| WEDNESDAY  
FEBRUARY 17 | THURSDAY  
FEBRUARY 18 | FRIDAY  
FEBRUARY 19 | SATURDAY  
FEBRUARY 20 |
|-------------|-------------|-------------|-------------|
| 8:00 AM – 6:00 PM  
Registration  
Sebastian Registration | 6:00 AM – 6:00 PM  
Registration  
Sebastian Registration | 6:00 AM – 6:00 PM  
Registration  
Sebastian Registration | 6:00 AM – 12:30 PM  
Registration  
Sebastian Registration |
| 8:00 AM – 6:00 PM  
Speaker Ready Room  
Wekiwa 1 | 6:00 AM – 6:00 PM  
Speaker Ready Room  
Wekiwa 1 | 6:00 AM – 6:00 PM  
Speaker Ready Room  
Wekiwa 1 | 6:00 AM – 12:30 PM  
Speaker Ready Room  
Wekiwa 1 |
| 1:30 – 5:30 PM  
Special Course I – Coding Update and Review  
Sebastian Ballroom I-1 | 6:30 – 7:00 AM  
Continental Breakfast  
Sebastian Ballroom L | 6:30 – 6:55 AM  
Case Presentations  
Sebastian Ballroom L | 6:30 – 6:55 AM  
Case Presentations  
Sebastian Ballroom L |
| Special Course II – Masters in Spinal Surgery: What Has Experience Taught Me?  
Sebastian Ballroom I-2 | 7:00 – 9:30 AM  
Scientific Session I – Spinal Surgery Ahead of the Curve (New Technology and Techniques)  
Sebastian Ballroom L | 7:00 – 9:30 AM  
Scientific Session III: Government and Societal Influences on Spinal Surgery  
Sebastian Ballroom L | 7:00 – 8:10 AM  
Scientific Session IV: Training in Neurosurgery  
Sebastian Ballroom L |
| Special Course III – Spinal Deformity (co-sponsored by the Scoliosis Research Society)  
Sebastian Ballroom I-3 | 9:00 AM – 7:00 PM  
Exhibit Hall Open  
Sebastian Ballroom J-K | 9:00 AM – 12:00 Noon  
Exhibit Hall Open  
Sebastian Ballroom J-K | 8:30 – 9:50 AM  
David Cahill Memorial Controversies Sessions  
Sebastian Ballroom L |
| Special Course IV – Advanced MIS Techniques/Managing MIS Complications  
Sebastian Ballroom I-4 | 9:30 – 10:15 AM  
Beverage Break and What’s New Session I  
Sebastian Ballroom J-K | 9:30 – 10:15 AM  
Beverage Break and What’s New Session IV  
Sebastian Ballroom J-K | 9:50 – 10:35 AM  
Beverage Break and What’s New Session IV  
Sebastian Ballroom J-K |
| Special Course V – Management of Perioperative Pain Issues  
Wekiwa 5 | 10:15 AM – 12:30 PM  
Oral Platform Presentations I  
Sebastian Ballroom L | 10:15 AM – 12:15 PM  
Oral Platform Presentations II  
Sebastian Ballroom L | 10:35 AM – 12:05 PM  
Scientific Session IV: Training in Neurosurgery  
Sebastian Ballroom L |
| Special Course VI – Pediatric Craniocervical  
Wekiwa 3-4 | 12:30 – 1:25 PM  
Lunch and What’s New Session II  
Sebastian Ballroom J-K | 12:15 – 12:30 PM  
Annual Business Meeting  
Sebastian Ballroom L | 12:05 – 12:45 PM  
Mayfield Awards and Presentations  
Sebastian Ballroom L |
| Special Course VII – Update on Spinal Surgery in Taiwan and the Far East  
Wekiwa 6 | 3:00 – 3:45 PM  
Beverage Break and What’s New Session III  
Sebastian Ballroom J-K | 3:00 – 3:45 PM  
Beverage Break and What’s New Session III  
Sebastian Ballroom J-K | 3:45 – 5:15 PM  
Luncheon Symposium I – Revision Spine Surgery  
Sebastian Ballroom I-3 |
| 6:00 – 8:00 PM  
Opening Reception  
Gatlin Terrace | 3:45 – 5:15 PM  
Oral Poster Presentations I and II  
Sebastian Ballroom I-1&2 and L | 3:45 – 5:15 PM  
Annual Business Meeting  
Sebastian Ballroom L | 5:15 – 6:45 PM  
Luncheon Symposium V – Spinal Arthroplasty  
Wekiwa 5 |
| | 5:15 – 6:45 PM  
Reception with the Exhibitors  
Sebastian Ballroom J-K | | 5:15 – 6:45 PM  
Luncheon Symposium V – Spinal Arthroplasty  
Wekiwa 5 |
| | | | 1:30 – 5:30 PM  
Special Course VIII – Peripheral Nerve Exposures and Nerve Repair Techniques  
Sebastian Ballroom I-1 |
| | | | Special Course IX – Evaluation and Management of the Spine Trauma Patient  
Sebastian Ballroom I-2 |
## PREVIOUS MEETINGS

<table>
<thead>
<tr>
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<tr>
<td>2009</td>
<td>Phoenix, Arizona</td>
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<tr>
<td>2008</td>
<td>Lake Buena Vista, Florida</td>
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<td>Phoenix, Arizona</td>
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<td>2005</td>
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<td>2004</td>
<td>San Diego, California</td>
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<td>2003</td>
<td>Wesley Chapel, Florida</td>
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<td>2002</td>
<td>Lake Buena Vista, Florida</td>
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<td>2001</td>
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<td>2000</td>
<td>Rancho Mirage, California</td>
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<td>1999</td>
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<td>1998</td>
<td>Rancho Mirage, California</td>
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<td>1997</td>
<td>Newport Beach, California</td>
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<td>Lake Buena Vista, Florida</td>
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<td>Fort Lauderdale, Florida</td>
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<td>1993</td>
<td>Tucson, Arizona</td>
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<td>1992</td>
<td>Miami, Florida</td>
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<td>1991</td>
<td>Rancho Mirage, California</td>
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<td>1990</td>
<td>Captiva Island, Florida</td>
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<td>1989</td>
<td>Cancun, Mexico</td>
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<td>1988</td>
<td>Phoenix, Arizona</td>
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<td>1987</td>
<td>Boca Raton, Florida</td>
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<td>1986</td>
<td>San Diego, California</td>
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<tr>
<td>1985</td>
<td>Greenleaf, Florida</td>
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The AANS/CNS Section on Disorders of the Spine and Peripheral Nerves welcomes you to the 2010 Annual Meeting. Thank you for joining us here at the Rosen Shingle Creek in Orlando, Florida. This year’s meeting will deliver the most value for your time away from the office as we explore the theme *Staying Ahead of the Curve: Succeeding in Changing Times.*

The Scientific Program Committee, with our faculty of experts from across the US and around the world, has created an innovative program designed to offer unique perspectives on how the technological and regulatory developments of today will affect our specialty in the years ahead. We also hope to address how we can work together to advance spinal surgery in the face of these many changes.

This year’s program offers five Luncheon Symposia, covering topics from the treatment of the aging spine to the business aspects of spinal surgery, in addition to nine Special Courses, highlighting contemporary neurosurgical and MIS techniques, complication avoidance strategies and coding updates, including a special course focusing on Spinal Surgery in Taiwan and the Far East. Two of these Special Courses are designed specifically for nurses, nurse practitioners and physician extenders. We hope you will find time in your schedule to attend these outstanding optional educational courses.

You will also find additional educational opportunities within our exhibit hall, featuring over 60 exhibitors displaying the latest medical technology innovations. Visit with our corporate partners during your breaks to learn more about the surgical products and services available to improve your practice. Be sure to join us for daily *What’s New* Sessions, each featuring a different product or technological advancement.

Along with the outstanding educational offerings, you will also find valuable networking events throughout the week. Wednesday evening’s Opening Reception on the Gatlin Terrace and Thursday’s Reception with the Exhibitors each present an opportunity to connect with new acquaintances and old colleagues alike. Residents will also enjoy networking with other young neurosurgeons and a special presentation by the 2010 Meritorious Service Recipient, Dr. Regis W. Haid, Jr., at the Young Neurosurgeons’ Dinner on Friday evening.

Thank you again for joining us at the 2010 Annual Meeting.

Sincerely,

Christopher I. Shaffrey, MD, FACS
Chairperson

Paul G. Matz, MD
Annual Meeting Chairperson

Praveen V. Mummaneni, MD
Scientific Program Chairperson
Christopher I. Shaffrey, MD, FACS, graduated magna cum laude from The Citadel in 1982 with a BS degree in Biology. He played varsity basketball and was the co-captain his senior year. In 1986 Dr. Shaffrey received his medical degree from the University of Virginia and in 1987 he completed his general surgical internship at the Naval Hospital in San Diego, California, where he was named the surgical intern of the year. He completed both neurosurgical and orthopaedics residencies at the University of Virginia. A spine fellowship in pediatric and adult reconstructive spine surgery was completed in 1995.

Following completion of his surgical training he was appointed to the senior staff in the Departments of Neurological Surgery and Orthopaedic Surgery at Henry Ford Hospital where he was actively involved in treating members of Detroit’s college and professional athletic teams. In 1999, Dr. Shaffrey was appointed Associate Professor of Neurological Surgery and Adjunct Associate Professor of Orthopaedic Surgery and Sports Medicine at the University of Washington in Seattle. In 2003, he returned to the University of Virginia as Professor of Neurological Surgery and Director of the Neurosurgery Spine Division. In 2008, he was named Harrison Distinguished Teaching Professor of Neurological and Orthopaedic Surgery. Dr. Shaffrey is board certified in the fields of Neurological Surgery and Orthopaedic Surgery.

Dr. Shaffrey has an active research interest in spinal surgery, particularly in numerous multicenter outcome research studies of pediatric and adult scoliosis, spinal trauma and tumors involving the spinal column. He has been a funded principal investigator in numerous grants and clinical trials. He serves on the Editorial Boards of Journal of Neurosurgery, Neurosurgery® and Journal of Spinal Disorders. Dr. Shaffrey has more than 100 publications, made more than 500 national and international presentations and has served as editor for several textbooks on spinal surgery.

During his career in medicine, Dr. Shaffrey has won numerous awards for clinical medicine. He has won the Council of State Neurosurgical Societies Young Neurosurgeons Award. He has been named to the “Best Doctors” and “Top Doctors” lists numerous times. He has an active role in organized neurosurgery and spinal surgery. He is currently the Chair for the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves. He has served as the Morbidity and Mortality Committee Chair for the Scoliosis Research Society and has been named to numerous honorary academic societies including the American Orthopaedic Association, the American Academy of Neurological Surgery and the Society of Neurological Surgeons.

Presidential Address
Thursday, February 18, 8:50 AM
Spine Surgery: A Bright Future in the Era of Comparative Effectiveness

PURPOSE OF THE SPINE AND PERIPHERAL NERVES SECTION
To foster the use of spinal neurosurgical methods for the treatment of diseases of the spinal neural elements, the spine and peripheral nerves. To advance spinal neurosurgery and related sciences, improve patient care, support meaningful basic and clinical research, provide leadership in undergraduate and graduate continuing education, and promote administrative facilities necessary to achieve these goals.
MERITORIOUS SERVICE AWARD

Regis W. Haid, Jr., MD

Dr. Haid received his undergraduate degree in 1978 from the University of Notre Dame with majors in philosophy and theology, and a minor in classical literature. He received his MD at West Virginia University in 1982 with membership in Alpha Omega Alpha. He completed his neurosurgical residency in 1988 at West Virginia University. A Fellowship with Dr. Joseph Maroon in Pittsburgh, Pennsylvania was performed in 1986. In 1988–89 he was Clinical Instructor at the University of Florida, where he also completed a one year Fellowship in Spine Surgery. He served in the United States Air Force at Wilford Hall Medical Center in San Antonio, Texas from 1989–93. He joined the faculty at Emory University, Atlanta, Georgia in 1993 as Associate Professor, and was promoted to Professor in 2001. In 2003, he was a founding partner of Atlanta Brain and Spine Care, a Spinal Research Foundation Regional Center of Excellence. He is Medical Director of the Piedmont Spine Center and Neuroscience Service Line, Piedmont Hospital, Atlanta, Georgia.

A renowned educator and author, Dr. Haid has been visiting professor at 30 universities worldwide, a Course Director more than 60 times, lectured over 170 Spinal Courses, presented over 400 papers, contributed over 130 scientific articles to peer-reviewed journals, has written more than 85 chapters on the treatment of spinal disorders and is presently editing his tenth textbook.

Dr. Haid has been honored as the Richard C. Schneider Lecturer for the American Association of Neurological Surgeons; the Charles Drake Lecturer for the University of Virginia; and the Canadian Neurosurgical Society (CNSS) Penfield Lecturer for the Canadian Congress of Neurological Sciences.

Dr. Haid has served on the Editorial and Review Boards of several leading journals, including Journal of Neurosurgery, Journal of Neurosurgery-Spine, NEUROSURGERY® and Spine. Dr. Haid is a member of the SpineUniverse Editorial Board and serves on the SpineUniverse Editorial Committee.

His research interests include spinal reconstruction techniques, with a number of patents and implants concerning such techniques as cervical lateral mass plating, anterior cervical plating, posterior and transforaminal lumbar interbody fusion techniques, and cervical arthroplasty.

He has been listed in the “Best Doctors of America” since 1994, and Consumers Research of America lists him as a “Top Surgeon”. Dr. Haid is also an active member and leader within several professional neurosurgical and spinal societies, including the AANS, the CNS, the North American Spine Society, the Neurosurgical Society of America, and the Cervical Spine Research Society. He is a former Chairman.

