

ADVANCES IN SPINAL FUSION

Molecular Science, Biomechanics,
and Clinical Management



EDITED BY

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Contents

<i>Preface</i>	<i>iii</i>
1 Reduction and Fixation of Sacroiliac Joint Dislocation by the Combined Use of S1 Pedicle Screws and an Iliac Rod <i>Kuniyoshi Abumi, Manabu Ito, Yoshihisa Kotani, and Michinori Saita</i>	1
2 Percutaneous Vertebroplasty in the Treatment of Osteoporotic Fractures <i>Luis Alvarez and Antonio Pérez-Higueras</i>	13
3 Biomechanics of Vertebroplasty <i>Stephen M. Belkoff</i>	23
4 Kyphoplasty and Vertebroplasty for the Treatment of Painful Osteoporotic Vertebral Compression Fractures <i>Christopher Bono and Steven Garfin</i>	33
5 Carbon Fiber-Reinforced Polymer Implants for Spinal Fusion: Biomechanical and Clinical Advantages of a New Material <i>John Brantigan</i>	51
6 Stand-Alone Anterior Lumbar Interbody Fusion Constructs: Effect of Interbody Design, Bone Graft, and Bone Morphogenetic Protein on Clinical and Radiographic Outcomes <i>Kenneth Burkus</i>	69
7 Overcoming Chemical Inhibition of Spine Fusion <i>Brian Claytor and Steven Theiss</i>	85
8 Use of a Cloned Osteoprogenitor Cell in Spinal Fusion <i>Quanjun Cui, Zeng Ming Xiao, Gary Balian, and Gwo-Jaw Wang</i>	93

9	Axially Loaded Computer Tomography and Magnetic Resonance Imaging of the Lumbar Spine <i>Barbro Danielson and Jan Willén</i>	103
10	Experience with OP-1 in a Rabbit Model of Lumbar Fusions <i>Jonathan S. Erulkar, Jonathan N. Grauer, Tushar Ch. Patel, and Gary E. Friedlaender</i>	117
11	Structure and Function of Normal, Degenerate, and Surgically Fixed Spinal Segments <i>Nicola Fazzalari, John J. Costi, and Trevor C. Hearn</i>	135
12	A Quantitatively Unstable Model to Evaluate the Biological Effects of Mechanical Forces on Spine Fusion <i>Mark R. Foster</i>	155
13	Ankylosing Spondylitis and Spinal Complications <i>Aaron M. From, Patrick W. Hitchon, Paul M. Peloso, and Matthew Brenton</i>	167
14	Atlantoaxial Transarticular Screw Fixation: Indication, Technique, Risks, and Pitfalls <i>Takeshi Fuji, Takenori Oda, and Yasuji Kato</i>	179
15	Biomechanics of Artificial Discs <i>Vijay K. Goel, Andrew P. Dooris, Dennis McGowan, and S. Rengachary</i>	191
16	Comparison of the Leukotactic Properties of Nucleus Pulposus, Anulus Fibrosus, and Cartilage Following Subcutaneous Injection in Pigs <i>Mats Grönblad, Bertel Kommonen, Outi Laitinen, Johanna Virri, Aklilu Habtemariam, and Ilkka Alitalo</i>	217
17	Advances in Bone Graft Substitutes in Spinal Fusion <i>Michael N. Tzermiadianos, Alexander G. Hadjipavlou, and John H. Gaitanis</i>	225
18	Titanium Mesh Cage in Spinal Reconstruction Surgery: Biomechanics and Clinical Application <i>Kazuhiro Hasegawa and Toshiaki Hara</i>	245
19	Posterior Lumbar Interbody Fusion Using the Brantigan I/F Cage <i>Tomoyuki Hashimoto, Keichi Shigenobu, and Masahiro Kanayama</i>	263
20	SF-36 Health Status and Oswestry Disability Index in Worker's Compensation Patients with Neck Pain <i>Hwan T. Hee, Thomas S. Whitecloud III, and Leann Myers</i>	279
21	Interbody Fusion in the Elderly <i>Lee D. Hieb</i>	293

