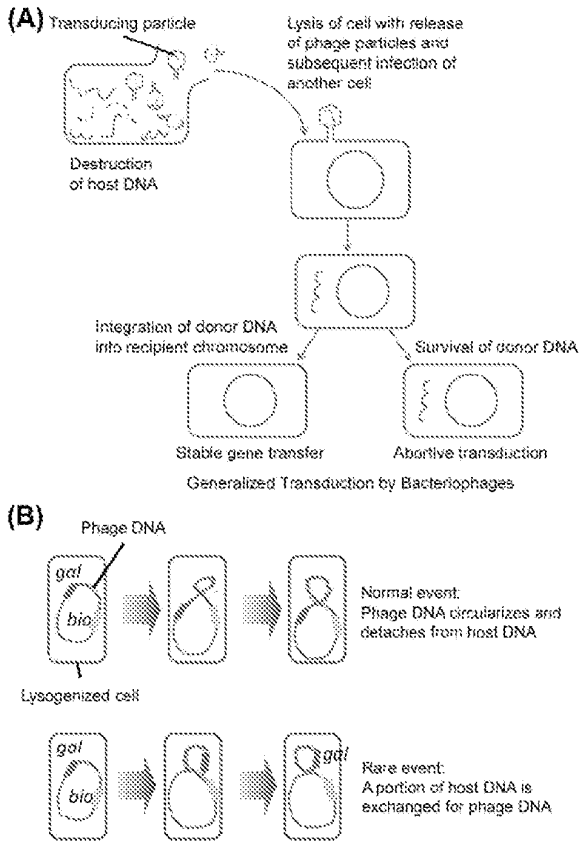


FIGURE 1.18 **(A) Generalized mode of transduction. (B) Restricted mode of transduction.**

itself from the bacterial chromosome and enter into the lytic phase. In the latest stages of the lytic phase, phage DNA is replicated in large quantities and errors can occur during phage assembly. Approximately one in 10^5–10^7 phages will contain bacterial DNA fragments that have been mistakenly packaged into the phage head, which results in the formation of a transducting phage. Transducting phages can infect another host bacterium and inject the DNA fragment they are carrying into the recipient cell, thereby transferring DNA from one bacterial cell to another.

Restricted transduction, or specific transduction, describes the process in which transduction is restricted to specific genes from the chromosome of the donor strain. If phage λ is transferred into *E. coli* K12 while it is in the lysogenic phase, the phage DNA is integrated into a specific site in the *E. coli* chromosome, between the galactose (*gal*) and biotin (*bio*) genes.

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Bacterial Colonization of the Dental Implant Fixture–Abutment Interface: An In Vitro Study

Michael Tesmer,* Shannon Wallet,*† Theofilos Koutouzis,* and Tord Lundgren*

Background: The geometry of the fixture–abutment interface (FAI) might influence the risk of bacterial invasion of the internal part of the implant. The aim of this study was to use an in vitro model to assess the potential risk for invasion of oral microorganisms into the FAI microgap of dental implants with different characteristics of the connection between the fixture and abutment.

Methods: Thirty implants were divided into three groups (n = 10 per group) based on their microgap dynamics. Groups 1 and 2 were comprised of fixtures with internal Morse-taper connections that connected to standard abutments and the same abutments with a 0.5-mm groove modification, respectively. Group 3 was comprised of implants with a tri-channel internal connection. Fixtures and abutments were assembled and allowed to incubate in a bacterial solution of Aggregatibacter actinomycetemcomitans (previously Actinobacillus actinomycetemcomitans) and Porphyromonas gingivalis. Two standard abutments were either exposed to bacterial culture or left sterile to serve as positive and negative controls. After disconnection of fixtures and abutments, microbial samples were taken from the threaded portion of the abutment, plated, and allowed to culture under appropriate conditions.

Results: Three of the 10 samples in group 1 developed one colony forming unit (CFU) for A. actinomycetemcomitans, whereas zero of 10 samples developed CFUs for P. gingivalis. Ten of 10 and nine of 10 samples from groups 2 and 3, respectively, developed multiple CFUs for A. actinomycetemcomitans and P. gingivalis.

Conclusion: This study indicated that differences in implant designs may affect the potential risk for invasion of oral microorganisms into the FAI microgap. J Periodontol 2009;80:19911997.

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KEY WORDS

Bacteria; dental leakage; endosseous dental implantation; microbiology; osseointegration; titanium.