He has also served on the Board of Directors of the Think First Foundation, the Foundation for International Education in Neurological Surgery, and the International Meeting of Advanced Spine Techniques (Scoliosis Research Society).

Dr. Haid and his wife, Betsy, have the blessing of six children: Meghan, Katie, Holly, Anna, Sam and Holly Anne; two sons-in-law, Walter and Adam, and a grandson, Will. The family shares their passion for outdoor activities, most notably in the mountains of Montana.

MERITORIOUS SERVICE AWARD RECIPIENTS
1990 – 2009

2009 Paul C. McCormick
2008 Ronald I. Apfelbaum
2007 David L. Kelly, Jr.
2006 John A. Jane, Sr.
2005 Ulrich Batzdorf
2004 Russell W. Hardy, Jr.
2003 Edward C. Benzel
2002 No Award Presented
2001 Stewart B. Dunsker
2000 Arnold H. Menezes
1999 Volker K. H. Sonntag
1998 Russell L. Travis
1997 David G. Kline
1996 No Award Presented
1995 No Award Presented
1994 Sanford J. Larson
1993 Joseph A. Epstein
1992 Charles A. Fager
1991 Frank H. Mayfield
1990 Ralph B. Cloward

YOUNG NEUROSURGEONS’ DINNER
Friday, February 19
7:00 PM
Conway Room
Rosen Shingle Creek
Special Presentation by Regis W. Haid, Jr., MD

All residents, fellows and young neurosurgeons are welcome.

RSVP to DePuy Spine, a Johnson & Johnson Company, Booth #411.

AWARDS

On pages 5–9 general information regarding section sponsored research and fellowship awards is listed. For more information, visit the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves web site at: www.spinesection.org.

RESEARCH FUNDING

The AANS/CNS Section on Disorders of the Spine and Peripheral Nerves has established three Research Grants. Depending upon the quality of the award submissions, there may be one award in each category annually.
**AWARDS AND FELLOWSHIPS**

**SANFORD LARSON RESEARCH AWARD**
The Larson Award, sponsored by DePuy Spine, a Johnson & Johnson Company, is limited to clinical research with funding up to $30,000. This research award is intended to establish funding for clinically relevant research related to the spine and peripheral nerves, to provide a means of peer review for clinical research projects to help improve the quality of the proposal and therefore, enhance competitiveness for National Institutes of Health (NIH) funding. The award is also meant to create an annual funding mechanism to establish the AANS/CNSS Section on Disorders of the Spine and Peripheral Nerves as a known source for quality clinical research aimed at answering questions pertaining to the treatment of disorders of the spine and peripheral nerves. Applicants should be residents in training or ABNS eligible fellows and must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director, a description of the proposed fellowship with the educational or research goals, and a current CV.

**Matthew J. McGirt, MD**
Dr. McGirt completed his undergraduate and medical school education at Duke University and is currently finishing his residency in Neurosurgery and spine fellowship with Dr. Ziya L. Gokaslan at Johns Hopkins. In July, Dr. McGirt will join the Neurosurgery faculty at Vanderbilt University. Dr. McGirt will be directing the Vanderbilt Spinal Surgery Outcomes Laboratory and will be studying the comparative effectiveness and cost-utility of various spinal fusion procedures for spine disease. As the recipient of the Larson Award, Dr. McGirt will be conducting a two-year prospective cohort study to 1) assess the efficacy of revision fusion procedures on pain, disability and quality of life in patients with failed back syndrome, 2) define the minimally clinically important differences in multiple outcome measures in the setting of failed back syndrome, and 3) determine the cost-utility of revision fusion for failed back syndrome.

Past Sanford Larson Research Award Recipient: 2009 – Justin M. Brown, MD

**RONALD I. APFELBAUM RESEARCH AWARD**
The Apfelbaum Award, sponsored by Aesculap, is for either basic or clinical research related to the spine with funding up to $15,000. This research award is intended to establish funding for research related to the spine, and to provide a means of peer review for clinical research projects to help improve the quality of the proposal and therefore, enhance competitiveness for National Institutes of Health (NIH) funding. The award is also meant to create an annual funding mechanism to establish the AANS/CNSS Section on Disorders of the Spine and Peripheral Nerves as a known source for quality clinical research aimed at answering questions pertaining to the treatment of disorders of the spine and peripheral nerves. Applicants should be residents in training or ABNS eligible fellows and must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director, a description of the proposed fellowship with the educational or research goals and a current CV.

**John H. Shin, MD**
Dr. Shin is currently a spine surgery fellow at the Cleveland Clinic and is pursuing a combined clinical and research fellowship. He received his undergraduate degree from Brown University and medical degree from the Chicago Medical School. In 2009, he completed neurosurgery residency at the University of Illinois at Chicago under Dr. Fady T. Charbel, during which time he developed interests in spine oncology, spinal cord injury, and spine outcomes research. Under the guidance of Dr. Michael P. Steinmetz, this research award will support his project, “Regeneration of Bladder Function following Spinal Cord Injury: A Combined Therapeutic Strategy Utilizing Macrophage Depletion, cAMP Elevation, and Neural Stem Cell Transplantation.”

Past Ronald I. Apfelbaum Research Award Recipient: 2009 – Mohammed Farid Shamji, MD, PhD
DAVID KLINE RESEARCH AWARD

The Kline Award, sponsored by Integra, is for either basic or clinical research related to peripheral nerves with funding up to $15,000. This research award is intended to establish funding for research related to the peripheral nerves, and to provide a means of peer review for clinical research projects to help improve the quality of the proposal and therefore, enhance competitiveness for National Institutes of Health (NIH) funding. The award is also meant to create an annual funding mechanism to establish the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves as a known source for quality clinical research aimed at answering questions pertaining to the treatment of disorders of the spine and peripheral nerves. Applicants should be residents in training or ABNS eligible fellows, must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director, a description of the proposed fellowship with the educational or research goals, and a current CV.

Gerald Tuite, MD

Dr. Tuite was awarded the Mayfield Award in 1993 during his neurosurgical residency at the University of Michigan. His combined spine and pediatric neurosurgical fellowship at Great Ormond Street Hospital at Queen Square was followed by a pediatric neurosurgery fellowship at Baylor College of Medicine. He practices and teaches pediatric neurosurgery at All Children’s Hospital in Saint Petersburg, Florida. He and his partners, Carolyn Carey, Bruce Storr and Luis Rodriguez, are enrolling patients in a randomized, prospective, double blinded surgical trial of the Xiaoprocedure (a “skin-CNS-bladder” procedure for the treatment of neurogenic bowel and bladder dysfunction related to spina bifida) in conjunction with their urology, neurology and physical therapy colleagues.

CAHILL FELLOWSHIP

The Cahill Fellowship, sponsored by Synthes, is awarded annually to one United States or Canadian trained neurosurgical resident to provide supplemental funding for advanced education and research in disorders of the spine or peripheral nerves in the form of fellowship training away from their parent institution. The amount of the award is $30,000. Applicants should be residents in training or ABNS eligible fellows and must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director, a description of the proposed fellowship with the educational or research goals and a current CV.

Chandan G. Reddy, MD

Dr. Reddy is a chief resident in Neurosurgery at the University of Iowa. He completed his undergraduate BA in cognitive neuroscience at Harvard University and his MD at the University of Michigan. He did an infolded epilepsy fellowship under the direction of Dr. Matthew Howard at the University of Iowa and pursued research attempting to decode movement related parameters from electrocorticographic subdural recordings in epilepsy patients. Under the auspices of the Cahill Fellowship, he will pursue fellowship training in peripheral nerve surgery with Dr. Robert Spinner. In addition to his clinical training, he wishes to pursue research at the interface between peripheral nerve surgery and neural prosthetics.

Past David Kline Research Award Recipient: 2009 – Wilson Zachary Ray, MD

Past Cahill Fellowship Recipient: 2009 – Ann Margaret Parr, MD, PhD
CLOWARD FELLOWSHIP
The Cloward Fellowship, sponsored by Medtronic, is awarded annually to one United States or Canadian trained neurosurgical resident to provide supplemental funding for advanced education and research in disorders of the spine or peripheral nerves in the form of fellowship training away from their parent institution. The amount of the award is $30,000. Applicants should be residents in training or ABNS eligible fellows and must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director, a description of the proposed fellowship with the educational or research goals and a current CV.

Helene T. Khuong, MD
Dr. Khuong completed her medical degree at Laval University in Quebec City, and will graduate from its neurosurgery program in 2010. She is also enrolled in a Clinician Investigator program, pursuing her Master’s degree. She will join Dr. Rajiv Midha for a twelve-month peripheral nerve surgery fellowship at the University of Calgary. The Cloward Fellowship will support her research work on the use of skin derived precursor stem (Schwann) cells for the augmentation of peripheral nerve repair. Dr. Khuong plans to establish a future practice focused on peripheral nerve surgery including translational research projects.

Past Cloward Fellowship Recipient: 2009 – Marie Noëlle Hébert-Blouin, MD

CROCKARD INTERNATIONAL FELLOWSHIP
The Crockard International Fellowship, sponsored by DePuy Spine, a Johnson & Johnson Company, is awarded annually to a neurosurgical resident or neurosurgeon from outside of the United States or Canada to provide supplemental funding for advanced education and research in disorders of the spine in the form of a fellowship experience in the United States or Canada. The amount of each award is $5,000. Applicants must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director if applicable, a description of the proposed fellowship with the educational or research goals and a current CV.

G. Balamurali, MBBS, MRCS, MD, FRCS(SN)
Dr. Balamurali completed his medical degree at Bangalore University, India in 1997 then moved to the United Kingdom in 1997 to complete his basic surgical training. In 2001, he entered Neurosurgical training at Northwest Deanery, Manchester and Preston. He completed his MRCS (General Surgery) and FRCS (SN) board certification exams in Neurosurgery in 2008 at the Royal College of Surgeons, Edinburgh and MD (research) degree in 2009 at the University of Central Lancashire, Preston. His research interest has been in Normal Pressure Hydrocephalus. Dr. Balamurali finished a one-year fellowship in Spine in a nationally accredited fellowship in Liverpool, UK with Dr. Gordon Findlay a very pronounced spinal surgeon in Europe. This involved operating on about 300 spinal cases of various pathologies. He has obtained more than 20 reviewed publications and presentations both nationally and internationally. His main interests currently are minimally invasive spinal surgery, cranio-cervical pathologies and intradural spinal surgery. Dr. Balamurali is looking forward to doing a fellowship with Dr. Praveen Mummaneni at UCSF Spine Center and Dr. Richard Fessler at Rush University.

Past Crockard International Fellowship Recipient: 2009 – Bassem I. Awad, MBCh
SONNTAG INTERNATIONAL FELLOWSHIP
The Sonntag International Fellowship, sponsored by Medtronic, is awarded annually to a neurosurgical resident or neurosurgeon from outside of the United States or Canada to provide supplemental funding for advanced education and research in disorders of the spine in the form of a fellowship experience in the United States or Canada. The amount of each award is $5,000. Applicants must provide a letter of acceptance from the designated mentor and program, a letter of support from their training program director if applicable, a description of the proposed fellowship with the educational or research goals and a current CV.

Payman Vahedi, MD
Dr. Vahedi is the Chief Resident of Neurosurgery at the Iman Hospital in Tabriz, Iran where he began his residency in 2005. He received his MD from Mashad Medical School in Mashad, Iran as one of the top 10% of the students. His 18-month internship included rotations at Qaem, Imam Reza, Ibn Sina, and Emdadi teaching Hospitals, Mashad University of Medical Sciences, Mashad, Iran. At Tabriz University of Medical Sciences, Dr. Vahedi was named Distinguished Best Postgraduate Researcher in 2007, 2008 and 2009 and Distinguished Best Young Researcher in 2009. Dr. Vahedi will pursue his fellowship training with Dr. Peter C. Gerszten at the University of Pittsburgh.

Past Sonntag International Fellowship Recipients: 2009 – Jau-Ching Wu, MD, Ramesh Teegala, MBBS, MCh

RESIDENT AWARDS
The Mayfield Awards are presented annually by the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves to neurosurgical residents or BC/BE fellows in North American training programs who author outstanding manuscripts detailing a laboratory or clinical investigation in the area of spinal or peripheral nerve disorders. This award is also applicable to individuals in DO training programs. The manuscript for this award is presented by attaching related information to their abstract during the abstract submission process. Two awards are available, one for clinical research and one for basic science research. Each recipient will receive a $1,000 cash award and an honorarium up to $2,000 to cover the expenses of attendance at the Annual Meeting.

MAYFIELD AWARD RECIPIENTS 1984 – 2009

2009
Basic Science: Daniel L. Master
Clinical Science: Matthew B. Masera
ti
2008
Basic Science: Ann Margaret Parr
Clinical Science: Dennis E. Cramer, Matthew M. Kang
2007
Basic Science: Sharad Rajpal
Clinical Science: Florian Roser
2006
Basic Science: Toshitaka Seki
Clinical Science: Benson Yang
2005
Basic Science: John Y. K. Lee
Clinical Science: Nicholas H. Post
2004
Basic Science: Bryan B. Barnes
Clinical Science: Michael Y. Wang
2003 No Awards Presented
2002
Basic Science: Edward R. Smith
Clinical Science: Ketan R. Bulsara
2001
Basic Science: Ketan R. Bulsara
Clinical Science: Gordon W. Tang
2000
Basic Science: Neil M. Wright
Clinical Science: Viswanathan Rajaraman
1999
Basic Science: Steven Casha
Clinical Science: Nicholas Theodore
1998 Tord D. Alden
1997 Michael A. Morone
1996
Basic Science: Paul C. Francel
Clinical Science: Paul D. Sawin
1995 Simcha J. Weller
1994 Timothy C. Ryken
1993
Basic Science: Allan D. Levi
Clinical Science: Gerald F. Tuite
1992 Rajiv Midha
1991 Peter G. Gianaris
1990 R. John Hurlbert
1988 No Award Presented
1987 John A. Feldenzer
1986 No Award Presented
1985 Abhijit Guha
1984 Mark N. Hadley

2010 MAYFIELD BASIC SCIENCE AWARD

Wilson Zachary Ray, MD
Dr. Ray is completing his residency at Washington University in St. Louis. He is currently spending two years working with Dr. Susan Mackinnon investigating the immunology of nerve allograft rejection.

