

Contents

Foreword xiii

Sam W. Wiesel, M.D.

Preface xv

Terry P. Corbin, B.S.B.M.E., Patrick J. Connolly, M.D.,

Hansen A. Yuan, M.D., Qi-Bin Bao, Ph.D.,

Scott D. Boden, M.D.

Part I Basic Considerations

1 Burden of Proof 3

Basic Science 4

Scott D. Boden, M.D.

Food and Drug Administration 6

Jeffrey K. Shapiro, Esq.

Reimbursement 12

Terry P. Corbin, B.S.B.M.E.

2 Technological Advances and the Dilemma of
Disabling Low Back Pain Illness 19

Eugene J. Carragee, M.D., Ivan Cheng, M.D.

Part II Biologic and Tissue Engineering

3 Biology of Spine Fusion 29

Andrew C. Hecht, M.D., Scott D. Boden, M.D.

4 Electricity: The History and Science of Bone
Growth Stimulation for Spine Fusion 53

Paul A. Glazer, M.D., Liane Clamen Glazer, M.D.

5 Structural Allografts 63

Patrick J. Connolly, M.D., Warren E.A. Wulff, M.D.

6 Demineralized Bone Matrix: Use in Spine
Surgery 71

Safdar N. Khan, M.D., Harvinder S. Sandhu, M.D., M.B.A.

7 Osteoinductive Growth Factors for Spine
Fusion 79

Bone Morphogenetic Protein-2 80

Bill McKay

Osteogenic Protein-1 98

D. Greg Anderson, M.D., Alexander R. Vaccaro, M.D.

Growth Differentiation Factor-5 104

Bobby Tay, M.D., Sigurd Berven, M.D.,

David S. Bradford, M.D.

8 Gene Therapy Approaches to Spine
Fusion 111

Charles W. Cha, M.D., Scott D. Boden, M.D.

9 Animal Models of Intervertebral Disc
Degeneration 127

S. Tim Yoon, M.D., Ph.D., William C. Hutton, D.Sc.

- 10** Disc Biology, Degeneration, and Repair Potential 143
Ezequiel H. Cassinelli, M.D., Corey James Wallach, M.D., James D. Kang, M.D.
- 11** Biologic Repair and Regeneration of the Intervertebral Disc 161
Howard S. An, M.D., Koichi Masuda, M.D., Eugene Thonar, Ph.D., M.D., Joji Mochida, M.D., Ph.D.
- 12** Intradiscal Proliferant Therapy 179
Vert Mooney, M.D., Robert G. Klein, M.D.
- 13** Spinal Cord Regeneration and Repair 195
Gwen Schwartz, M.Sc., Michael G. Fehlings, M.D., Ph.D.

Part III Surgical Navigation

- 14** Image-Guided Spinal Navigation 217
Iain H. Kalfas, M.D.
- 15** Electromagnetic Navigation 239
Henry Claude Sagi, M.D., James C. Krieg, B.S.E.E., G. Lee Beauregard, Ph.D., Tina Kapur, Ph.D., Ron von Jako, M.D.
- 16** Intraoperative Use of the CT Scan in Spine Surgery 253
Bernard A. Pfeifer, M.D., Stephen R. Freidberg, M.D.

Part IV Surgical Techniques

- 17** History of Minimally Invasive Spine Surgery 263
Parviz Kambin, M.D.
- 18** Current Minimally Invasive Surgical Techniques for the Lumbar Spine 273
Hoang Le, M.D., Tsai-Sheng Fu, M.D., Tae-Ahn Jahng, M.D., Ph.D., Daniel H. Kim, M.D.
- 19** Arthroscopic Lumbar Decompression: The Foraminal Approach 291
Anthony T. Yeung, M.D., Christopher A. Yeung, M.D.