The quantity and quality of the bone surrounding a dental implant influences implant osseointegration and affects the shape and contour of the overlying soft tissues and, consequently, the esthetic outcome. Only with careful considerations of the biologic principles of peri-implant soft and hard tissues, as well as the appropriate selection of implant type and position, can a functional and esthetic treatment result be achieved.[1,2] Early bacterial colonization around implants by microorganisms associated with periodontitis was reported,[3-5] and this colonization of implant surfaces and peri-implant tissues can occur within minutes after implant placement.[6]

When a prosthetic abutment is connected to a fixture, a microgap is created between the components. Microorganisms may grow into this fixture–abutment interface (FAI) microgap[7-9] and set up a bacterial reservoir, resulting in an area of inflamed soft tissue facing the fixture– abutment junction.[10] A study by Callan et al.[9] used DNA probe analysis to examine the bacterial colonization into the FAI in patients. The authors reported moderate to high levels of eight different putative periodontal pathogens, including Aggregatibacter actinomycetemcomitans (previously Actinobacillus actinomycetemcomitans) and Porphyromonas gingivalis, colonizing the FAI. These findings support the results of other researchers[4,5] indicating a translocation

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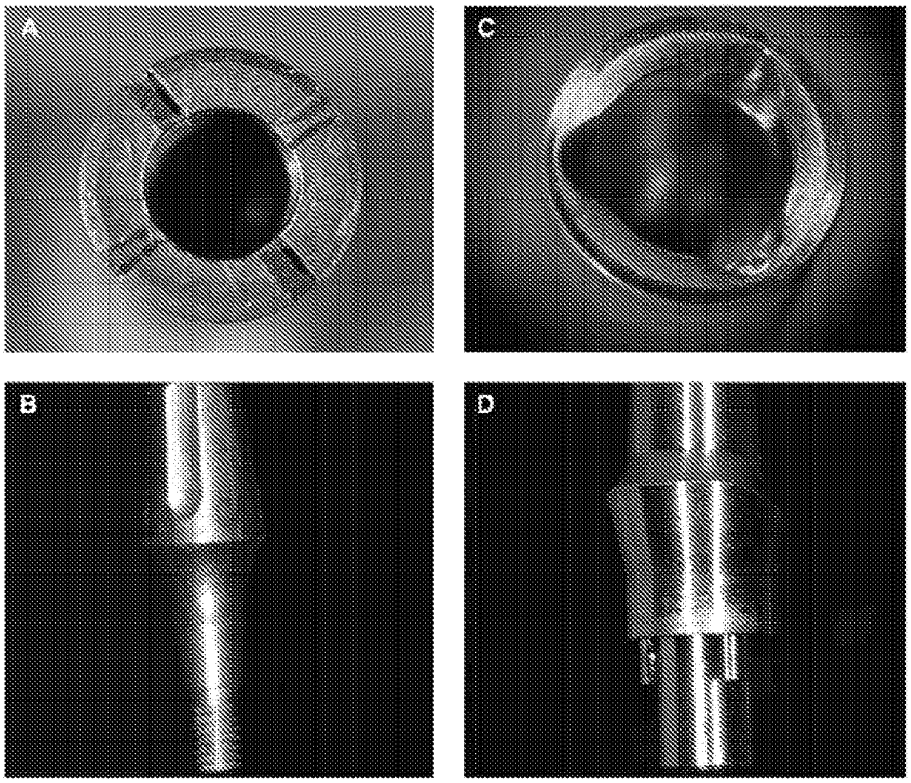


Figure 1.
A) Implant of group 1. B) Abutment of group 1. C) Implant of group 3. D) Abutment of group 3.

of microorganisms from the remaining dentition to implants.

Thus, the presence of an FAI microgap in close relation to bone may have a role in the development of peri-implant inflammation and bone loss.[11-16] Furthermore, when using one-piece implants that do not have an FAI microgap, minimal early bone resorption was found.[12] This result is consistent with the favorable 8-year outcomes of one-piece implants in patients reported by Buser et al.[17] and suggests the potential impact of the FAI microgap on successful implant therapy.

The design of the FAI may have an impact on the amount of microbial penetration into the internal part of dental implants.[8,16,18] For instance, in an in vitro study, Quirynen et al.[8] demonstrated the microbial penetration of the FAI microgap of fixtures with an external hex design. However, there was no comparison among implants with different FAI designs in the study. Jansen et al.[18] reported microbial leakage of 13 different implant–abutment combinations using Escherichia coli as indicator bacteria. Among the different implant–abutment combinations, an implant with an internal connection and a silicon washer demonstrated the fewest cases of leakage. In the report by implants were compared based on their FAI microgap geometry. Ten implants were tested in each experimental group: group 1 = fixtures with an internal Morse-taper connection‡ were connected to standard straight abutments§ with a height of 6 mm (Fig. 1); the Callan et al.,[9] implants from different manufacturers were used without the authors specifying thecharacteristicsoftheFAIgeometry. Therefore, despite the fact that they reported moderate to high levels of colonization of the FAI microgap by periodontal pathogens, it was not possible to evaluate the impact of the design of the FAI on the microbial penetration. Thus, there is limited information regarding differences in the microbial penetration of the FAI microgap of implants withdifferent internal connection designs. The aim of this study was to use an in vitro model to assess the potential risk for invasion of oral microorganisms into the FAI microgap in dental implants with different internal connection designs.

