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Editors

David L. Turpin, DDS, MSD, Editor-in-Chief

University of Washington, Department of Orthodontics, D-569, HSC Box 357446, Seattle, WA 98195-7446
Telephone, (206) 221-5413; fax, (206) 221-5467; e-mail, dlturpin@aol.com

T. M. Graber, DMD, MSD, PhD, OdontDr, DSc, ScD, MD (hon), FDSRCS (Eng), Editor-Emeritus

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82 Laurel Dr, Massapequa Park, NY 11762

Robert P. Scholz, DDS, Editor of Techno Bytes

332 Dutton Ave, San Leandro, CA 94577-2806

Demetrios J. Halazonetis, DMD, MS, Associate Editor of Techno Bytes

6 Menandrou St, Kifisia 145 61, Greece, e-mail, dhal@dhal.com

Martin Abelson, Associate Editor of Techno Bytes

14720 N Shotgun Pl, Tucson, AZ 85737

S. Ed Owen, ABO Liaison

PO Box 628, Jackson, WY 83001

Brent E. Larson, DDS, Education Liaison

410 16th St SE, Rochester, MN 55904; e-mail, belarson@home.com

Joseph Zernik, DMD, PhD, E-mail Editor

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Gerald Nelson, DDS, Editor of Clinical Section

1200 LakeShore, #21D, Oakland, CA 94606

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Department of Growth and Development, Harvard School of Dental Medicine,

188 Longwood Ave, Boston, MA 02115; e-mail, lwill@hms.harvard.edu.

Zane Muhl, DDS, MS, PhD, Editor of Continuing Education

University of Illinois at Chicago, College of Dentistry, Department of Orthodontics,

MC 841, 801 S Paulina, Chicago, IL 60612; e-mail, zfmuhl@uic.edu

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1950 S Cedar, Tacoma, WA 98405

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Mosby Staff

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Mosby, Inc (314) 453-4127; fax, (314) 579-3370; e-mail, B.Botello@elsevier.com

Editors of Constituent Society Newsletters

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Invisalign A to Z

Benson H. Wong, DDS

San Bruno, Calif

Movement of teeth without the use of bands, brackets, or wires was described as early as 1945 by Dr H. D. Kesling,¹ who reported on the use of a flexible tooth positioning appliance. Later, Nahoum² and others³⁻⁶ wrote about various types of overlay appliances such as invisible retainers.

Minor tooth movements have also been achieved with a technique developed by Raintree Essix (New Orleans, La). This technique uses clear aligners formed on plaster models of the teeth. The aligners are then modified with "divots," which create a force to push on the individual teeth, and "windows," which create the space for teeth to move into. This type of appliance can be effective in correcting mild discrepancies in the alignment of teeth. However, movements are limited to 2 to 3 mm; beyond this range, another impression and a new appliance are needed.

Align Technology, Inc (Santa Clara, Calif), introduced the Invisalign system several years ago. Invisalign takes the principles of Kesling,¹ Nahoum,² others,³⁻⁶ and Raintree Essix even further, using computer-aided-design-computer-aided-manufacture (CAD-CAM) technology combined with laboratory techniques to fabricate a series of custom appliances that are esthetic and removable, and that can move teeth from beginning to end.

For each patient, the orthodontist submits a set of polyvinyl siloxane impressions, a centric occlusion bite registration, a panoramic radiograph, a lateral cephalometric radiograph, and photographs to Align Technology. The impressions are poured up in dental plaster and then placed in a tray and encased with epoxy and urethane. The tray is placed into a destructive scanner; the scanner's rotating blade makes numerous passes over the epoxy-encased models, removing a thin layer with each pass. A computer linked with the scanner then assembles the scanned information to create a 3-dimensional rendering of the models (Fig 1).

After the bite has been established, the Invisalign virtual orthodontic technician (VOT) uses software to "cut" the virtual models and separate the teeth, allowing them to be moved individually. A virtual gingiva is placed along the gingival line of the clinical crown to serve as the margin for the manufacturing of the aligners (Fig 2).

The orthodontist's prescription is followed in positioning the teeth and the bite to proper alignment virtually on the computer with the company's Treat software (Align Technology, Santa Clara, Calif). Once the final setup has been done, tooth movements are staged so that there are no occlusal and interproximal interferences, and the velocity of the movements is within the criteria set by the company. The number of stages necessary depends on the amount and complexity of the movement. The VOT can now send the data to the referring orthodontist so that he or she can check the proposed treatment on the Invisalign Web site.

When the orthodontist has approved the treatment plan, the aligners will be manufactured so that the movements seen on the computer screen can be transferred clinically to the patient. The computer images are converted to physical models by using a process called stereolithography. These models are then used to fabricate the aligners on a Biostar pressure molding machine (Great Lakes Orthodontic Products, Tonawanda, NY) (Fig 3). Align Technology engineers have formulated a proprietary material for use in the aligners. The aligners are trimmed and laser-etched with the patient's initials, case number, aligner number, and arch (upper or lower). They are then disinfected, packaged, and shipped to the doctor's office.