- 20** Video-Assisted Thoracic Surgery: Thoracoscopic Deformity Correction With Fusion and Thoracic Spine Decompression 307
Peter O. Newton, M.D.
- 21** Laparoscopic Lumbar Fusions 319
Timothy A. Moore, M.D., Isador H. Lieberman, B.Sc., M.D., F.R.C.S.(C.)
- 22** Future Direction of Minimally Invasive Spine Surgery 327
Tae-Ahn Jahng, M.D., Ph.D., Hoang Le, M.D., Daniel H. Kim, M.D.
- 23** Vertebral Body Augmentation: History, Current Technique, and Future Considerations 347
John Kostuik, M.D.
- 24** Vertebral Body Augmentation: Kyphoplasty 365
Christopher M. Bono, M.D., Christopher P. Kauffman, M.D., Steve R. Garfin, M.D.
- 25** Thermomodulation 377
F. Todd Wetzel, M.D., Thomas A. McNally, M.D., Gunnar B.J. Andersson, M.D., Ph.D.
- 26** Endoscopic, Percutaneous Lumbar Discectomy With the Holmium:YAG Laser 389
Marc I. Malberg, M.D., Terry P. Corbin, B.S.B.M.E.

Spinal Implants

- 27** Minimally Invasive Surgery: Segmental Fixation Rod and Screw Technology 397
Randal R. Betz, M.D., David H. Clements, M.D., Rohinton K. Balsara, M.D., F.A.C.S., F.A.C.C.P., Peter O. Newton, M.D., Lawrence G. Lenke, M.D., Alvin H. Crawford, M.D., F.A.C.S.
- 28** Minimally Invasive Fusion Using the Endius Atavi Atraumatic Spine Surgery System 407
Michael Winer, M.D., Charles Goodwin, M.D., Charles A. Hartjen, M.D., Thomas W. Davison, Ph.D., Todd Alamin, M.D.

- 29** Design of Interbody Fusion Cages: Historical Considerations and Current Perspectives in Cage Technology 421
Bryan W. Cunningham, M.Sc., George W. Bagby, M.D., M.S., Paul C. McAfee, M.D.
- 30** Interbody Stabilization: New Innovations 445
Stephen D. Kuslich, M.D., James W. Ahern, B.Sc.
- 31** Cages: Clinical Indications and Augmentation 457
Alexander J. Ghanayem, M.D.
- 32** Anterior Thoracic and Lumbar Fixation 467
Allen Carl, M.D., John H. Velyvis, M.D.
- 33** A New Anterior Intermedullary Rod Fixation System for the Spine: The K-Centrum 475
Stephen D. Kuslich, M.D., Matthew Garner, P.A.-C.
- 34** DYNESYS: The Dynamic Neutralization System for the Spine 485
Othmar Schwarzenbach, M.D., Thomas M. Stoll, M.D., Gilles G. Dubois, M.D.
- 35** Artificial Intervertebral Disc Prostheses: An Overview 501
Henry Claude Sagi, M.D., Qi-Bin Bao, Ph.D., Hansen A. Yuan, M.D.
- 36** Artificial Discs: Clinical Results of Motion Segment Replacement 519
Stephen H. Hochschuler, M.D., Donna D. Ohnmeiss, Dr.Med.
- 37** CHARITÉ Artificial Disc Replacement 527
Paul C. McAfee, M.D., Richard D. Guyer, M.D., F.A.A.O.S.
- 38** Cervical Motion Segment Replacement 563
Vincent E. Bryan, M.D.
- 39** Porous Coated Motion Cervical Arthroplasty 573
Paul C. McAfee, M.D., Luiz Pimenta, M.D., Ph.D., Roberto Díaz Orduz, M.D., Bryan W. Cunningham, M.Sc., Anton Dmitriev, B.S., Nianbin Hu, M.D., Andrew Cappuccino, M.D.
- 40** The Raymedica Prosthetic Disc Nucleus: An Update 583
Charles Dean Ray, M.S., M.D., F.A.C.S., F.R.S.H.(Lond.)
- 41** Disc Dynamics In Situ Cured Prosthetic Intervertebral Nucleus 595
R. Garryl Hudgins, Ph.D., Qi-Bin Bao, Ph.D., Hansen A. Yuan, M.D.
- Index** 605

Disc Replacement