MATERIALS AND METHODS

Implant Experiment Groups

For this study, three groups of abutments were connected to the fixtures with a torque of 25 Ncm according to the manufacturer's protocol; group2=identicalfixturesandabutmentsasdescribed in group 1 were used with the exception that prior to fixture–abutment connection, a vertical groove of ;0.5 mm depth was prepared with a fissure bur‖ on one side of the abutment (Fig. 2). The fixtures and abutments were connected using a torque of 25 Ncm according to the manufacturer's protocol. The introduction of a 0.5-mm groove to the abutment was to ensure microbial penetration to the internal part of the implant, while allowing for the exact same torque for connecting the abutment as the implants in group 1; group 3 = fixtures with a tri-channel internal connection¶ were connected to 3-mm high abutments#

‡ Ankylos Fixtures (B14), 4.5 · 14 mm, Dentsply Friadent, Mannheim, Germany.
§ Standard C/Abutment b/3.0/6.0 straight, Dentsply Friadent.‖ US#557MX, XtremeCut, Brasseler, Savannah, GA ¶ Nobel Biocare Replace Select, 4.3 · 13 mm, Nobel Biocare, Gothenburg, Sweden
Esthetic Abutment Nobel Replace RP 3 mm, Nobel Biocare.

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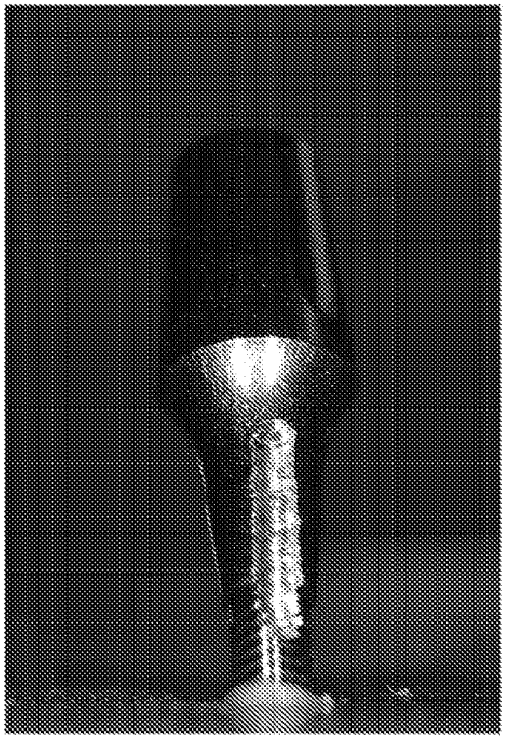


Figure 2.
Standard straight abutment of group 2 with 0.5-mm vertical groove.

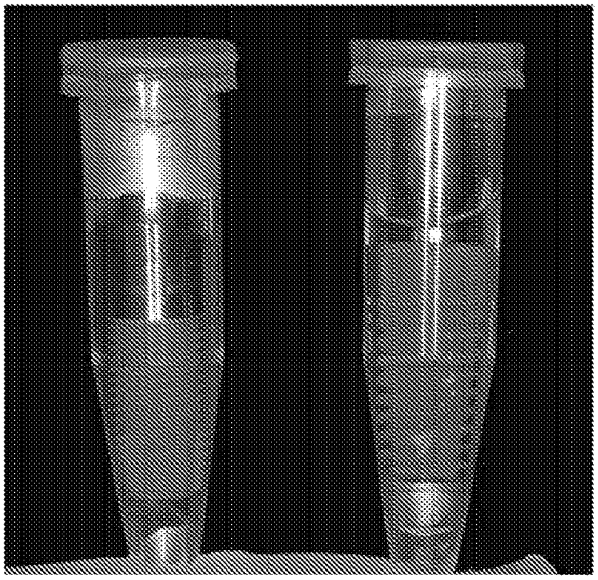


Figure 3.
Implant and abutment of group 1 (right) and group 3 (left) in a plastic container with the bacterial solution.

(Fig. 1). The components were connected with a torque of 35 Ncm according to manufacturer's recommendation.

To evaluate the microbial detection techniques, two standard straight abutments with a height of 6 mm were used as negative and positive controls. The negative-control abutment was not connected to a fixture and was not subjected to bacterial culture. The positive-control abutment was not connected to a fixture but was subjected to the same bacterial cultures as groups 1 through 3.

All fixtures and abutments were connected in a sterile environment and placed in a plastic container with a bacterial solution covering the FAI interface and containing microorganisms as described (Fig. 3).

Bacterial Culture Conditions

A. actinomycetemcomitans VT1169 (State University of New York [SUNY] 465 nalidixic acid resistant rifampicin resistant) was grown in liquid tryptic soy broth supplemented with yeast extract and cultured at 37C in 10% CO_2 to the mid-logarithmic phase. P.gingivalis W83 was grown in liquid tryptic soy broth supplemented with hemin, vitamin K, yeast extract, and L-cysteine hydrochloride at 37C under anaerobic conditions to the mid-logarithmic phase. Implants were placed in an aliquot of a 1:10 dilution of a 1:1 stock solution of A. actinomycemcomitans VT1169 and P. gingivalis W83 and incubated at 37C under anaerobic conditions for 5 days.