Saturday, February 20, 12:05 – 12:13 PM
Role of the Direct and Indirect Pathways in Nerve Allograft Rejection
**2010 MAYFIELD CLINICAL SCIENCE AWARD**

Raqeeb Haque, MD

Dr. Haque is currently a fifth year neurosurgical resident at the Department of Neurological Surgery at Columbia University Medical Center in New York City. He was originally born in Washington D.C. and grew up in Bethesda, Maryland, where he attended Walt Whitman High School. His research interests began at that time at the National Institutes of Health, where he won numerous awards for his research on cell cycle regulatory proteins and cancer biology. Dr. Haque then attended Harvard University, where he majored in Biology and graduated with distinction and honors, and received the prestigious Harvard College Scholarship for scholastic achievement. Following his undergraduate studies, he then was accepted to the Johns Hopkins Medical School and began to develop an early interest in neurosurgery and neurological based disorders. To help develop his basic science interest in neurosurgery, he was the recipient of the Howard Hughes Medical Institute Research Fellowship and spent a dedicated year after his second year of medical school at the National Cancer Institute with Dr. Howard Fine. There, he was integral in identifying the critical role of Notch protein in glioma cell proliferation.

Dr. Haque then began his neurosurgical residency training at Columbia in 2005. As only a second year resident, he spent a year in the laboratory of Dr. John Martin, a well-renowned neuroanatomist who specializes in understanding brain and spinal cord motor pathways, and Dr. Christopher Winfree, an attending neurosurgeon at Columbia. It is during this time Dr. Haque began to study new ways to restore motor control after spinal cord injury using a peripheral nerve bridge model and received a NRSA research grant to do his research. Over the past few years, he has continued to develop this model in animal and cadaveric models, which recently culminated in an invitation to develop a clinical trial to study this novel model of bypass in spinal cord injury. His work has lead to numerous accolades, including the Synthes Spine Resident Award, the Neurosurgery Research and Education Foundation (NREF) for the study a novel delivery of nerve growth factors into the spinal cord, and the current Mayfield Clinical Research Award. Dr. Haque aspires to become an academic neurosurgeon specializing in the spine and spinal cord injuries, and will spend a year with Dr. Richard Fessler in 2012–2013 doing a Minimally Invasive Spine Fellowship.

**Saturday, February 20, 12:15 - 12:23 PM**

**Spinal Accessory and Intercostal Nervesto Bypass Spinal Cord Injury**

Raqeeb M. Haque, Michael Kellner, Martin Bauknight, Christopher P. Kellner, Kurenai Tanji, John H. Martin, Christopher J. Winfree

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**2010 OUTCOMES COMMITTEE AWARD**

The Outcomes Committee Award is presented annually by the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves to a neurosurgical resident or BC/BE neurosurgeon in North America who authors an outstanding abstract presenting the results of a clinical investigation in the area of spine or peripheral nerve disorders, that demonstrates sound methodological design and includes evaluation of patient–oriented outcomes as the primary endpoint. The recipient of this award will be selected by the members of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves Outcomes Committee. The award is a gift from the David and Jean Wallace Fund. The recipient will receive a $2,000 honorarium to help cover the expenses of attendance at the Joint Section Annual Meeting. Abstracts to be considered should be identified on the Annual Meeting abstract submission form and submitted prior to the deadline.

**Daniel C. Lu, MD**

Dr. Lu graduated from the neurosurgery residency at University of California, San Francisco (UCSF). He received his BA degree from Dartmouth College and MD–PhD degrees from University of California, San Diego (UCSD). In addition to clinical research interests in spine, his basic science research interests are neurotrauma with focus on spinal cord injury. He is currently pursuing a fellowship in minimally invasive spine surgery with Dr. Kevin Foley at Semmes–Murphey Clinic in Memphis, Tennessee.

**Saturday, February 20 12:25 - 12:33 PM**

**Multilevel ACDF with and without BMP: A Comparison of Outcomes and Dysphagia Rates in 150 Patients**

Daniel C. Lu, Dean Chou, Gerald E. Rodls, Jr., Praveen V. Mummaneni

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Past Outcomes Committee Award Recipient: 2009 – Michael G. Fehlings, MD, PhD, FRCSC, FACS
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**MEETING AGENDA**

**WEDNESDAY, FEBRUARY 17**

**1:30 – 5:30 PM  Sebastian Ballroom I-1**  
**Special Course I – Coding Update and Review**

Additional $200 for medical registrants. Includes lunch.  
**Directors:** Joseph S. Cheng, John J. Knightly  
**Faculty:** Domagoj Coric, Peter D. Angevine, Karin R. Swartz, R. Patrick Jacob, Robert R. Johnson  
**Course Description:** This course will provide up-to-date information on current issues in spine coding. Coding scenarios will be reviewed for the correct coding of routine as well as complex spinal procedures.  
**Learning Objectives:** Upon completion of this course, participants should be able to:  
- Recognize the newest changes in CPT coding for spine.  
- Review the methodology for correct spine coding.  
- Identify specific difficult coding scenarios and bring clarity to the coding process.

1:30 – 2:00 PM  
**Introduction and New Codes**  
Joseph S. Cheng, John J. Knightly

2:00 – 2:30 PM  
**Surgical Modifiers**  
Domagoj Coric

2:30 – 3:00 PM  
**22000 Series**  
John J. Knightly

3:00 – 3:30 PM  
**63000 Series**  
Peter D. Angevine

3:30 – 3:45 PM  
**Break**

3:45 – 4:15 PM  
**Peripheral Nerve Coding**  
Karin R. Swartz

4:15 – 4:45 PM  
**CPT/RUC Process**  
R. Patrick Jacob

4:45 – 5:30 PM  
**Coding Scenarios**  
Robert R. Johnson

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**1:30 – 5:30 PM  Sebastian Ballroom I-2**  
**Special Course II – Masters in Spinal Surgery: What Has Experience Taught Me?**

Additional $200 for medical registrants. Includes lunch.  
**Directors:** Regis W. Haid, Jr., Kevin T. Foley  
**Faculty:** Richard G. Fessler, Vincent C. Traynelis, Paul C. McCormick, Christopher I. Shaffrey, Robert F. Heary  
**Course Description:** This course will discuss the evolution in diagnosis and treatment of spinal disorders and surgery from the perspective of those that have extensively contributed to that evolution. Attendees will serve to gain wisdom through historical knowledge and experiential narration.  
**Learning Objectives:** Upon completion of this course, participants should be able to:  
- Discuss the evolution of spinal surgery principles and techniques.  
- Describe the treatment algorithms learned via durable experience and outcomes analysis.

1:30 – 1:35 PM  
**Welcome**

1:35 – 2:05 PM  
**Intramedullary Tumors: How Aggressive and When to Stop; Intradural-extradural Tumors: “Tricks of the Trade”**  
Paul C. McCormick

2:05 – 2:15 PM  
**Questions and Answers**

2:15 – 2:45 PM  
**How to Select the Patient and Determine the Optimal Fusion Technique**  
Robert F. Heary

2:45 – 3:00 PM  
**Questions and Answers**

3:00 – 3:30 PM  
**Decompression and Reconstruction for Complex Cervical Deformities**  
Vincent C. Traynelis

3:30 – 3:45 PM  
**Break**

3:45 – 3:55 PM  
**Questions and Answers**

3:55 – 4:25 PM  
**Lumbar Scoliosis: How High and How Low to Fuse...When to Stop**  
Christopher I. Shaffrey
1:30 – 5:30 PM  Sebastian Ballroom I-3

Special Course III – Spinal Deformity
(co-sponsored by the Scoliosis Research Society)

Additional $200 for medical registrants. Includes lunch.

Participants will receive complimentary Spinal Deformity textbook, provided through an educational grant from Globus Medical.

Directors: Christopher I. Shaffrey, Steven D. Glassman
Faculty: Lawrence Lenke, David W. Polly, Jr., Robert F. Heary, Peter D. Angevine, Tyler Koski, Sigurd Berven, Praveen V. Mummaneni, Frank LaMarca, Charles Kuntz, IV, Justin S. Smith, Todd Albert, J. Patrick Johnson, David O. Okonkwo, Ziya L. Gokaslan, Michael K. Rosner

Course Description: This course will discuss adult spinal deformity with a focus on the evaluation, classification and treatment options available to this patient population. Non-surgical management options will be noted but emphasis will be placed on surgical correction principles and techniques. Complication management and operative outcomes will be emphasized.

Learning Objectives: Upon completion of this course, participants should be able to:

- Discuss the evaluation and classification of adult spinal deformity.
- Identify the various treatment indications and options for adult spinal deformity.
- Describe the unique complication avoidance strategies employed during spinal deformity surgery.

1:25 – 1:30 PM  Welcome
Christopher I. Shaffrey, Steven D. Glassman

Segment #1 – Evaluation of the Adult Deformity Patient
Moderators: Christopher I. Shaffrey, David W. Polly, Jr.

1:30 – 1:45 PM  Radiographic Evaluation of the Adult Deformity Patient: Importance of Global Balance and Pelvic Parameters
Charles Kuntz, IV

2:30 – 2:45 PM  Posterior Osteotomies: When Have You Done Enough?
Lawrence Lenke

2:45 – 3:00 PM  Anterior Surgical Options: Releases and/or Instrumentation
Peter D. Angevine

3:00 – 3:15 PM  Fixation Options in Osteoporotic Spine Deformity
David W. Polly, Jr.

3:15 – 3:30 PM  Sacro-pelvic Fixation: When and How
Praveen V. Mummaneni

3:30 – 3:45 PM  Break

3:45 – 4:00 PM  The Role of Decompression in Deformity Surgery: Does Realignment Solve the Problem?
Justin S. Smith

4:00 – 4:15 PM  Questions and Discussion

Segment #3 – Application of Deformity Management Concepts: Case Discussions

4:15 – 4:45 PM  Panel 1: How Lumbar Degenerative Cases Turn into Deformity Problems
Moderators: Todd Albert, J. Patrick Johnson

Case Discussion
Frank LaMarca

Case Discussion
David O. Okonkwo
Case Discussion
Robert F. Heary
4:45 – 5:15 PM
Panel 2: Management of Intraoperative Problems in Deformity Cases
Moderators: Lawrence Lenke, Ziya L. Gokaslan

Case Discussion
Todd Albert

Case Discussion
Steven D. Glassman

Case Discussion
Michael K. Rosner

Segment #4 – Joint Section and the SRS/Neurosurgeons and Spinal Deformity Surgery
5:15 – 5:30 PM
Questions and Discussion
Christopher I. Shaffrey, Lawrence Lenke

1:30 – 5:30 PM  Sebastian Ballroom I–4
Special Course IV – Advanced MIS Techniques/Managing MIS Complications
Additional $200 for medical registrants. Includes lunch.
Directors: Michael Y. Wang, Langston T. Holly
Faculty: Adam S. Kanter, Justin S. Smith, Paul Park, Daniel J. Hoh, Anthony Frempong-Boadu, Farbod Asgarzadie
Course Description: This course will discuss contemporary data and experience through MIS case-based, interactive, didactic presentations. Faculty will discuss their evaluation and treatment algorithms regarding minimally invasive vs. open surgical options to maximize complication avoidance. Focus will be given to cases initially treated minimally invasively with immediate or subsequent necessity for open conversion.
Learning Objectives: Following completion of this special course, participants should be able to:
➤ Discuss the indications for minimally invasive spinal surgery.
➤ List the techniques available for minimally invasive surgery.
➤ Describe strategies for complication avoidance.

1:30 – 1:45 PM
Introduction
Langston T. Holly, Michael Y. Wang

1:45 – 2:05 PM
Minimally Invasive Thoracic Discectomy
Adam S. Kanter

2:05 – 2:20 PM
Minimally Invasive Lumbar Interbody Fusion
Farbod Asgarzadie

2:20 – 2:55 PM
Minimally Invasive Atlantoaxial Fusion
Anthony Frempong-Boadu

2:55 – 3:15 PM
Managing Complications in Obese Patients in MIS
Paul Park

3:15 – 3:30 PM
Questions and Discussion
Christopher I. Shaffrey, Lawrence Lenke

3:30 – 3:45 PM
Break

3:45 – 4:15 PM
Minimally Invasive Scoliosis Surgery
Justin S. Smith

4:15 – 4:45 PM
Special Course V – Management of Perioperative Pain Issues
Special Course for Nurses, Nurse Practitioners and Physician Extenders.
Additional $110 for medical registrants. Includes lunch.
Directors: Michael P. Steinmetz, Andrea L. Strayer, MSN, CNRN, ACNP
Faculty: Sanjay S. Dhall, Luis M. Tumialan, Olawale Sulaiman, Krista Mousled, NP, Denise K. Brost, NP, Daniel J. Hoh
Course Description: This course will discuss perioperative pain issues with emphasis on up-to-date practical bedside and outpatient management strategies, with a target audience of nurses, nurse practitioners and physician extenders. Expert practice nurses, physician extenders and neurosurgeon faculty will explore the challenges of caring for our increasingly complex patient population.
Learning Objectives: Upon completion of this course, participants will be able to:
➤ Discuss general postoperative pain issues following spinal surgery.
➤ Analyze the indications for postoperative diagnostic studies in patients with extraordinary pain issues following spinal surgery.
➤ Review care considerations for postoperative pain remote from the surgical site (e.g., voiding difficulties, constipation, etc.).