22	Choice of Anterior and Posterior Thoracolumbar Spinal Implants <i>Patrick W. Hitchon, Mathew Brenton, Andrew G. Black, Aaron M. From, Jeremy Harrod, Kurt Eichholz, and James Torner</i>	313
23	Spondylotic Cervical Myelopathy: Clinical Aspects <i>Z. Kadanka and J. Bednarik</i>	325
24	Autogenous Free Fat Grafts After Posterior Lumbar Surgery <i>Masahiko Kanamori</i>	337
25	In Vitro Stability of Cervical Spine Cages <i>F. Kandziora, J. Schäfer, M. Scholz, R. Pflugmacher, K. Ludwig, T. Eindorf, and N. P. Haas</i>	347
26	In Vivo Performance of Cervical Spine Cages <i>F. Kandziora, R. Pflugmacher, M. Scholz, J. Schäfer, K. Ludwig, T. Eindorf, and N. P. Haas</i>	361
27	Autologous Growth Factors and Progenitor Cells as Effective Components in Bone Grafting Products for Spine <i>Terri A. Kapur, Sudha Kadiyala, David J. Urbahns, and Scott P. Bruder</i>	381
28	Process of Lumbar Spinal Degeneration: Interrelationships Between Disc Degeneration and Facet Joint Osteoarthritis <i>Yuichi Kasai, Kenji Takegami, Koichiro Morishita, and Atsumasa Uchida</i>	397
29	Relationships Between Lumbar Sagittal Alignment and Clinical Outcomes After Decompression and Posterolateral Spinal Fusion for Degenerative Spondylolisthesis <i>Mamoru Kawakami and Tetsuya Tamaki</i>	405
30	Histological Findings in Revision Surgery of Instrumented Spine Fusion with the Use of Coralline Hydroxyapatite <i>Panagiotis Korovessis, Maria Repanti, and Giorgos Koureas</i>	415
31	New Developments in Spinal Cord Monitoring <i>Danielle D. Langeloo, Henricus L. Journée, and Marinus de Kleuver</i>	423
32	The Physical Properties and Biocompatibility of Plasma-Sprayed Hydroxyapatite Coating <i>T. M. Lee, E. Chang, and C. Y. Yang</i>	441
33	Biomechanical Efficacy of Vertebroplasty and Kyphoplasty <i>Michael A. K. Liebschner and Kay Sun</i>	463
34	Bioactive Bone Cement for the Treatment of Osteoporotic Vertebral Compression Fracture <i>W. W. Lu and G. X. Ni</i>	489

35	Advances in Technology and Spinal Fusion: A Clinician's Perspective <i>Stefano Lupporelli and Sergio Cecconi</i>	509
36	Replacement of Autograft with BMP for Spinal Arthrodesis: Future Perspectives Following Recent Research <i>Michael N. Magin</i>	543
37	Occipitocervical Fusion for Rheumatoid Arthritis Patients with Myelopathy <i>Shunji Matsunaga, Takashi Sakou, and Nobuhiko Sunahara</i>	561
38	Validity of a Bioactive Ceramic Spacer in Posterior Lumbar Interbody Fusion with Studies of the Stability of the Pedicle Screw for the Osteoporotic Spine In Vivo and In Vitro <i>Naohisa Miyakoshi, Koichiro Okuyama, Tetsuya Suzuki, Eiji Abe, Yochi Shimada, and Eiji Itoi</i>	569
39	Thoracic Pedicle Screws: Biomechanical Considerations of the Extrapedicular Approach <i>W. Morgenstern, S. J. Ferguson, and P. Metz-Stavenhagen</i>	591
40	Two-Cage Reconstruction Versus Single Mega-Cage or Dual Nested Cages for Lumbar Interbody Fusion <i>Hideki Murakami, William C. Horton, and William C. Hutton</i>	611
41	Spontaneous Remission of Intervertebral Disc Hernia and Responses of Surrounding Macrophages <i>Kensei Nagata and Michiyo Tsuru</i>	619
42	Gene Expression Profiling During Osteochondrogenic Events in the Spinal Region: Use in the Development of Promising Spinal Fusion <i>Takanobu Nakase</i>	639
43	Cells, Signals, and Scaffolds: The Future of Spinal Fusion <i>Leon J. Nesti, Timothy R. Kuklo, and Edward J. Caterson</i>	649
44	Roentgen Stereometric Analysis: A Novel In Vivo Method to Assess Spinal Fusion <i>Dietrich Pape, Frank Adam, Ekkehard Fritsch, and Dieter Kohn</i>	669
45	The Morbidity of Autogenous Bone Graft Donation <i>Peter A. Robertson and Mark J. Sherwood</i>	683
46	Loads on an Internal Spinal Fixation Device Measured In Vivo <i>Antonius Rohlmann, Friedmar Graichen, and Georg Bergmann</i>	699
47	New Anterior Cervical Instrumentation Systems Combining Intradiscal Cage with Integrated Plate: Biomechanics and Clinical Applications <i>George Samandouras and Peter John Hamlyn</i>	711

Contents	ix
48 Improvement of Pedical Screw Fixation with Hydroxyapatite Coating <i>Bengt Sandén</i>	725
49 Multilevel Cervical Decompression and Reconstruction <i>Michael L. Swank</i>	737
50 Decision Support Tools in Spinal Surgery: Artificial Neural Networks and Predictive Modeling <i>Scott G. Tromanhauser and Marc E. Parham</i>	767
51 Porous Tantalum for Spinal Interbody Fusion <i>Crispin C. Wigfield and Bruce H. Robie</i>	775
52 Advances in Spinal Fusion <i>Sami Zeineddine and Reginald Q. Knight</i>	781
<i>Index</i>	791