Microbial Sampling and Detection

After disconnection of fixtures and abutments under sterile conditions, microbial samples were taken from the threaded portion of the abutment using sterile cotton swabs. Samples were plated onto tryptic soybroth agar plates supplemented with yeast extract for the detection of A. actinomycetemcomitans and onto tryptic soy-broth agar plates supplemented with hemin, vitamin K, yeast extract, and L-cysteine hydrochloride for detection of P. gingivalis colony forming units (CFUs). Plates were incubated at 37C in 10% CO_2 for 7 and 2 days, respectively. Individual CFUs were counted and recorded.

Statistical Analyses

Median values and interquartile ranges were calculated for the number of CFUs for A. actinomycetemcomitans and P. gingivalis. In addition, the total number of implants per group exhibiting bacterial colonization of the FAI microgap was calculated. The KruskalWallis test with Dunn comparisons was applied to evaluate differences among the three groups regarding the number of CFUs for A. actinomycetemcomitans and P. gingivalis. The x^2 test was used to evaluate differences in the number of implants exhibiting bacterial colonization of

the FAI microgap among the different groups. A P value <0.05 was considered significant.

RESULTS

To validate the colonization and detection techniques, abutments similar to those in group 1 were left unassembled and either exposed to bacterial culture or left sterile. Zero CFUs of A. actinomycetemcomitans or P. gingivalis were detected from sampling of abutments that were left sterile (negative control), whereas 188 CFUs of A. actinomycetemcomitans and 113 CFUs of P. gingivalis were detected in samples from abutments exposed to bacterial culture (positive control). These data indicate that the conditions for colonization and sample collection were appropriate for the experimental design.

To semiquantitate the ability of A. actinomycetemcomitans or P. gingivalis to colonize the FAI microgap, CFUs from cultured samplings were quantified (Table 1). Group 1 exhibited significantly lower numbers of CFUs for A.actinomycetemcomitans (median: 0; interquartile range: 0 to 1) compared to group 2 (median: 81; interquartile range: 44.5 to 96.5) (difference: -36.25; P <0.05) and group 3 (median: 24.5; interquartile range: 11 to 56.5) (difference: -22; P <0.05). There was a significant difference in the number of CFUs for P. gingivalis between group 1 (median: 0; interquartile range: 0 to 0) and group 2 (median: 55; interquartile range: 35.5 to 96) (difference: -35.8; P <0.05). However, the difference in the number of CFUs for P. gingivalis between group 1 and group 3 (median: 12, interquartile range: 6 to 29.5) did not reach a statistically significant level (difference: -19.05; P >0.05).

The number of implants that had an FAI microgap contaminated with A. actinomycetemcomitans and P. gingivalis according to the different implant groups is presented in Table 2. Three of ten implants of group 1 had FAI microgaps colonized by A. actinomycetemcomitans, whereas none of the implants of this group had FAI microgaps colonized by P. gingivalis. In contrast, 10 of 10 implants in group 2 and nine of 10 implants in group 3 had FAI microgaps colonized by both A. actinomycetemcomitans and P. gingivalis. There was a statistically significant difference for the number of implants that had FAI microgaps colonized by A. actinomycetemcomitans between groups 1 and 2 (x^2 = 10.76; P<0.05) and between groups 1 and 3 (x^2=7.5; P <0.05). Similarly, there was a statistically significant difference between groups 1 and 2 (x^2 = 20; P <0.05) and between groups 1 and 3 (x^2=16.36; P <0.05) regarding the number of implants that had FAI microgaps colonized by P. gingivalis.

Table 1.

Median Number of CFUs (interquartile range) for A. actinomycetemcomitans and P. gingivalis by Implant Group

Group	A. actinomycetemcomitans (CFU)	P. gingivalis (CFU)
1 (n = 10)	0 (0 to 1)*†	0 (0 to 0)‡
2 (n = 10)	81 (44.5 to 96.5)	55 (35.5 to 96)
3 (n = 10)	24.5 (11 to 56.5)	12 (6 to 29.5)

* P <0.05; group 1 versus group 2 for A. actinomycetemcomitans (KruskalWallis test with Dunn comparisons).
† P <0.05, group 1 versus group 3 for A. actinomycetemcomitans (KruskalWallis test with Dunn comparisons).
‡ P <0.05; group 1 versus group 2 for P. gingivalis (Kruskal-Wallis test with Dunn comparisons).

Table 2.

Number of Implants With an FAI Microgap Contaminated With A. actinomycetemcomitans and P. gingivalis by Implant Group

Group	Number of Implants Contaminated With A. actinomycetemcomitans	Number of Implants Contaminated With P. gingivalis
1 (n = 10)	3*†	0‡§
2 (n = 10)	10	10
3 (n = 10)	9	9

* P <0.05, group 1 versus group 2 for A. actinomycetemcomitans (x^2 test). † P <0.05; group 1 versus group 3 for A. actinomycetemcomitans (x^2 test).
‡ P <0.05; group 1 versus group 2 for P. gingivalis (x^2 test). § P <0.05; group 1 versus group 3 for P. gingivalis (x^2 test).