The entire process of making the Invisalign aligners is a marvel of modern technology. Without the aid of computers and technologically advanced machinery, it would be impossible to fabricate aligners in such large numbers and with such great accuracy. Fabricating these aligners in an orthodontic office would be a very time-consuming and labor-intensive process that probably would not be practical for everyday treatment. The Invisalign technique gives patients an esthetic choice in their

Private practice.

Reprint requests to: Robert P. Scholz, 332 Dutton Ave, San Leandro, CA 94577-2806.

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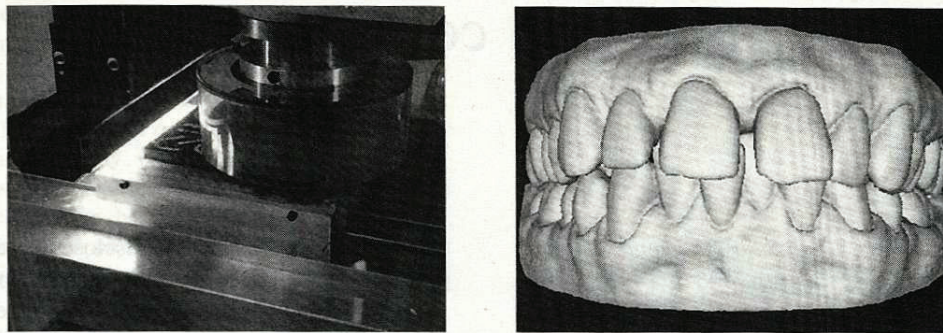


Fig 1. A, Destructive scanner, and B, 3-D generated computer model.

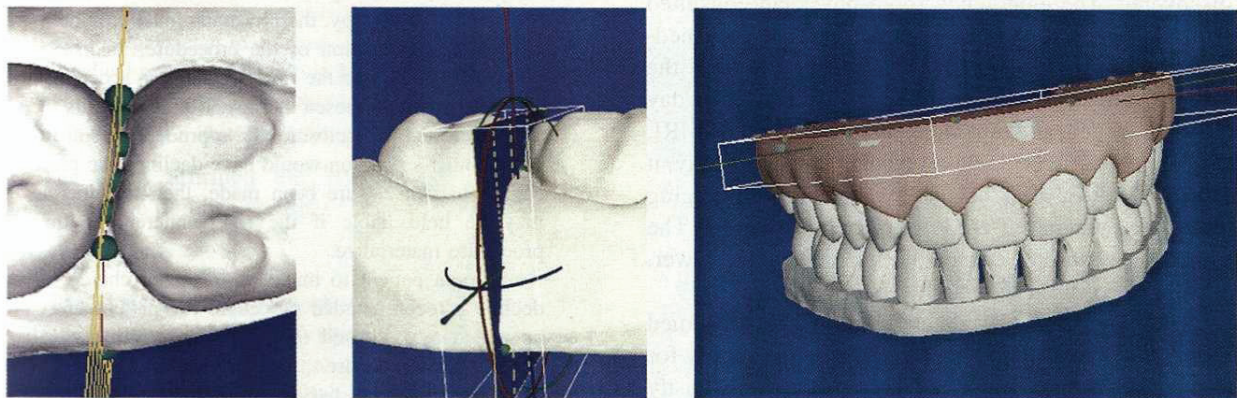


Fig 2. A, B, Cutters separate teeth, and C, placement of virtual gingiva.

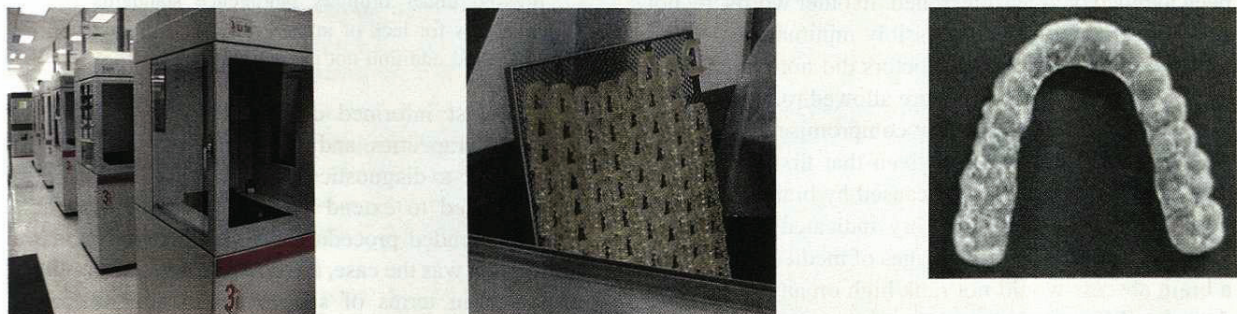


Fig 3. A, Stereolithography machines, B, stereolithography models, and C, aligners.

orthodontic treatment that all orthodontists can easily implement in their offices.

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The use of technology in the orthodontic practice will be reported under this section of the American Journal of Orthodontics and Dentofacial Orthopedics. Manuscripts, comments, and reprint requests, unless otherwise noted, may be submitted to Dr David L. Turpin, University of Washington, Department of Orthodontics, D-569, HSC Box 357446, Seattle, WA 98195-7446.