Physician attendees will not be awarded CME credit for this course. Nursing contact hours may be provided through AANN. The American Association of Neuroscience Nurses is accredited as a provider of continuing nursing education by...
the American Nurses Credentialing Center’s Commission on Accreditation.

Physician assistants/physician extenders will need to contact their individual membership association and certification board to determine the requirements for accepting credits. All attendees will receive a certificate of attendance.

1:30 – 2:00 PM
Pain Pathophysiology; Postoperative Pain; Spine Pain
Sanjay S. Dhall

2:00 – 2:20 PM
Mechanisms of Action for Various Analgesics Including Voiding Issues, Constipation Prevention
Daniel J. Hoh

2:20 – 2:40 PM
NSAIDS, Review, Contraindications, Options
Denise Brost, NP

2:40 – 2:50 PM
IV vs. Epidural PCA
Luis M. Tumialan

3:05 – 3:30 PM
Do Minimal Access Surgical Patients Have Less Pain?
Michael P. Steinmetz

3:30 – 3:45 PM
Break

3:45 – 4:30 PM
Red Flags What Studies, When – Including Cases
Olawale Sulaiman

4:30 – 5:00 PM
Healing Services
Krista Moustic, NP

5:00 – 5:30 PM
Multimodal Therapy
Andrea L. Strayer, MSN, CNRN, ACNP

1:30 – 5:30 PM
Special Course VI – Pediatric Cranio-Cervical

Additional $200 for medical registrants. Includes lunch.

Directors: Douglas L. Brockmeyer, Francesco T. Mangano
Faculty: Richard C. E. Anderson, Nicholas M. Wetjen, Luis Rodriguez, Keyne K. Johnson, Tord Alden

Course Description: This course will serve as a symposium for those with an interest in pediatric cranio-cervical abnormalities and disease. It seeks to examine issues related to the management of pediatric cranio-cervical disease including surgical and non-surgical treatment, complication management and disease pathophysiology.

Learning Objectives: Upon completion of this course, participants should be able to:
- Discuss appropriate management of complex pediatric craniospinal disorders.
- Discuss appropriate research strategies to further the care of patients with craniospinal disorders.
- Understand the mechanism involved in the pathophysiology and progression of pediatric cranio-cervical disease.

1:30 – 3:00 PM
Roundtable Discussion and Presentations

3:00 – 3:10 PM
Welcome and Address by President of the Taiwan Neurospinal Society
Robert Yung-Hsiao Chiang

3:10 – 3:30 PM
Neuroregeneration Study and Clinical Application in Spinal Cord Injury Patients – Taiwan Experience
Lecturer: Henrich Cheng
Moderator: Robert Yung-Hsiao Chiang

1:30 – 1:35 PM
Welcome and Address by President of the Taiwan Neurospinal Society
Robert Yung-Hsiao Chiang

1:35 – 1:55 PM
Neuroregeneration Study and Clinical Application in Spinal Cord Injury Patients – Taiwan Experience
Lecturer: Henrich Cheng
Moderator: Robert Yung-Hsiao Chiang

1:55 – 2:15 PM
Surgical Viewpoint for Cervical OPLL – Personal Experience
Lecturer: Tzu-Yung Chen
Moderator: Jau-Ching Wu
### MEETING AGENDA

#### THURSDAY, FEBRUARY 18

<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Lecturer</th>
<th>Moderator</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:15 – 2:30 PM</td>
<td>Fusion of Cervical Radiolucent Cages Evaluated by Thin Section Helical CT</td>
<td>Cheng-Kuei Chang</td>
<td>Ham-Min Tseng</td>
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<tr>
<td>2:30 – 2:45 PM</td>
<td>Application of Cervical Laminoplasty with Miniplates and Screws</td>
<td>Chih-Ju Chang</td>
<td>Sheng-Huang Hsiao</td>
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<tr>
<td>2:45 – 3:00 PM</td>
<td>Posterior Vertebral Bridging Undercutting for Segmental Cervical OPLL – Technique Note</td>
<td>Lin-Hsue Yang</td>
<td>Jui-Feng Lin</td>
</tr>
<tr>
<td>3:00 – 3:15 PM</td>
<td>SRS for IMSC</td>
<td>Jia-Wei Lin</td>
<td>Chih-Ju Chang</td>
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<tr>
<td>3:15 – 3:30 PM</td>
<td>Management of C1/2 Subluxation by Articular Screws</td>
<td>Dar-Ming Lai</td>
<td>Hsu-Tung Lee</td>
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<tr>
<td>3:30 – 3:45 PM</td>
<td>Break</td>
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<tr>
<td>3:45 – 4:00 PM</td>
<td>A Comparison of Clinical and Mage Outcome between Patients with Cervical Spondylosis Undergoing Open-Door Laminoplasty and Wide Laminectomy</td>
<td>Ming-Yang Lee</td>
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<tr>
<td>4:00 – 4:15 PM</td>
<td>Incidence of Heterotopic Ossification after Cervical Disc Replacement: Is X-ray Good Enough to Tell?</td>
<td>Wen-Cheng Huang</td>
<td>Cheng-Kuei Chang</td>
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<tr>
<td>4:15 – 4:30 PM</td>
<td>Cervical Artificial Disc – Personal Experience</td>
<td>Ming-Yang Lee</td>
<td>Tzu-Yung Chen</td>
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<tr>
<td>4:30 – 4:45 PM</td>
<td>Experiences in Interspinous Device–Coflex in Degenerative Lumbar Disease</td>
<td>Chao-Jan Wang</td>
<td>Wen-Cheng Huang</td>
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<tr>
<td>4:45 – 5:00 PM</td>
<td>The Outcome after Interspinous Device–Coflex in Usage for 2-Year Follow-up</td>
<td>Dar-Yu Yang</td>
<td>Hsin-I Ma</td>
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<tr>
<td>5:00 – 5:20 PM</td>
<td>Minimal Invasive Spine Surgery for Degenerative Unstable Spine Disease</td>
<td>Robert Yung-Hsiao Chiang</td>
<td>Henrich Cheng</td>
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<tr>
<td>5:20 – 5:30 PM</td>
<td>Closing Remarks by Honor President of the Taiwan Neurospinal Society</td>
<td>Henrich Cheng</td>
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<tr>
<td>6:00 – 8:00 PM</td>
<td>Opening Reception</td>
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<td></td>
<td>Opening Reception</td>
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<td></td>
<td>Network with old colleagues and new acquaintances on the beautiful Gatlin Terrace during a relaxed evening overlooking the lush landscape of the Rosen Shingle Creek. Dine on a delicious assortment of food and beverages as you mingle and enjoy an evening under the stars. Please note this event is held outdoors.</td>
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#### 6:30 – 6:55 AM  Sebastian Ballroom L
**Case Presentations**

**Moderators:** Eve C. Tsai, Charles A. Sansur

#### 6:55 – 7:00 AM  Sebastian Ballroom L
**Introductory Remarks and Meeting Announcements**

**Paul G. Matz**

#### 7:00 – 9:30 AM  Sebastian Ballroom L
**Scientific Session I – Spinal Surgery Ahead of the Curve (New Technology and Techniques)**

**Moderators:** Praveen V. Mummamani, Paul G. Matz  
**Session Description:** This Scientific Session will critically review newly introduced surgical technologies and techniques via analysis of randomized controlled trials and IDE studies in reference to practical clinical implications. Currently available technologies and rapidly evolving experimental techniques will be discussed, including the...
evolution of motion preservation and minimally invasive surgical practices. 

Learning Objectives: Upon completion of this course, participants should be able to:

- List the results of new randomized controlled clinical trials.
- Describe how those clinical trials will affect similar patients seen in the practitioner’s clinical practice.
- Discuss new treatments and technologies with attention to motion preservation and minimally invasive surgical techniques.

7:00 AM
Looking Ahead in Peripheral Nerve Surgery
Lynda J-S. Yang

7:15 AM
Looking Ahead in Spinal Cord Repair
Michael G. Fehlings

7:30 AM
Looking Ahead in MIS Surgery
Michael Y. Wang

7:45 AM
Looking Ahead in Degenerative Disc Disease
Domagoj Coric

8:00 AM
Looking Ahead in Extradural Spinal Oncology
Ziya L. Gokaslan

8:15 AM
Looking Ahead in Intradural Spinal Oncology
Paul C. McCormick

8:30 AM
Looking Ahead in Spinal Deformity Surgery
Lawrence Lenke

8:45 AM
Introduction of Section Chairman
Praveen V. Mummaneni

8:50 AM
Presidential Address – Spine Surgery: A Bright Future in the Era of Comparative Effectiveness
Christopher I. Shaffrey

9:05 AM
Introduction of Meritorious Award Winner
Mark R. McLaughlin

9:10 AM
Meritorious Award Presentation – There is Always a Curve ... How to “Be Successful”
Regis W. Haid, Jr.

9:30 – 10:15 AM
Sebastian Ballroom J-K
Beverage Break with Exhibitors
What's New Session I
Moderators: Dean Chou, Daryl R. Fourney

10:15 AM – 12:30 PM
Sebastian Ballroom L
Oral Platform Presentations I

Moderators: Justin S. Smith, Michael W. Groff


10:15 – 10:24 AM
100. Is Surgical Treatment for Mild Cervical Spondylotic Myelopathy Effective? One-year Outcomes of AOSpine North America CSM Multi-center Prospective Study
Michael G. Fehlings, Branko Kopjar, Paul M. Arnold, Tim Yoon, Alexander R. Vaccaro, Eric J. Woodard, Darrel S. Brodke, Jens Chapman, Christopher I. Shaffrey, Michael Janssen, Rick Sasso

10:24 – 10:27 AM
Discussant: Gregory R. Trost

10:27 – 10:36 AM
101. Comparative Effectiveness of Ventral vs. Dorsal Surgery for Cervical Spondylotic Myelopathy
Zoher Ghogawala, Edward C. Benzel, Subu N. Magge, Khalid M. Abbed, Ronald I. Apfelbaum, Javed Shahid, Jean-Valery Coumans, Tanvir Choudhri, Robert F. Heary

10:36 – 10:39 AM
Discussant: Daniel K. Resnick

10:39 – 10:48 AM
102. Endoscopic Endonasal Resection of the Odontoid Process: Clinical Outcomes
Matthew J. Tormenti, Ricky Madhok, Amin B. Kassam, Carl Snyderman, Richard M. Spiro, Ricardo Carrau, Paul A. Gardner

10:48 – 10:51 AM
Discussant: Joseph T. Alexander
10:51 – 11:00 AM
103. Complications in the Surgical Treatment of 19,956 Cases of Pediatric Scoliosis: A Review of the Scoliosis Research Society Database
Davis Reames, Kai-Ming G. Fu, Justin S. Smith, David W. Polly, Jr., Sigurd Berven, Joseph Perra, Oheneba Boachie-Adjei, Christopher I. Shaffrey

11:00 – 11:03 AM
Discussant: Michael W. Groff

11:03 – 11:16 AM
Discussion

11:16 – 11:25 AM
104. Phase II Study for New Medical Techniques in Patients with Chronic Spinal Cord Injury
Henrich Cheng, Jau-Ching Wu, Wen-Cheng Huang

11:25 – 11:28 AM
Discussant: R. John Hurlbert

11:28 – 11:37 AM
105. FDA IDE Prospective Randomized Comparison of Three Lumbar Artificial Disc Replacements (ADR) with Minimum Three-year Follow-up
Kenneth Pettine

11:37 – 11:40 AM
Discussant: Anthony Frempong-Boadu

11:40 – 11:49 AM
106. Acidic Fibroblast Growth Factor in Brachial Plexus Injury and Common Peroneal Nerve Injury
Henrich Cheng, Jau-Ching Wu, Wen-Cheng Huang

11:49 – 11:52 AM
Discussant: Eric L. Zager

11:52 AM – 12:01 PM
107. Complications Associated with BMP Use in 11,281 Cases of Spinal Fusion
Brian Jeremy Williams, Kai-Ming G. Fu, Justin S. Smith, David Kojo Hamilton, Joseph Perra, David W. Polly, Jr., Sigurd Berven, Oheneba Boachie-Adjei, Christopher I. Shaffrey

12:01 – 12:04 PM
Discussant: Christopher E. Wolfla

12:04 – 12:13 PM
108. Rate of Return to Military Active Duty after Single Level Lumbar Interbody Fusion: A 5 year Retrospective Review
Luis M. Tumialan, Ryan Ponton, Anthony I. Riccio, Wayne Gluf

12:13 – 12:16 PM
Discussant: Michael G. Kaiser

12:16 – 12:30 PM
Discussion

12:30 – 1:25 PM
Sebastian Ballroom J–K
Lunch with Exhibitors

What’s New Session II
Moderators: Michael P. Steinmetz, Anthony Frempong-Boadu

1:25 – 1:30 PM
Sebastian Ballroom L
Meeting Announcements

1:30 – 3:00 PM
Sebastian Ballroom L
Scientific Session II – Spinal Surgery Complication Avoidance and Management

Moderators: Andrew T. Dailey, Robert F. Heary
Session Description: This course will address the complications encountered in a case-based format with attention to management techniques and learned avoidance strategies. Cases will specifically address complications encountered during minimally invasive procedures, anterior approach fusions, intraoperative spinal cord injuries, junctional kyphosis and postoperative infections.

Learning Objectives: Upon completion of this course, participants should be able to:

► Identify risk factors associated with spinal surgery complications.
► Discuss intra- and postoperative management strategies following spinal cord injuries.
► Identify a practical treatment algorithm for managing postoperative osteomyelitis.
► Recognize postoperative instability/deformity such as fusion failures and junctional kyphosis.