DISCUSSION

The present study shows that the tested dental implants with a Morse-taper internal connection had negligible bacterial penetration down to the threaded part of the FAI under in vitro conditions. Three of 10 implants with this connection (group 1) had one CFU of A. actinomycetemcomitans. In addition, none of those implants developed CFUs for P. gingivalis. These results seem to be relevant with the geometry of the internal connection because nine of 10 implants with a tri-channel internal connection (group 3) developed multiple CFUs for both A. actinomycetemcomitans and P. gingivalis.

However, there was no statistically significant difference between implants of groups 1 and 3 regarding the number of CFUs of P. gingivalis.

Microbial penetration along the internal part of dental implants was reported in some in vitro studies[8,16,18] using implants with different geometries of the FAI. For instance, Quirynen et al.[8] demonstrated that bacterial invasion of the FAI microgap was detected when fixtures and abutments were assembled and installed in a liquid blood medium inoculated with oral microorganisms. Similarly, Jansen et al.[18] reported microbial leakage of 13 different implant–abutment combinations using E. coli as the indicator bacteria. In addition, an in vivo study by Quirynen and van Steenberghe[7] reported the presence of microorganisms in the inner threads of external hex implants. All screw threads in this study harboredsignificantquantitiesofmicroorganisms.Most recently,Callanetal.[9]describedmoderatetohighlevels of eight different periodontopathogenic microorganisms,includingA.actinomycetemcomitansandP.gingivalis, colonizing the FAI using DNA-probe analysis. Interestingly, the study did not detect the colonization ofthescrew-threadsoftheabutments.Thisisincontrast to what was found in the present study, where the threads of the abutments of groups 2 and 3 were colonized with bacteria. This difference may lie in the sample-collection technique. Callan et al.[9] used paper points for sample collection, whereas in the present study, sterile cotton swabs were used for the microbial sampling. In addition, our group used CFUs, whereas Callan et al.[9] used DNA-probe analysis.

In the present study, we tested for microbial colonization of the FAI microgap by A. actinomycetemcomitans and P. gingivalis because both microorganisms have an established role as putative periodontal pathogens.[19] In this context, the bacterial flora associated with peri-implantitis resembles that of chronic periodontitis[20,21] with significant levels of bacteria such as Fusobacterium spp., Treponema spp., Tannerella forsythia (previously T. forsythensis), Prevotella intermedia, A. actinomycetemcomitans, and P. gingivalis. An FAI that is colonized early by putative periodontal pathogens such as A. actinomycetemcomitans and P. gingivalis may act as a reservoir of bacteria. This contributes to the establishment and maintenance of microflora that resembles that of chronic periodontitis. In fact Quirynen et al.,[5] using a checkerboard DNA–DNA hybridization and real-time polymerase chain reaction, revealed that a complex microbiota with several pathogenic species was established in peri-implant pockets within 2 weeks after abutment connection. However, the mere presence of putative periodontal pathogens does not indicate a direct etiologic relationship that may lead to a destructive process but may simply indicate a potential pathogenic environment.[22]

Few studies[23-25] focused on the decontamination of the inner-implant cavity of two-stage implants. In a recent study, Paolantonio et al.[25] reported that the application of a 1% chlorhexidine gel in the internal part ofthe fixturebefore abutment placement and screw tightening could be an effective method to reduce bacterial colonization over a 6-month period. The authors reported their findings for dental implants with an external hex design that was previously shown to exhibit microbial leakage at the FAI microgap.[7,8] In addition, Groenendijk et al.[24] reported that, the internal implant decontamination with0.2%chlorhexidinesolutionledtoareducedgingival index and crevicular fluid flow compared to saline treated controls. Although, the clinical impact of bacterial leakage on the implant survival rate seems to be very limited, as shown by longitudinal and cross-sectional studies,[26] the exclusion of bacteria from peri-implant regenerative procedures is considered of paramount importance to obtain clinical success.[27]

Loading forces on implants may also contribute to the bacterial colonization of the FAI microgap. One disadvantage of the present in vitro study is that loading conditions were not applied. For instance, in an in vitro experiment using loading forces, Steinebrunner et al.[16] evaluated bacterial leakage along the FAI microgap and discovered statistically significant differences between five implant systems withrespecttothenumberofchewingcycles andbacterial colonization. Thus, it is important to confirm or contrast the results of the present study using loading conditions.

The importance of the position, size, and geometry of the implant on marginal bone levels was a subject of various studies[13,14,28,29] demonstrating that several factors are important regarding peri-implant marginal bone loss. The bacterial colonization of the FAI microgap was reported to be one of these factors. The potential colonization of oral microorganisms of the FAI microgap is presumably impacted by multifactor conditions like the precision fit between the implant components, torque forces when the components are connected, and loading forces when the implants are in function. Indeed, Zipprich et al.[30] evaluated the dynamic behavior of dental implants with different designs of the fixture–abutment connection with respect to microbial colonization. The authors reported the micromovement of the fixture–abutment complex of implants loaded at an angle of 30 when a force of up to 200 N was applied. Interestingly, the same implant system used in our experiment was one of four systems reported to exhibit no micromovement when loaded at 100 N and one of two systems showing no measurable microgap when loaded at 200 N.[30] The authors speculated that certain implant designs would minimize the pumping effect between the fixture and the abutment, thus preventing bacterial colonization of the FAI interface.