Group 1

bone graft

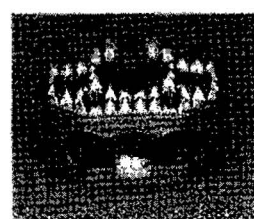
fusion score: C



Group 2

cylinder cage + bone graft

fusion score: B



Group 3

box cage + bone graft

fusion score: B

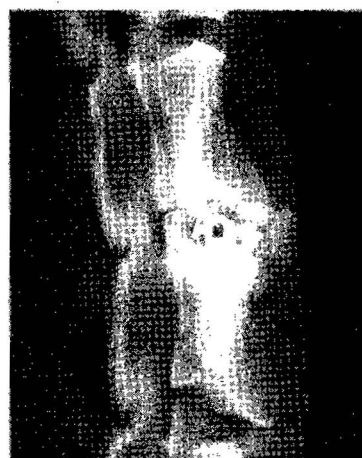
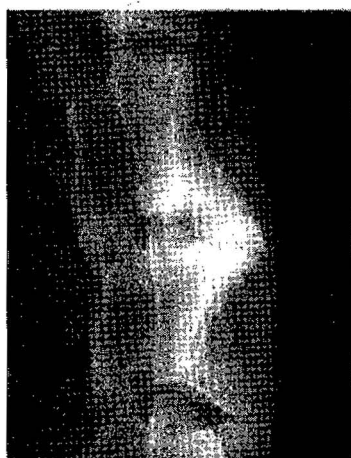


Figure 4 Radiographic analysis: bony fusion evaluated after 12 weeks on radiographic scans (example). The small pictures show the different implants. Notice the larger contiguous cranial pore in the cylinder design cage. The results of the fusion score are depicted: (A) no bony fusion; (B) maximum intervertebral gap of more than 5 mm; (C) maximum intervertebral gap of less than 5 mm; (D) complete bony fusion.

Table 1 Radiographic Analysis

Bony fusion parameter (score)	Group 1 (<i>n</i> = 8), bone graft	Group 2 (<i>n</i> = 8), cylinder cage + bone graft	Group 3 (<i>n</i> = 8), box cage + bone graft
A	0	0	0
B	5	4	5
C	3	3	3
D	0	1	0

Bony fusion was determined after 12 weeks on radiographic scans using following parameters: (A) no bony fusion, (B) intervertebral gap >5 mm, (C) intervertebral gap <5 mm, (D) complete bony fusion. All radiographic measurements were evaluated by three independent observers.

Table 2 Functional Radiographic Evaluation of Flexion/Extension at 12 Weeks

Flexion/extension (difference in degrees)	Group 1 (<i>n</i> = 8), bone graft	Group 2 (<i>n</i> = 8), cylinder cage + bone graft	Group 3 (<i>n</i> = 8), box cage + bone graft
IVA	13.6 ± 3.7 (6.0–13.5)	7.7 ± 3.0 ^a (4.5–11.0)	9.6 ± 2.8 (7.0–12.5)
LA	14.1 ± 5.0 (6.5–17.0)	7.9 ± 3.4 ^a (4.5–11.5)	10.1 ± 3.2 (6.0–13.5)

Flexion/extension differences of intervertebral angle (IVA) and lordosis angle (LA) were calculated.

^a $p < 0.05$ in comparison to the bone graft (group 1).

values in rotation and bending were constantly found in group 2. Average stiffness in axial rotation and lateral bending was significantly higher ($p < 0.05$) in the cylinder-design cages than in any other group. ROM in rotation was significantly lower ($p < 0.05$) in group 2 than in both other groups.

G. Histomorphological Results

Histomorphological analysis supported the findings of radiographic and biomechanical examinations (Fig. 7).

Group 1 (autologous iliac crest bone graft) showed extensive callus formation with cartilage and connective tissue cells. The tricortical bone graft, however, collapsed and was mainly reabsorbed. Osteoclastic activity was noted as an indicator of graft resorption. Most of the callus was seen ventrally. Groups 2 and 3, stabilized with cages, showed bony islands between the endplates with cartilage and fibrous tissue components. These findings were accompanied by capillary ingrowth and resorptive lacunae. The tissue surrounding the cages appeared similar in both groups. However, inside the cage of group 3, extensive osteoclastic activity was noted as an indication of graft resorption.

Bony fusion was evaluated histomorphologically (Table 6). In the cage groups (groups 2 and 3) a progressed interbody fusion was found in comparison to the tricortical iliac crest graft group (group 1). However, the cylinder-design cage showed a slightly more progressed bone matrix formation than the box-design cage.

H. Histomorphometric Results

The results of histomorphometric analysis are depicted in Table 7. In histomorphometric analysis no significant differences of sagittal diameter distance (baseline) were determined between all groups. Compared to the bone graft group and the box-design cage group, histomorphometric parameters showed significantly progressed bone formation (BV/TV) in the cylinder-design cage group ($p < 0.05$). The bone graft group showed significantly higher histomorphometric values for CV/TV and mCV/TV than both cage design groups ($p < 0.05$).

I. Fluorochrome Analysis Results

The results of fluorochrome analysis are depicted in Table 8. Both cage designs exhibited earlier new bone formation both within and around the cages compared to the bone graft group at all