1:30 PM
Complication Avoidance and Management in Minimally Invasive Spine Surgery
Adam S. Kanter, Richard G. Fessler

1:40 PM
Complication Avoidance and Management with Multilevel ALIF Case
Brian R. Subach, David W. Polly, Jr.

1:50 PM
Complication Avoidance and Management with Global Balance Postoperative Case
Peter D. Angevine, Charles Kuntz, IV

2:00 PM
Complication Avoidance and Management with Intraoperative Spinal Cord Injury Case
David O. Okonkwo, Michael G. Fehlings

2:10 PM
Complication Avoidance and Management with Proximal Junctional Kyphosis Case
Frank LaMarca, Steven D. Glassman
2:20 PM  
Complication Avoidance and Management with Spinal Trauma Case  
Sanjay S. Dhall, James S. Harrop

2:30 PM  
Complication Avoidance and Management with Postoperative Osteomyelitis Case  
Dean Chou, Gerald E. Rodts, Jr.

3:00 – 3:45 PM  
Sebastian Ballroom J-K  
Beverage Break with Exhibitors

What’s New Session III  
Moderators: Sanjay S. Dhall, Andrew C. Roeser

3:45 – 5:15 PM  
Sebastian Ballroom L  
Oral Poster Presentations I  
(Concurrent Session)

Moderators: David O. Okonkwo, Adam S. Kanter

3:45 – 3:50 PM  
200. Minimal Access Surgery for the Correction and Treatment of Adult Degenerative Scoliosis  
Michael Y. Wang, Matthew D. Cummock

3:50 – 3:55 PM  
201. Efficacy and Safety of Large Doses of Tranexamic Acid in Spine Surgery: Randomized Placebo-controlled Study  
Sherif M.F. El-Watidy, Essam Elgamal, Zain Alabedeen Jamjoom

3:55 – 4:00 PM  
Scott Parker, Matthew J. McGirt, Anubhav Amin, S. Harrison Farber, Ali Bydon, Daniel M. Sciubba, Jean-Paul Wolinsky, Ziya L. Gokaslan, Timothy F. Witham

4:00 – 4:05 PM  
203. Accuracy of Free Hand Pedicle Screws in the Thoracic and Lumbar Spine: Analysis of 6,816 Consecutive Screws  
Scott Parker, Matthew J. McGirt, Anubhav Amin, S. Harrison Farber, Anne-Marie Rick, Ali Bydon, Daniel M. Sciubba, Jean-Paul Wolinsky, Ziya L. Gokaslan, Timothy F. Witham

4:05 – 4:10 PM  
204. Surgical Factors Associated with Recurrent Back Pain and Cyst Recurrence after Surgical Resection of Spinal Synovial Cysts: Analysis of 160 Consecutive Cases  
Scott Parker, Matthew J. McGirt, Risheng Xu, Jean-Paul Wolinsky, Timothy F. Witham, Ziya L. Gokaslan, Ali Bydon

4:10 – 4:15 PM  
Discussion

4:15 – 4:20 PM  
205. A Revised Spinal Instability Neoplastic Score (SINS): Final Results of a Validity and Reliability Analysis  
Daryl R. Fourney, Evan Mark Frangou, Timothy C. Ryken, Charles Fisher

4:20 – 4:25 PM  
206. C5 Radiculopathy as a Complication of Cervical Spine Surgery  
James Richman, Kenneth Defontes, Hasan Zaidi, Timothy Flerlage, Camilo A. Molina, Wesley Hsu, Ali Bydon, Ziya L. Gokaslan, Timothy F. Witham, Jean-Paul Wolinsky, Daniel M. Sciubba

4:25 – 4:30 PM  
207. Non-operative Management of Odontoid Fractures: A Review of 101 Cases  
Elias Rizk, Jonas Sheehan, G. Timothy Reiter, James McInerney, John Paul Kelleher

4:30 – 4:35 PM  
208. International Differences in Preference for Timing of Surgical Intervention in Spinal Cord Injury  
Doron Rabin, Michael G. Fehlings, William Sears, David W. Cadotte, Bizhan Aarabi

4:35 – 4:40 PM  
209. Biomechanical Comparison of C7 Lateral Mass vs. Pedicle Screws in Subaxial Cervical Constructs  
Risheng Xu, Matthew J. McGirt, Edward Grant Sutter, Scott Parker, Daniel M. Sciubba, Jean-Paul Wolinsky, Timothy F. Witham, Ziya L. Gokaslan, Ali Bydon

4:40 – 4:45 PM  
Discussion

4:45 – 4:50 PM  
210. Treatment of Gait and Sensory Changes in Experimental Disc Herniation Radiculopathy by Local and Sustained Anticytokine Delivery  
Mohammed F. Shamji, Kyle D. Allen, Mosfata Gabr, Samuel B. Adams, Brian Mata, Junn Chen, Liufang Jing, William J. Richardson, Lori A. Setton

4:50 – 4:55 PM  
211. Treatment with Combined Immunomodulatory Therapy Results in Early Bladder Recovery after Experimental Spinal Cord Injury  
Daniel J. Hoh, Christopher A. Iannotti, Hai-Hong Jiang, Ran Harel, Megan Clark, John H. Shin, Nico van Rooijen, Margot Damaser, Michael P. Steinmetz

4:55 – 5:00 PM  
212. Clinical and Radiographic Outcomes of C2 Translaminar Screw Fixation  
Ian G. Dorward, Neil Marshall Wright
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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</table>
| 2:00 – 2:05 PM | 213. Functional Organization and Behavioral Significance of the Rostral Spinocerebellar System in Primates  
Ran Harel, Nofya Zinger, Oren Cohen, Yifat Prut |
| 2:05 – 2:10 PM | 214. The Result of Early Decompression for Acute Traumatic Central Cord Syndrome  
Insoo Kim |
| 2:10 – 2:15 PM | Discussion |

3:45 – 5:15 PM  
Sebastian Ballroom I-1 & 2  
Oral Poster Presentations II  
(Concurrent Session)  

Moderators: Eve C. Tsai, Daniel M. Sciubba

<table>
<thead>
<tr>
<th>Time</th>
<th>Poster Presentations II</th>
</tr>
</thead>
</table>
| 3:45 – 3:50 PM | 215. Dynesys for Degenerative Spondylolisthesis: Clinical Trial of Dynesys Alone vs. Dynesys with Adjunct Decompression with or without Fusion  
Fras Dakhil-Jerew, John Shepperd |
| 3:50 – 3:55 PM | 216. A Retrospective Case-study of Post-traumatic Syringomyelia  
Youssef Karam |
| 3:55 – 4:00 PM | 217. Minimally Invasive Anterior Lumbar Interbody Fusion followed by Percutaneous Pedicle Screw Fixation for Isthmic Spondylolisthesis: Minimum 5-year Follow-up  
Jin-Sung Kim, Won Gyu Choi, Sang-Ho Lee |
| 4:00 – 4:05 PM | 218. Selective Treatment of Thoracic Curve by VEPTR in the Growing Spine: What Happens to the Lumbar Curve?  
Amer F. Samdani, John K. Birknes, Reed Williams, Norman Ramirez, John M. Flynn, Randal Betz |
Amer F. Samdani, Jahangir Asghar, Patrick Cahill, David Clements, Darryl Antonacci, Peter Newton, Randal Betz, Harms Study Group |
| 4:10 – 4:15 PM | Discussion |

4:15 – 4:20 PM  
220. Complications of Transforaminal Lumbar Interbody Fusion: A Single Center Experience  
Matthew J. Tomenti, Matthew B. Maserati, Christopher Michael Bonfield, Peter C. Gerszten, John Jefferson Moossy, Richard M. Spiro, Adam S. Kanter, David O. Okonkwo
### FRIDAY, FEBRUARY 19

#### 6:30 – 6:55 AM  
**Sebastian Ballroom L**  
**Case Presentations**

*Moderators:* Laurence D. Rhines, Daryl R. Fourney

#### 6:55 – 7:00 AM  
**Sebastian Ballroom L**  
**Meeting Announcements**

#### 7:00 – 9:00 AM  
**Sebastian Ballroom L**  
**Scientific Session III: Government and Societal Influences on Spinal Surgery**

*Moderators:* Christopher E. Wolfia, Michael K. Rosner  
*Session Description:* This Scientific Session will critically review the socioeconomic impact of spinal surgery by examining a variety of domestic and international healthcare reimbursement systems. It will further evaluate the comparative effectiveness of spinal research, resident training and the influence of industrial sponsorship. Additionally, the Washington Report on spinal surgery will be critically evaluated.

*Learning Objectives:* Upon completion of this course, participants should be able to:
- Discuss the socioeconomic impact of spinal surgery on society.
- Evaluate the influence of industrial sponsorship in spine surgery.
- Discuss the various approaches to healthcare reimbursement and medical liability.
- Discuss spinal surgery resident training and the impact of recent work hour restrictions.

#### 7:00 AM  
**The Changing Landscape of Reimbursement**  
Joseph S. Cheng

#### 7:15 AM  
**Comparative Effectiveness Research**  
Daniel K. Resnick

#### 7:30 AM  
**Managing Relationships with Industry**  
Edward C. Benzel

#### 7:45 AM  
**Questions**

#### 8:00 AM  
**The State of Medical Liability Reform: Success and Challenges for the Future**  
Kalie O. Orrico, JD

#### 8:15 AM  
Troy M. Tippett

#### 8:30 AM  
**An International Comparison of Health Care Systems, Payment and Cost Control**  
James R. Bean

#### 8:45 AM  
**Questions**

#### 9:00 – 9:30 AM  
**Sebastian Ballroom L**  
**Fellowship Awards and Clinical Trials Awards**

*Moderators:* Marjorie C. Wang, Adam S. Kanter

#### 9:30 – 10:15 AM  
**Sebastian Ballroom J-K**  
**Beverage Break with Exhibitors**

*What’s New Session IV*  
*Moderators:* Nirav K. Shah, Harel Deutsch

#### 10:15 AM – 12:15 PM  
**Sebastian Ballroom L**  
**Oral Platform Presentations II**

*Moderators:* Gregory R. Trost, Eric J. Woodard  

#### 10:15 – 10:24 AM  
**109. Loss of Correction Does Not Influence Clinical Outcome following Anterior Cervical Fusion. Final Clinical Results of a Multicenter Randomized Controlled Study**  
Tobias Pilzen

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5:05 – 5:10 PM  
229. Changes in Coronal and Sagittal Plane Alignment following Minimally Invasive Direct Lateral Interbody Fusion for the Treatment of Adult Degenerative Lumbar Disease  
Frank L. Acosta, Jr., John C. Liu, Nicholas P. Slimack, David J. Moller, Stephen L. Ondra, Richard G. Fessler, Tyler R. Koski

5:10 – 5:15 PM  
**Discussion**

### 5:15 – 6:45 PM  
**Sebastian Ballroom J-K**  
**Reception with the Exhibitors**

Join us for this special event in the exhibit hall! Attendees will have the opportunity to interact with exhibiting companies while enjoying cocktails and hors d’oeuvres with colleagues.
10:24 – 10:27 AM
Discussant: Paul C. McCormick

10:27 – 10:36 AM
110. Correlation of C2 Fractures and Vertebral Artery Injury

10:36 – 10:39 AM
Discussant: J. Patrick Johnson

10:39 – 10:48 AM
111. Cervical Laminoplasty vs. Instrumented Posterior Cervical Fusion for Cervical Spondylotic Myelopathy
Sanjay S. Dhall, Jason M. Highsmith, Regis W. Haid, Jr., Gerald E. Rodts, Jr., Praveen V. Mummaneni

10:48 – 10:51 AM
Discussant: John J. Knightly

10:51 – 11:00 AM
112. A Prospective, Randomized Trial Comparing Expansile Cervical Laminoplasty vs. Cervical Laminctomy and Fusion for Multi-level Cervical Compressive Myelopathy
Allan D. Levi, Gizelda T. Casella, Michael Y. Wang, Steven Vanni, Glen R. Manzano

11:00 – 11:03 AM
Discussant: Michael G. Kaiser

11:03 – 11:12 AM
113. Prospective, Non-randomized, Multi-center Clinical Evaluation of Extreme Lateral Interbody Fusion (XLIF) in the Treatment of Adult Scoliosis

11:12 – 11:15 AM
Discussant: Robert F. Heary

11:15 – 11:24 AM
114. Prospective Randomized Series Comparing Maverick™ Lumbar Total Disc Replacement (TDR) with Anterior Lumbar Interbody Fusion (ALIF) with Five-Year Follow-up
Kenneth Pettine

11:24 – 11:27 AM
Discussant: Zoher Ghogawala

11:27 – 11:36 AM
Jason A. Ellis, Michael Castelli, Peter D. Canoll, Jeffrey N. Bruce, Alfred T. Ogden

11:36 – 11:39 AM
Discussant: Paul G. Matz

11:39 – 11:48 AM
Peter Campbell, Jennifer Malone, Sanjay Yadla, Mitchell G. Maltenfort, Ashwini D. Sharan, James S. Harrop, John K. Ratliff

11:48 – 11:51 AM
Discussant: Frank LaMarca

11:51 AM – 12:00 PM
117. An Analysis of Postoperative Thigh Symptoms after Transpsoas Interbody Fusion
Matthew D. Cummock, Steven Vanni, Yong Yu, Michael Y. Wang

12:00 – 12:03 PM
Discussant: Charles L. Branch, Jr.

12:03 – 12:15 PM
Discussion

12:15 – 12:30 PM
Annual Business Meeting
Ziya L. Gokaslan

12:30 PM
Lunch on your own.