CONCLUSIONS

The present study indicated that differences in implant design may affect the potential risk for colonization of oral microorganisms into the FAI microgap. Also, this study indicated a negligible bacterial penetration down to the threaded part of the FAI of dental implants with a Morse-taper connection, although the effects of functional loading still need to be assessed.

ACKNOWLEDGMENTS

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REFERENCES

1. Cochran DL, Hermann JS, Schenk RK, HigginbottomFL, Buser D. Biologic width around titanium implants. A histometric analysis of the implanto-gingival junction around unloaded and loaded nonsubmerged implants in the canine mandible. J Periodontol 1997; 68:186-198.
2. Tarnow DP, Cho SC, Wallace SS. The effect of interimplant distance on the height of inter-implant bone crest. J Periodontol 2000;71:546-549.
3. Mombelli A, Buser D, Lang NP. Colonization of osseointegarted titanium implants in edentulous patients. Early results. Oral Microbiol Immunol 1988;3: 113-120.
4. van Winkelhoff AJ, Goene´ RJ, Benschop C, Folmer T. Early colonization of dental implants by putative periodontal pathogens in partially edentulous patients. Clin Oral Implants Res 2000;11:511-520.
5. Quirynen M, Vogels R, Peters W, van Steenberghe D,Naert I, Haffajee AA. Dynamics of initial subgingival colonization of pristine peri-implant pockets. Clin Oral Implants Res 2006;17:25-37.
6. Fu¨rst MM, Salvi G, Lang NP, Persson R. Bacterial colonization immediately after installation of oral titanium implants. Clin Oral Implants Res 2007;18: 501-508.
7. Quirynen M, van Steenberghe D. Bacterial colonization of the internal part of two-stage implants. An in vivo study. Clin Oral Implants Res 1993;4:158-161.
8. Quirynen M, Bollen CM, Eyssen H, van Steenberghe D.Microbial penetration along the implant components of the Bra˚nemark system. An in vitro study. Clin Oral Implants Res 1994;5:239-244.
9. Callan DP, Cobb CM, Williams KB. DNA probe identification of bacteria colonizing internal-surfaces of the implant-abutment interface: A preliminary study. J Periodontol 2005;76:115-120.
10. Ericsson I, Persson LG, Berglundh T, Marinello CP,Lindhe J, Klinge B. Different types of inflammatory reactions in peri-implant tissues. J Clin Periodontol 1995;22:255-261.
11. Persson LG, Lekholm U, Leonardt A, Dahlen G, Lindhe J.Bacterial colonization on internal surfaces of Bra˚nemark system componenets. Clin Oral Implants Res 1996;7: 90-95.
12. Hermann JS, Cochran DL, Nummikoski PV, Buser D.Crestal bone changes around titanium implants. A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible. J Periodontol 1997;68:1117-1130.
13. Hermann JS, Schoolfield JD, Schenk RK, Buser D,Cochran DL. Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in the canine mandible. J Periodontol 2001; 72:1372-1383.
14. King GN, Hermann JS, Schoolfield JD, Buser D,Cochran DL. Influence of the size of the microgap on crestal bone levels in non-submerged dental implants. A radiographic study in the canine mandible. J Periodontol 2002;73:1111-1117.
15. Piattelli A, Vrespa G, Petrone G, Iezzi G, Annibali S,Scarano A. The role of the microgap between implant and abutment: A retrospective histologic evaluation in monkey. J Periodontol 2003;74:346-352.
16. Steinebrunner L, Wolfart S, Bo¨ssmann K, Kern M. In vitro evaluation of bacterial leakage along the implantabutment interface of different implant designs. Int J Oral Maxillofac Implants 2005;20:875-881.
17. Buser D, Mericske-Stern R, Bernard JP, et al. Longterm evaluation of non-submerged ITI implants. Part 1: 8-year life table analysis of a prospective multi-center study with 2359 implants. Clin Oral Implants Res 1997; 8:161-172.
18. Jansen VK, Conrads G, Richter EJ. Microbial leakageand marginal fit of the implant-abutment interface. Int J Oral Maxillofac Implants 1997;12:527-540.
19. Socransky SS, Haffajee AD, Ximenez-Fyvie LA, FeresM, Mager D. Ecological considerations in the treatment of Actinobacillus actinomycetemcomitans and Porphyromonas gingivalis periodontal infections. Periodontol 2000 1999;20:341-362.
20. Mombelli A, Lang NP. Antimicrobial treatment of periimplant infections. Clin Oral Implants Res 1992;3: 162-168.
21. Leonhardt A˚ , Renvert S, Dahle´n G. Microbial findings at failing implants. Clin Oral Implants Res 1999;10: 339-345.
22. Mombelli A, Lang NP. Microbial aspects of implantdentistry. Periodontol 2000 1994;4:74-80.
23. Rimondini L, Marin C, Brunella F, Fini M. Internalcontamination of a 2-component implant system after occlusal loading and provisionally luted reconstruction with or without a washer device. J Periodontol 2001; 72:1652-1657.
24. Groenendijk E, Dominicus JJ, Moorer WR, AartmanIH, van Waas MA. Microbiological and clinical effects of chlorhexidine enclosed in fixtures of 3ITitamed implants. Clin Oral Implants Res 2004; 15:174-179.
25. Paolantonio M, Perinetti G, D'Ercole S, et al. Internaldecontamination of dental implants: An in vivo randomized microbiologic 6-month trial on the effects of a chlorhexidine gel. J Periodontol 2008;79: 1419-1425.
26. van Steenberghe D, Naert I. The first two-stage dentalimplant system and its clinical application. Periodontol 2000 1998;17:89-95.
27. Persson LG, Ericsson I, Berglundh T, Lindhe J. Osseintegration following treatment of peri-implantitis and replacement of implant components. An experimental study in the dog. J Clin Periodontol 2001;28: 258-263.
28. Hermann JS, Buser D, Schenk RK, Cochran DL.Crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged and submerged implants in the canine mandible. J Periodontol 2000;71:1412-1424.
29. Jung RE, Jones A, Higginbottom F, et al. The influence of non-matching implant and abutment diameters on radiographic crestal bone levels in dogs. J Periodontol 2008;79:260-270.
30. Zipprich H, Weigl P, Lange B, Lauer H-C. Micromovements at the implant-abutment interface: Measurement, causes, and consequences [in German]. Implantologie