12:30 – 2:30 PM
Luncheon Symposium I – Revision Spine Surgery
Additional $200 for medical registrants. Includes lunch.

Directors: Iain H. Kalfas, Michael W. Groff
Faculty: Timothy Ryken, David O. Okonkwo

Course Description: This course will provide state-of-the-art information on complication avoidance during revision spine surgery. Faculty will review their clinical experience and lessons learned via interactive case discussions.

Learning Objectives: Upon completion of this seminar, participants should be able to:
► Explain the management issues unique to revision surgery.
► List the common reasons for spinal instrumentation failure.
► Discuss the management of recurrent spinal conditions such as restenosis and reherniation.
► Identify strategies for the management of postoperative deformity and adjacent segment failure.

12:30 – 12:45 PM
Biomechanics of Spinal Instrumentation Failure
Timothy Ryken
### Management of Recurrent Lumbar Stenosis and Disc Herniation
David O. Okonkwo

### Management of Adjacent Segment Failure
Michael W. Groff

### Management of Iatrogenic Cervical Deformity
Iain H. Kalfas

### Break

### Case Presentations and Discussion

**12:30 – 2:30 PM  Sebastian Ballroom I–IV**

**Luncheon Symposium II – Neurosurgeon as CEO: Business Aspects of Spinal Surgery**

Additional $200 for medical registrants. Includes lunch.

**Directors:** John J. Knightly, Domagoj Coric  
**Faculty:** Mark R. McLaughlin, Robert F. Heary  
**Course Description:** This course will examine neurosurgery from the philosophy of the small business operation. It will review the basics of revenue generation, transactions with third-party payors, marketing, and operations including management of expenses and personnel.  
**Learning Objectives:** Upon completion of this course, participants should be able to:  
- Understand the mechanisms of revenue generation as well as critically examine future scenarios to change in revenue generation.  
- Critically examine operations including costs, personnel and efficiency.  
- Discuss different management paradigms for small business.

### Revenue Generation: Ancillary Income – Surgicenter/Imaging Center
Domagoj Coric

### Discussion

### Third Party Payors – Negotiations
John J. Knightly

### Break

**12:30 – 2:30 PM  Wekiwa 6**

**Luncheon Symposium III – Treatment of Primary and Metastatic Spine Tumors**

Additional $200 for medical registrants. Includes lunch.

**Directors:** Ehud Mendel, Ziya L. Gokaslan  
**Faculty:** Dean Chou, Daryl R. Fourney, Jean-Paul Wolinsky, Laurence D. Rhines, Juan Uribe  
**Course Description:** This course will review the natural history and management of primary and metastatic spinal tumors. Radiographic imaging, intervention strategies and treatment algorithms will be reviewed. Surgical treatment including approaches will be discussed. Extensive interactive case presentations will illustrate treatment and care considerations and explore the challenges of caring for this complex patient population.  
**Learning Objectives:** Upon completion of this course, participants should be able to:  
- Understand the significance of tumor biology in considering management options.  
- Review the indications and techniques for management of primary and metastatic spinal tumors.  
- Discuss surgical approaches and techniques for tumor resection and spinal reconstruction.

### Introduction
Ziya L. Gokaslan, Ehud Mendel

### A Case Presentation: Thoracic Metastases with Cord Compression and Neuro Deficit
Juan Uribe

### A Case Presentation: En Bloc Resection for Primary Bone Tumor
Laurence D. Rhines

### A Case Presentation: Vertebroplasty/Radiosurgery
Daryl R. Fourney

### Break
### Luncheon Symposium IV – The Geriatric Spine

Additional $200 for medical registrants. Includes lunch.

**Directors:** Gregory R. Trost, James S. Harrop  
**Faculty:** Shaun T. O’Leary, Michael P. Steinmetz, Edward C. Benzel, Daniel M. Sciubba, Tyler R. Koski, Srinivas K. Prasad  
**Course Description:** This course will review degenerative disease from the perspective of the aging spine. It will examine basic spinal pathology and determine what effects these processes will have in regards to surgical and non-surgical management in the elderly, as well as their societal and economic impact.  
**Learning Objectives:** Upon completion of this seminar, participants should be able to:  
- Describe the complexities when dealing with geriatric patients with spinal disorders, specifically focusing on osteoporosis, odontoid fractures and traumatic central cord injuries.  
- Determine how diseases of the aging shift treatment protocols and the modification that may be employed for the surgical and non-surgical management of the aging spine.

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
</table>
| 12:30 – 12:35 PM | **Introduction**  
Gregory R. Trost                                                                 |
| 12:35 – 12:45 PM  | **Osteoporosis and Surgery**  
James S. Harrop                                                                 |
| 12:45 – 1:00 PM     | **Degenerative**  
Edward C. Benzel                                                                                  |
| 1:00 – 1:15 PM     | **Degenerative Deformity**  
Tyler R. Koski                                                                                   |
| 1:15 – 1:30 PM     | **Trauma – Odontoid Fractures Type II vs Type III**  
Daniel M. Sciubba                                                                 |

### Luncheon Symposium V – Spinal Arthroplasty

Additional $200 for medical registrants. Includes lunch.

**Directors:** Regis W. Haid, Jr., Praveen V. Mummaneni  
**Faculty:** Vincent C. Traynelis, Domagoj Coric, Brian R. Subach, Richard G. Fessler  
**Course Description:** This course will examine the indications and contraindications of cervical and lumbar arthroplasty via the scrutiny of IDE studies and personal experience. Complications and revision strategies will be examined. A comparison between arthroplasty and arthrodesis will be elucidated.  
**Learning Objectives:** Upon completion of this course, participants should be able to:  
- Describe the indications and contraindications for arthroplasty.  
- Discuss the associated complications and management strategies for them.

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
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| 12:30 – 12:50 PM | **Cervical Arthroplasty: Outcomes, Complications and Comparison to ACDF**  
Domagoj Coric                                                                 |
| 12:50 – 1:10 PM  | **Economics of Cervical Arthroplasty**  
Vincent C. Traynelis                                                                  |
| 1:10 – 1:30 PM    | **Lumbar Arthroplasty: Outcomes, Complications and Comparison to Fusion**  
Brian R. Subach                                                                         |
| 1:30 – 1:45 PM    | **Break**                                                                                   |
| 1:45 – 2:05 PM    | **Compare and Contrast: Arthroplasty vs. Fusion, Cervical vs. Lumbar**  
Richard G. Fessler                                                                   |
| 2:05 – 2:30 PM    | **Discussion**                                                                            |
### Special Course VIII – Peripheral Nerve Exposures and Nerve Repair Techniques

<table>
<thead>
<tr>
<th>Time</th>
<th>Sebastian Ballroom I-1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:30 – 5:30 PM</td>
<td>Special Course VIII – Peripheral Nerve Exposures and Nerve Repair Techniques</td>
</tr>
</tbody>
</table>

Complimentary to Residents.
Additional $200 for medical registrants. Includes lunch.

**Directors:** Allen H. Maniker, Robert J. Spinner

**Faculty:** Lynda J.-S. Yang, Eric L. Zager, W. Jeffrey Elias, Marie Noëlle Hébert-Blouin, Rajiv Midha, Line Jacques

**Course Description:** This course will demonstrate the common exposures to peripheral nerves in the upper extremity and common techniques used for peripheral nerve reconstruction. It is targeted to practicing surgeons, senior residents and fellows.

**Learning Objectives:** Upon completion of this course, participants should be able to:

- Understand the pertinent and practical surgical anatomy of the brachial plexus and peripheral nerves in the upper limb as related to common nerve injuries, nerve entrapments and other nerve disorders.
- Review common techniques utilized in the reconstruction of peripheral nerves (direct repair, grafting, nerve transfers and nerve conduits).
- This course will prepare residents for written board examinations and young neurosurgeons for oral board examinations.

<table>
<thead>
<tr>
<th>Time</th>
<th>Sebastian Ballroom I-1</th>
</tr>
</thead>
</table>
| 1:30 – 1:50 PM| **Supraclavicular Brachial Plexus**  
Lynda J.-S. Yang |
| 1:50 – 2:10 PM| **Infraclavicular Brachial Plexus**  
Marie Noëlle Hébert-Blouin |
| 2:10 – 2:30 PM| **Basics Nerve Physiology**  
Rajiv Midha |
| 2:30 – 2:50 PM| **Median Nerve**  
Line Jacques |
| 2:50 – 3:10 PM| **Ulnar Nerve**  
W. Jeffrey Elias |
| 3:10 – 3:30 PM| **Discussion** |
| 3:30 – 3:45 PM| **Beverage Break** |
| 3:45 – 4:05 PM| **Radial Nerve**  
Eric L. Zager |
| 4:05 – 4:25 PM| **Nerve Transfers**  
Allen H. Maniker |

### Special Course IX – Evaluation and Management of the Spine Trauma Patient

Special Course for Nurses, Nurse Practitioners and Physician Extenders.
Additional $110 for medical registrants. Includes lunch.

**Directors:** Mark E. Shaffrey, Andrea L. Strayer, MSN, CNRN, ACNP

**Faculty:** Adam S. Kanter, Eve C. Tsai, Sanjay S. Dhall, Charles A. Sansur, Justin S. Smith, David O. Okonkwo, Connie Rios, NP, Jeffrey R. Holtz, PA

**Course Description:** This course will provide practical, current didactic information on spine trauma with particular emphasis on medical therapy updates and intensive care after a complete injury; radiographic interpretation and classification schemes of cervical as well as thoracolumbar fractures. Interactive case presentations will illustrate treatment and care considerations. Expert faculty will explore the challenges of caring for this complex patient population.

**Learning Objectives:** Upon completion of this course, participants will be able to:

- Analyze current evidence regarding steroid therapy and hypothermia after SCI.
- Describe radiographic evaluation following spinal trauma and classification of fracture types.
- Describe radiographic evidence as well as care considerations for facet fractures, ligamentous injury and upper cervical spine including odontoid fractures.
- Discuss ICU care considerations following a complete SCI.

<table>
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<tr>
<th>Time</th>
<th>Sebastian Ballroom I-2</th>
</tr>
</thead>
</table>
| 1:30 – 2:00 PM| **Steroid Therapy and Hypothermia**  
David O. Okonkwo |
| 2:00 – 2:35 PM| **O – C2: Radiographs, Classification, Non-operative vs. Operative**  
Charles A. Sansur |
| 2:35 – 3:05 PM| **Subaxial: Radiographs, Classification, Non-operative vs. Operative**  
Justin S. Smith |
| 3:05 – 3:30 PM| **Complete SCI – Care Considerations**  
Connie Rios, NP |
| 3:30 – 3:45 PM| **Break** |
3:45 – 4:10 PM
T/L Junction, Radiographs Classification, Operative vs. Non-operative
Sanjay S. Dhall

4:10 – 4:40 PM
T/L Junction: Operative vs. Non-operative
Adam S. Kanter

4:40 – 5:00 PM
Care Consideration of the T/L Junction; Including Neuro/B/B/Post-operative
Jeffrey R. Holtz, PA

5:00 – 5:30 PM
SCI: What Does the Future Hold?
Eve C. Tsai

Physician attendees will not be awarded CME credit for this course. Nursing contact hours may be provided through AANN. The American Association of Neuroscience Nurses is accredited as a provider of continuing nursing education by the American Nurses Credentialing Center’s Commission on Accreditation.

Physician assistants/physician extenders will need to contact their individual membership association and certification board to determine the requirements for accepting credits. All attendees will receive a confirmation of attendance.

6:30 – 6:55 AM
Case Presentations
Sebastian Ballroom L
Moderators: Shaun T. O’Leary, Peter D. Angevine

6:55 – 7:00 AM
Meeting Announcements
Sebastian Ballroom L
Paul G. Matz

7:00 – 8:30 AM
Oral Posters Presentations III (Concurrent Session)
Sebastian Ballroom L
Moderators: Justin S. Smith, Anthony Frempong-Boadu

7:00 – 7:05 AM
230. Perioperative Nutrition Status in Spine Surgery: Preliminary Results
David M. Panczykowski, Matthew B. Maserati, Richard M. Spiro, David O. Okonkwo

7:05 – 7:10 AM
231. Does Minimal Exposure Spine Surgery Increase or Decrease Complications in Spinal Decompression or Fusion Surgery?
Daryl R. Fourney, Joseph Dettori, Daniel Norvell, Mark B. Dekutoski

7:10 – 7:15 AM
232. TceMEP Monitoring Improves Detection of Iatrogenic Nerve Root Injury During Cervical and Lumbar Spine Surgery
Bikash Bose, Anthony K. Sestokas, Daniel M. Schwartz

7:15 – 7:20 AM
233. Changes in Trunk Muscle Cross-sectional Area following Posterior Lumbar Surgery
Lacey E. Bresnahan, Silviu Diaconu, Steven Quinn, Richard G. Fessler

7:20 – 7:25 AM
234. Tuberculosis of the Thoracic Spine: A Study of 22 Surgically Treated Children
Rabi Narayan Sahu, Ashok Mahapatra, Raj Kumar, Sanjay Behari, Vijendra K. Jain, Awadhesh K. Jaiswal

7:25 – 7:30 AM
Discussion

7:00 PM
Young Neurosurgeons’ Dinner
Conway Room
Enjoy a special presentation by 2010 Meritorious Service Award winner, Regis W. Haid, Jr., MD.
Open to all residents, fellows and young neurosurgeons.
RSVP to DePuy Spine, a Johnson & Johnson Company, Booth #411.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
</tr>
</thead>
<tbody>
<tr>
<td>7:35-7:40AM</td>
<td><strong>236. Two-year Results from Five IDE Study Sites: CerviCore® Intervertebral Disc vs. Fusion</strong>&lt;br&gt;Neill Marshall Wright, Willie S. Edwards, Charles S. Theofilos, Rolando García, Lee L. Thibodeau</td>
</tr>
<tr>
<td>7:40-7:45AM</td>
<td><strong>237. The Surgical Treatment of Charcot Spinal Arthropathy</strong>&lt;br&gt;Bradley Jacobs, Carlo Bellabarba, Richard Bransford, Jens Chapman</td>
</tr>
<tr>
<td>7:45-7:50AM</td>
<td><strong>238. Stereotactic Radiosurgery Delays Paraparesis in an Animal Model of Metastatic Epidural Spinal Cord Compression</strong>&lt;br&gt;Wesley Hsu, James Richman, Timothy Flerage, Michael Armour, Kristen Redmond, Lawrence Kleinberg, Eric Ford, Michael Lim, Ziya L. Gokaslan, Daniel M. Sciuibaba</td>
</tr>
<tr>
<td>7:50-7:55AM</td>
<td><strong>239. Smoking Negatively Impacts Generic and Disease-specific Outcomes following Anterior Cervical Discectomy and Fusion: Analysis of a Prospective Multi-center Randomized Controlled Trial</strong>&lt;br&gt;Michael G. Fehlings, Rick Sasso, Paul M. Arnold</td>
</tr>
<tr>
<td>7:55-8:00AM</td>
<td><strong>Discussion</strong></td>
</tr>
<tr>
<td>8:00-8:05AM</td>
<td><strong>240. DuraSeal™ Spinal Sealant as an Adjunct to Sutured Dural Repair in the Subaxial Spine: Results of a Prospective, Multi-center, Randomized Controlled Study</strong>&lt;br&gt;Neill Marshall Wright, Kee Duk Kim, Rees Cosgrove, John M. Tew, Jr., Michael G. Kaiser, Paul C. McCormick, Randall Chestnut, Richard G. Ellenbogen, Harry R. Van Loveren, Fernando L. Vale, Mark Edwin Shaffrey, Thomas C. Chen, Michael Y. Wang, Marc R. Mayberg</td>
</tr>
<tr>
<td>8:05-8:10AM</td>
<td><strong>241. Development of a Novel Intravertebral Human Breast Adenocarcinoma Rat Model for the Study of Intravertebral Metastatic Spine Disease</strong>&lt;br&gt;Camilo A. Molina, Wesley Hsu, Anthony Gregory, Timothy Flerage, James Richman, John Thurston, Mikhail Gorbounov, Ziya L. Gokaslan, Ali Bydon, Timothy F. Wilham, Jean-Paul Wolinsky, Daniel M. Sciuibaba</td>
</tr>
<tr>
<td>8:10-8:15AM</td>
<td><strong>242. How Does Age and Body Mass Index Impact Length of Stay and Hospital Cost in Spine Surgery?</strong>&lt;br&gt;Mohammad Sami Walid, Edward R. M. Robinson, Joe S. Robinson, III</td>
</tr>
<tr>
<td>8:20-8:25AM</td>
<td><strong>244. High Fusion Rates with Synthetic Bone: Anterior Cervical Arthrodesis Using Beta-tricalcium Phosphate with Local Bone Marrow Aspirate in Over 100 Patients</strong>&lt;br&gt;Neill Marshall Wright, Wilson Zachary Ray</td>
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<tr>
<td>8:25-8:30AM</td>
<td><strong>Discussion</strong></td>
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<tr>
<td>7:00-8:30AM</td>
<td><strong>Sebastian Ballroom I-1&amp;2</strong>&lt;br&gt;Oral Poster Presentations IV (Concurrent Session)</td>
</tr>
<tr>
<td>7:00-7:05AM</td>
<td><strong>245. Biomechanical Advantage of the Index Level Screw in Thoracolumbar Fracture Fixation</strong>&lt;br&gt;Ali A. Baaj, Phillip Reyes, Ali Yaqoobi, Juan S. Uribe, Fernando L. Vale, Nicholas Theodore, Volker K. H. Sonntag, Neil R. Crawford</td>
</tr>
<tr>
<td>7:05-7:10AM</td>
<td><strong>246. Preoperative ASA Grade Predicts Complication and Mortality Rates in Patients Undergoing Spinal Surgery</strong>&lt;br&gt;Kai-Ming G. Fu, Justin S. Smith, Christopher L. Shaffrey, Joseph Perra, David W. Polly, Jr., Sigurd Berven, Oheneba Boachie-Adjei</td>
</tr>
<tr>
<td>7:10-7:15AM</td>
<td><strong>247. Incidence of Heterotopic Ossification after Cervical Disc Replacement: Is X-ray Good Enough to Tell?</strong>&lt;br&gt;Wen-Cheng Huang, Tsung-Hsi Tu, Jau-Ching Wu, Henrich Cheng</td>
</tr>
<tr>
<td>7:15-7:20AM</td>
<td><strong>248. Teriparatide for the Treatment of New-onset Adjacent Vertebral Compression Fracture after Percutaneous Vertebroplasty</strong>&lt;br&gt;Yuan Yun Tseng</td>
</tr>
<tr>
<td>7:20-7:25AM</td>
<td><strong>249. Traumatic Spondylolisthesis of the Axis: Analysis of Treatment and Outcome in 40 Cases</strong>&lt;br&gt;Tao Ding, Mitchell G. Maltenfort, James S. Harrop</td>
</tr>
<tr>
<td>7:25-7:30AM</td>
<td><strong>Discussion</strong></td>
</tr>
<tr>
<td>7:30-7:35AM</td>
<td><strong>250. To Fuse or Not To Fuse: Lumbar Synovial Cysts</strong>&lt;br&gt;Basheal Mohan Agrawal, Daniel K. Resnick</td>
</tr>
</tbody>
</table>
7:35 – 7:40 AM  
251. The Patient with Myelomeningocele: Is Untethering Necessary Prior to Deformity Correction?  
Amer F. Samdani, Sookdeep Sagoo, Shailja Shah, Patrick Cahill, David Clements, Randal Betz

7:40 – 7:45 AM  
252. Rate of Return to Military Active Duty after Single Level and Two Level Anterior Cervical Discectomy and Fusion: A 4-year Retrospective Review  
Ryan Ponton, Wayne Gluf, Angelina N. Garvin, Luis M. Tumialan

7:45 – 7:50 AM  
253. Clinical and Radiographic Outcomes in Myelomeningocele Patients Undergoing Spinal Fusion for Neuromuscular Scoliosis  
Mohammad S. Shukairy, Peter F. Sturm

7:50 – 7:55 AM  
254. Pedicle Screw Electrical Resistance: Hydroxyapatite Coated vs. Non-Coated  
Timothy T. Davis, Ajay Vatave, James Patla, Johannes Bemberck, Hyun W. Bae, Rick B. Delamarter

7:55 – 8:00 AM  
Discussion

8:00 – 8:05 AM  
255. A Quantitative Value Analysis Formula Designed for Comparison of Spine Interventions Based on Outcome, Success Rate and Cost Data  
James B. Macon

8:05 – 8:10 AM  
256. XLIF for Grade II Spondylolisthesis at L4–5: The “Worst Case” Scenario  
W. B. Rodgers, Edward J. Gerber, Jamie R. Patterson

8:10 – 8:15 AM  
257. Performance of the TM-100 Cervical Fusion Device in a Prospective, Randomized, Controlled Trial  
Robert G. Louis, Mark Edwin Shaffrey

8:15 – 8:20 AM  
258. Clinical and Radiographic Outcome of the NeoDisc Cervical Total Disc Replacement (TDR) at One-year Follow-up  
Kenneth Pettine

8:20 – 8:25 AM  
259. Treatment of Intramedullary Spinal Cord Tumors with Stereotactic Radiosurgery  
Timothy Flerlage, James Richman, Camilo A. Molina, Wesley Hsu, Eric Ford, Michael Lim, Ziya L. Gokaslan, Ali Bydon, Timothy F. Wilham, Jean-Paul Wolinsky, Daniel M. Sciubba

8:25 – 8:30 AM  
Discussion

8:30 – 9:50 AM  
Sebastian Ballroom L  
David Cahill Memorial Controversies Session – Spine and Peripheral Nerves

Moderators: Praveen V. Mummaneni, Charles Kuntz, IV  
Session Description: This session will involve a debate presentation format where controversial clinical management decisions will be presented. Experts will argue their perspectives with regard to the management scenarios for difficult spine and peripheral nerve cases.  
Learning Objectives: Upon completion of this course, participants should be able to:  
- Discuss the treatment options for patients with solitary renal cell metastasis and spinal cord compression.  
- List the risks and benefits associated with early vs. late decompression of central cord injuries.  
- Describe the utility of lumbar disc fragmentectomy vs. aggressive discectomy.  
- Discuss degenerative spondylolisthesis and the controversy associated with interbody vs. posterolateral fusion techniques.

8:30 AM  
En Bloc Resection vs. Radiosurgery for Solitary Renal Cell Metastasis with Cord Compression  
Faculty: Ziya L. Gokaslan vs. Mark H. Bilsky

8:50 AM  
Early vs. Late Decompression for Central Cord Injury  
Faculty: Michael G. Fehlings vs. James S. Harrop

9:10 AM  
Lumbar Disc: Fragmentectomy vs. Aggressive Discectomy  
Faculty: Michael Y. Wang vs. John A. Jane, Sr.

9:30 AM  
Degenerative Spondylolisthesis: Interbody vs. Instrumented Posterolateral Fusion  
Faculty: Regis W. Haid, Jr. vs. Edward C. Benzel

9:50 – 10:35 AM  
Sebastian Ballroom J–K  
Beverage Break with Exhibitors

What’s New Session V  
Moderators: Alfred T. Ogden, Frank LaMarca

10:35 AM – 12:05 PM  
Sebastian Ballroom L  
Scientific Session IV: Training in Neurosurgery

Moderators: Mark Edwin Shaffrey, Edward C. Benzel  
Session Description: This Scientific Session will critically compare residency and spinal fellowship training in Taiwan and the Far East to that of the United States. Furthermore, it will review changes occurring in neurosurgery training in the United States as a consequence of work hour restrictions and increased sub-specialization. Finally, issues related to US neurosurgery examinations and recertification will be addressed.
**Learning Objectives:** Upon completion of this course, participants should be able to:

- Discuss changes to neurosurgery residency training in the setting of work hour restrictions.
- Evaluate differences between neurosurgical training in Taiwan and the US.
- Discuss US Neurosurgery board certification and recertification issues.

<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Discussant</th>
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</thead>
<tbody>
<tr>
<td>10:35 AM</td>
<td><strong>Neurosurgery Residency Training in Taiwan and the Far East</strong> Henrich Cheng</td>
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<tr>
<td>10:55 AM</td>
<td><strong>Spinal Fellowship Training in Taiwan and the Far East</strong> Robert Yung-Hsiao Chiang</td>
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<tr>
<td>11:15 AM</td>
<td><strong>Neurosurgery Residency and Fellowship Training in the US</strong> Philip R. Weinstein</td>
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<tr>
<td>11:35 AM</td>
<td><strong>Neurosurgery Oral Board Examination and MOC Recertification: Keys to Success</strong> Charles L. Branch</td>
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<tr>
<td>11:55 AM</td>
<td>Questions</td>
<td></td>
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<tr>
<td>12:05 – 12:45 PM</td>
<td><strong>Mayfield Awards/Presentations</strong></td>
<td><strong>Moderator:</strong> Adam S. Kanter</td>
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<tr>
<td></td>
<td><strong>Mayfield Basic Science Award</strong></td>
<td><strong>Discussants:</strong> Adam S. Kanter, Marjorie C. Wang, Jogi V. Pattisapu</td>
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<tr>
<td></td>
<td>Role of the Direct and Indirect Pathways in Nerve Allograft Rejection</td>
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<td>12:13 – 12:15 PM</td>
<td><strong>Discussant:</strong> Adam S. Kanter</td>
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<tr>
<td>12:15 – 12:23 PM</td>
<td><strong>Mayfield Clinical Science Award</strong></td>
<td><strong>Spinal Accessory and Intercostal Nerves to Bypass Spinal Cord Injury</strong> Raqeeb M. Haque, Michael Kellner, Martin Bauknight, Christopher P. Kellner, Kurenai Tanji, John H. Martin, Christopher J. Winfree</td>
</tr>
<tr>
<td>12:23 – 12:25 PM</td>
<td><strong>Discussant:</strong> Jogi V. Pattisapu</td>
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<tr>
<td>12:25 – 12:33 PM</td>
<td><strong>Outcomes Committee Award</strong></td>
<td><strong>Multilevel ACDF with and without BMP: A Comparison of Outcomes and Dysphagia Rates in 150 Patients</strong> Daniel C. Lu, Dean Chou, Gerald E. Rodls, Jr., Praveen V. Mummaneni</td>
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<tr>
<td>12:33 – 12:35 PM</td>
<td><strong>Discussant:</strong> Marjorie C. Wang</td>
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<td>12:35 – 12:42 PM</td>
<td><strong>Award Presentations</strong></td>
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<tr>
<td>12:42 – 12:45 PM</td>
<td><strong>Clinical Trials Award</strong></td>
<td><strong>Cervical Spondylotic Myelopathy: Can Outcome Be Predicted by Diffusion Tensor Imaging?</strong> Marjorie C. Wang</td>
</tr>
<tr>
<td>12:45 PM</td>
<td><strong>Meeting Adjourns</strong></td>
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</table>

**YOUR OPINION COUNTS!**

A link to the online evaluations will be sent to the e-mail address that you used to register for the meeting. Links to the evaluation system will also be online at www.spine-section.org. You will need to login in with your last name and the e-mail address where the link was sent. After logging in, simply follow the links to Claim Credits. Each session evaluation will be listed on this page. You will also be able to submit a request for CME credits at the same time though submission of evaluations is not mandatory to receive CME credit. For instructions on how to submit CME credits, please see CME Credit on page 128. Your feedback is critical in helping the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves plan future education and Annual Meetings.
The AANS/CNS Section on Disorders of the Spine and Peripheral Nerves and the CNS control the content and production of this CME activity and attempt to assure the presentation of balanced, objective information. In accordance with the Standards for Commercial Support established by the Accreditation Council for Continuing Medical Education, anyone in the position to control the content of the educational activity is asked to disclose any relationship they have with commercial companies. Individuals who have disclosed a relationship* with commercial companies whose products may have a relevance to their participation in the Annual Meeting are listed here.