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2007;15:31-46. http://impl.quintessenz.de/index.php. Accessed November 3, 2009.

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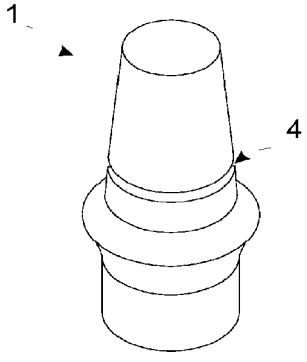
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(54) **Title:** IMPRESSION AND MODEL COMPONENTS

(57) **Abstract:** This invention is related to the impression and model component in order to determine easily and extremely sensitively the place of metal superstructure of implant supported prostheses (screw, cement and bar retained restorations).

Figure 1



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Description

IMPRESSION AND MODEL COMPONENTS

[I] Technical Field:

[2] This invention is related to the impression and model components in order to determine easily and highly sensitively the place of metal superstructure of implant supported prostheses (screw, cement and bar retained restorations).

[3] Prior Art:

[4] Today, implants are placed in jawbone in case of full, partial or single tooth loss and excellent mouth rehabilitation is achieved by placing fixed or mobile prosthesis on them.

[5] Implant supported prostheses has a metal superstructure in order to mount them in their place in the mouth. To manufacture metal superstructure, a model prepared by taking impression from the patient is required. For said model, impression is taken from the patient with closed tray or open tray techniques.

[6] Closed tray impression technique:

[7] To take mouth impression;

[8] Impression pick-up (impression cap) is placed using snap-on mechanism on the abutment screwed on the implant. Snap-on mechanism operates in such way that rabbet part whose plastic impression pick-up diameter is smaller than the abutment stretches and covers around the abutment.

[9] Mouth impression and position of impression pick-up in the mouth are obtained through placing impression tray filled with rubber based impression material into the mouth and polymerizing the same. When the impression is removed from the mouth, impression pick-up remains inside the impression because polymerized impression material holds the impression pick-up by means of groove and extensions located on the impression cap.

[10] Modelling according to the impression;

[II] Analog which is a replica of the abutment in the mount is placed on the impression pick-up via snap-on mechanism. Plaster is poured into the impression in such way to include analog and left to harden. After hardened plaster is removed from the impression and thus a mouth model with abutment analog is provided.

[12] Casting cylinder (wax-up coping, burn-out cap, burn-out cylinder) is placed on abutment analog using snap-on mechanism or directly. Metal superstructure form is provided by waxing up the casting cylinder, that is wax figure of metal superstructure with casting cylinder in it is obtained. Wax figure is removed from abutment analog and invested, and casting is conducted conventionally. Thus, metal superstructure is manufactured.

[13] Furthermore, in certain systems impression is taken by screwing transfer coping instead of abutment into implant. Impression is removed from the mouth, transfer coping is unscrewed from implant and implant analog is screwed to the same. Transfer coping on which implant analog is screwed is then repositioned in the slot inside the impression and plaster is poured in. After hardening, plaster is removed from the impression. Hence, implant analog is inside the plaster model and transfer coping is on this model. Transfer coping is removed from the plaster model and abutment is screwed in the same place. Casting cylinder is placed on the abutment via snap-on mechanism or directly and metal superstructure is provided using the casting method as described above.

[14] There also exist systems in which transfer cap is placed on the transfer coping and said transfer cap remains in the impression. In those systems, transfer coping is required to be placed in the transfer cap remaining in the impression after transfer coping is unscrewed from the implant and implant analog is screwed instead.

[15] Open Tray Impression Technique:

[16] To take mouth impression;

[17] Plaster model is produced by taking mouth impression of the patient. Individual impression tray specific to the patient (custom made impression tray) is prepared on the said model. Hole is made on the custom made impression tray by being aligned to the implant. Impression pick-up is screwed on the implant using integral positioning screw (implant guide pin). Individual impression tray is filled with rubber based impression material and then applied into the patient's mouth in such way to the screw head protrude from the hole.

[18] Modelling according to the impression;

[19] After polymerization of the impression material, screw is loosened and the impression is removed from the mouth. Implant analog (implant replica) is screwed into the impression pick-up remaining in the impression and plaster is poured in. After plaster harden, screw is loosened and removed from the impression. Thus, plaster model in which implant analog is present is provided. Abutment is screwed into the implant analog and casting cylinder is placed on the abutment and metal superstructure is manufactured via casting method as described above.

[20] Furthermore, in certain systems transfer copings and transfer pick-ups used in the closed tray method are also used in this method. Weakened area on the transfer caps is punctured and integral positioning screws are screwed into the implant by passing through this hole and the channel in the transfer coping. As described above, impression is taken in such way that screw heads protrude from the custom made impression tray and the same procedures are followed.

[21] Technical problem:

[22] In the prior art; impression is taken by using the combinations of

[23] - Impression pick-up + abutment analog,

[24] - Transfer coping + implant analog or;

[25] - Transfer cap + transfer coping + implant analog.

[26] During the combinations, abovementioned parts were screwed to each others and unscrewed and then screwed again or inserted in each other, then removed and then inserted again or removed from the impression and then repositioned inside the impression. During these procedures some mistakes were possibly be made. For instance, during screwing, unscrewing, screwing again, torque force could not be standardized, therefore screw might be sometimes wound excessively and sometimes less than required.

[27] Moreover; as a result of

[28] - slipping into foreign objects into the gap during inserting parts to each other and removing parts from each other, or

[29] - folding very thin rubber extensions during the procedure of removing from the impression and repositioned into the impression;

[30] position of the implant in the plaster model or abutment analogs on the plaster model might be different from the position in the mouth. Thus, it is highly possible to manufacture an incompatible metal superstructure because of obtaining a faulty plaster model.

[31] Dental technician obtains wax figure of the metal superstructure to be used in the casting by placing casting cylinders on the abutments in the plaster model and waxing up. In prior art, dental technician removes this wax figure and then invests it and performs casting procedure.

[32] Especially in the long bridges and full mouth restorations, deformations may occur during removing and investing the wax figure and metal superstructure may not fit with the desired accuracy.

[33] Open tray impression is a technique developed in order not to remove the impression pick-up or transfer coping from the impression. Necessity of such method can be showed as a proof of existence of the problems listed above. However, in the further steps of the open tray impression technique; screwing, unscrewing and screwing again procedures are performed sequentially.

[34] In most of the systems according to the prior art, snap-on mechanism is used on the shoulder of the implant in order to fit properly casting cylinders on the abutment analogs and to keep them fixed during wax-up. When metal superstructure is cast, this snap-on mechanism is required to be removed using finishing instruments because metal is not elastic. No matter how carefully was this process performed, it was impossible to be performed sensitive by hand. However, marginal fit should be perfect

for the success of an implant for a long time. Casting cylinder of the systems in which snap-on mechanism is not used are placed directly on the abutment analog. However, in this case any attachment was not used; therefore, casting cylinders could not be kept fixed on the abutment during wax-up, so incompatibility could be seen in metal super-structure.

[35] Primary and secondary, if any, objects of the invention

[36] Object of the invention is to provide the impression and model components in order to determine precisely the position of implant during taking impression from the mouth in which implant is placed and producing model.

[37] Detailed Description of Embodiment according to the Invention related to Cement retained Restorations

[38] Impression and model components provided for attaining the objects of the invention are shown in the accompanying drawings wherein;

[39] Figure 1- is a perspective view of abutment according the invention.

[40] Figure 2- is a cross-section view of embodiment of hybrid cylinder with wide-spaced ledge according to the invention.

[41] Figure 3- is a cross-section view of embodiment of hybrid cylinder with narrow-spaced ledge according to the invention.

[42] Figure 4- is a cross-section view of peripheral ledge embodiment of hybrid cylinder according to the invention.

[43] Figure 5- is a perspective view of the guide piece according to invention.

[44] Figure 6- is a perspective view of die pin according to invention.

[45] Figure 7- is a cross-section perspective view in which die pin guide piece and hybrid cylinder according to invention are inserted in each other.

[46] Figure 8- is the cross-section view of position of the abutment according to the invention in the mouth.

[47] Figure 9- is the cross-section view of the hybrid cylinder which is inserted into the abutment in the mouth.

[48] Figure 10- is the cross-section view of the impression which is taken after the hybrid cylinder according to the invention is inserted in the abutment.

[49] Figure 11- is the cross-section view of the hybrid cylinder according to the invention while being disengaging from the abutment when the impression is removed from the mouth.

[50] Figure 12- is the cross-section view in which die pin according to the invention is passed through the hybrid cylinder by means of the guide piece and inserted in the im-pression material.

[51] Figures 13- is the cross-section view of the hybrid cylinder and die pin according to the invention after the guide piece is removed.