*Relationship refers to receipt of royalties, consultanship, funding by research grant, receiving honoraria for educational services elsewhere, or any other relationship to a commercial company that provides sufficient reason for disclosure.

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<td>Farbod Asgarzadie</td>
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<td>Jahangir Asghar</td>
<td>Consultant – DePuy Spine; SpineVision, Inc.</td>
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<td>Basar Atalay</td>
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<td>Andy Cappuccino</td>
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<td>Thomas C. Chen</td>
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<td>Charles Kuntz, IV</td>
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<td>Allan D. Levi</td>
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**DISCLOSURE LISTING**

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NOTHING TO DISCLOSE
Individuals who have reported they do not have any relationship with commercial companies are listed here.

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Mohamed Mudathir
Abdulhamid
Toshiaki Abe
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Juni Chen
Tzu-Yung Chen
Ying-Chih Chen
Henrich Cheng
Joseph S. Cheng
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NON-FDA APPROVED LISTING

Faculty Presentations including Non-FDA Approved Investigational Drugs or Devices

Scientific Session II: Spinal Surgery Complication Avoidance and Management
Peter D. Angevine

Scientific Session IV: Training in Neurosurgery
Edward C. Benzel
Henrich Cheng

Special Course III: Spinal Deformity
Peter D. Angevine

Special Course IV: Advanced MIS Techniques/Managing MIS Complications
Paul Park

Special Course VII: Update on Spinal Surgery in Taiwan and the Far East
Tzu-Yung Chen
Sheng-Huang Hsiao
Jui-Feng Lin
Lin-Hsue Yang

Special Course VIII: Peripheral Nerve Exposures and Nerve Repair Techniques
Marie-Noelle Hébert-Blouin

What’s New Session III
Andrew C. Roeser

What’s New Session IV
Harel Deutsch

Case Presentations
Peter D. Angevine

Mayfield and Outcomes Awards
120: Daniel C. Lu

Oral Platform Presentations I
105: Kenneth Pettine
111: Sanjay S. Dhall

Oral Platform Presentations II
Zoher Ghogawala
114: Kenneth Pettine

Oral Poster Presentations I
200: Michael Y. Wang
212: Ian G. Dorward

Oral Poster Presentations II
215: Fras Dakhlil-Jerew
221: Christopher E. Wolfia
224: Kenneth Pettine

Oral Poster Presentations III
236: Neill Marshall Wright
239: Michael G. Fehlings
240: Neill Marshall Wright

Oral Poster Presentations IV
Andrew C. Roeser
258: Kenneth Pettine

Digital Posters
314: Kevin S. Cahill
322: Mohamed Mohi Eldin
334: Eric W. Nottmeier
335: Tsung-Hsi Tu
351: Walter W. Eckman
387: Josey Simon
399: W.B. Rodgers
408: Eric W. Nottmeier
417: Narayan Sundaresan
419: Charles S. Theofilos
428: Kenneth Pettine
441: Samer Ghostine
450: Lana D. Christiano
458: Daniel S. Yanni
469: Robert E. Isaacs
485: Hector Humberto Gomez-Acevedo
489: Sanjay S. Dhall
490: Sanjay S. Dhall

THE AANS/CNS SECTION ON DISORDERS OF THE SPINE AND PERIPHERAL NERVES gratefully acknowledges

for providing an educational grant in support of the 2010 Annual Meeting
The Exhibit Hall, located in the Sebastian Ballroom J–K, will feature:

More than 60 exhibiting companies displaying state-of-the-art equipment, products and services.

Lunch in the Exhibit Hall*: Plan to spend your Thursday lunch break mingling with exhibitors between What’s New Sessions.

Reception with the Exhibitors: Join us Thursday evening for another great networking opportunity! Take this time to browse the aisles of the Exhibit Hall and visit your favorite companies or perhaps encounter some fresh faces on the exhibit floor, all while enjoying cocktails and hors d’oeuvres.

Cyber Café: Stay in touch with home and the office through this complimentary attendee service.

Digital Posters: Explore the exhibit floor browse abstracts enhanced by photos and video. The digital format also makes it easy to search for abstracts by author or topic.

What’s New Sessions: Join the crowd during daily breaks and Thursday lunch as speakers share the latest in cutting-edge research and technology.

EXHIBITORS

ACIGI Relaxation/Fujiiryoki 623
4399 Ingot Street
Fremont, CA 94538
510-651-9088
www.drfuji.com

Aesculap Implant Systems 100, 102
3773 Corporate Parkway
Center Valley, PA 18034
800-234-9179
www.aesculapusa.com

Alphatec Spine, Inc. 205
5818 El Camino Real
Carlsbad, CA 92008
760-431-9286
www.alphatecmfg.com

Amedica Corporation 412
1885 West 2100 South
Salt Lake City, UT 84119
801-839-3500
www.amedicacorp.com

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561-627-1080
www.anspach.com

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www.biometspine.com
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**AANS/CNS Section on Disorders of the Spine and Peripheral Nerves**
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<td>Regent Surgical Health</td>
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<td>2302 La Mirada Drive Vista, CA 92081 760-727-8399 <a href="http://www.seaspine.com">www.seaspine.com</a></td>
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<td>18888 Lake Drive East Chanhassen, MN 55317 952-294-8700 <a href="http://www.signusmedical.com">www.signusmedical.com</a></td>
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<td>419</td>
<td>2744 Loker Avenue West, Suite 100 Carlsbad, CA 92010 760-607-0121 <a href="http://www.spinalelements.com">www.spinalelements.com</a></td>
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<td>SpineGuard</td>
<td>600</td>
<td>301 Howard Street, Suite 970 San Francisco, CA 94105 415-512-8001 <a href="http://www.spineguard.com">www.spineguard.com</a></td>
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<td>Spineology, Inc.</td>
<td>511</td>
<td>7200 Hudson Boulevard North, Suite 205 St. Paul, MN 55128 651-256-8500 <a href="http://www.spineology.com">www.spineology.com</a></td>
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<td>TeDan Surgical Innovations</td>
<td>219</td>
<td>11333 Chimney Rock Road, Suite 180 Houston, TX 77035 713-726-0886 <a href="http://www.tedansurgical.com">www.tedansurgical.com</a></td>
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<td>Zimmer Spine</td>
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**THURSDAY, FEBRUARY 18**

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**THE AANS/CNS SECTION ON DISORDERS OF THE SPINE AND PERIPHERAL NERVES gratefully acknowledges**

**NEUROSURGICAL LEADERSHIP AMBASSADOR**

for providing an educational grant in support of the 2010 Annual Meeting
100. Is Surgical Treatment for Mild Cervical Spondylotic Myelopathy Effective? One-year Outcomes of AOSpine North America CSM Multi-center Prospective Study


Introduction: The effectiveness of surgery for patients with mild cervical spondylotic myelopathy has been questioned and many physicians opt for nonoperative management. To address this controversy, we examined the 12-month outcomes of operative treatment for patients with mild cervical myelopathy based on the data from a large prospective multicenter clinical study.

Methods: Out of 280 subjects with CSM who were enrolled at 12 sites across North America, 85 had mild impairment (with a baseline modified JOA greater than 14). Seven patients were lost to follow-up (38% females; average age 56 years) (sd = 10). Outcomes assessments included the modified JOA (mJOA), Neck Disability Index (NDI), Nurick score and SF-36. Data were analyzed using uni- and multi-variate analysis of variance.

Results: Surgical treatment was through an anterior (76%), posterior (20%) or posterior or combined “360” (4%) approach. There was a significant improvement from baseline values to 12 months in all measured outcome parameters (see Table 1). Modified JOA scores improved from 15.85 to 17.01, average improvement 1.17 (95% CI 0.68, 1.65). The NDI scores improved from 33.09 to 21.70, average improvement 11.40 (95% CI 7.08, 15.71). The average Nurick scores improved from 3.38 to 1.89, average improvement 1.49 (95% CI 1.20, 1.77). The SF-36 PCS scores improved from 41.31 to 47.45, average improvement 6.14 (95% CI 3.80, 8.50) and the SF-36 MCS scores improved from 43.78 to 49.90, average improvement 6.12 (95% CI 3.72, 8.52).

Conclusion: The data from this large prospective clinical study provide strong evidence that surgical treatment for mild CSM results in significant improvement in generic and disease specific outcomes which is maintained out to one year postoperatively.

101. Comparative Effectiveness of Ventral vs. Dorsal Surgery for Cervical Spondylotic Myelopathy

Zoher Ghogawala, Edward C. Benzal, Subu N. Magge, Khalid M. Abbed, Ronald I. Apfelbaum, Javed Shahid, Jean-Valery Comans, Tanvir Choudhri, Robert F. Heary

Introduction: The optimal surgical (ventral vs. dorsal) strategy for treating cervical spondylotic myelopathy (CSM) is unclear.

Methods: A prospective non-randomized pilot clinical trial was conducted. Patients were screened and enrolled from 8 sites over 2 years (2007-2009). Patients aged 45-75 with degenerative CSM and cervical spinal cord compression at 2 or more levels were eligible. Patients with >5 degrees kyphosis, segmental kyphotic deformity (Fig 1), ossification of posterior longitudinal ligament (OPLL), developmental narrow canal, or previous cervical spine surgery were excluded.

Results: Outcome assessments (mJOA, Oswestry Neck Disability Index (ODI), and SF-36) were obtained pre-operatively, 3 months, 6 months, and 1 year post-operatively.

Conclusion: Of the 91 patients enrolled, 50 patients with 1-year follow-up data were analyzed. 24 patients were treated with ventral fusion and 26 patients were treated with dorsal surgery. Average age was 62.6 years. 60% were male. Baseline patient demographic and radiographic features were comparable. Baseline ODI (35.2) and SF-36 physical component summary (PCS) (34.6) were comparable between the two groups. Both groups had comparable improvement in mJOA scores at 1 year (1.9 points) (P = 0.001). Ventral surgery patients had superior SF-36 PCS scores (45.0 vs. 40.3) and better ODI scores (17.7 vs. 24.3) at 1 year (Fig 2).

Conclusion: Multi-variate regression analysis demonstrated that ventral surgery had superior improvements in SF-36 PCS scores compared with dorsal surgery patients (P = 0.04). Major complications were identified at 1 month after surgery in 7/50 (14%) patients. Dysphagia was observed in 4/24 (17%) ventral cases and CS paresis was noted in 3/26 (12%) dorsal cases.

Conclusion: Surgery for CSM reduces disease-specific symptoms and improves overall quality of life. Ventral surgery appears to improve SF-36 PCS scores more than dorsal surgery 1 year after surgery.

102. Endoscopic Endonasal Resection of the Odontoid Process: Clinical Outcomes

Matthew J. Tormenti, Ricky Madhok, Amin B. Kassam, Carl Snyderman, Richard M. Spiro, Ricardo Carrau, Paul A. Gardner

Introduction: Traditional treatment of odontoid disease from a ventral approach has consisted of a transoral approach. More recently, an endoscopic endonasal approach has been used to access this region for decompression of the cervicomedullary junction.

Methods: A retrospective review was conducted for all patients from 1997-2008 who underwent a completely endoscopic endonasal odontoidectomy for decompression of the cervicomedullary junction. Each patient’s clinical outcome was assessed using the Neck Disability Index and Nurick cervical myelopathy scale.

Results: Twenty-four patients underwent a completely endoscopic endonasal resection of the odontoid. The most common pathology treated was rheumatoid pannus disease. The mean patient age was 63.4 years. No patient suffered worse of their preoperative neurologic status with all patients having either improvement or stabilization of their neurologic status. Twenty-one of the twenty-four patients had an additional posterior fusion. There were no patients that required a tracheostomy related to the surgical procedure or suffered a surgical site infection. NURICK and NDI data was available for 12 patients who had a mean follow-up of 28.6 months (range 3-57).

Conclusion: A completely endoscopic endonasal approach can be performed for odontoid disease with good outcomes and low morbidity. In objective follow-up evaluation, the majority of patients returned to an excellent quality of life with no or minimal disability.
103. Complications in the Surgical Treatment of 19,956 Cases of Pediatric Scoliosis: A Review of the Scoliosis Research Society Database

Davis Reames, Kai-Ming G. Fu; Justin S. Smith, David W. Polly, Jr., Sigurd Berven, Joseph Perra; Oheneba Boachie-Adjei, Christopher I. Shaffrey

Introduction: Wide variability is reported for complications associated with operative treatment of pediatric scoliosis. Limited numbers of patients, surgeons and diagnoses occur in most reports. The Scoliosis Research Society (SRS) Morbidity and Mortality database aggregates deidentified patient data, permitting determination of complication rates from large numbers of patients and surgeons.

Methods: Consecutive cases of pediatric scoliosis, prospectively entered into the SRS M&M database from 2004–2007, were analyzed. Age, scoliosis type, surgical approach, fusion technique, intraoperative neuromonitoring, and complications were reviewed and summarized. Scoliosis was divided into congenital, idiopathic, neuromuscular, post-traumatic, and other types.

Results: 19,956 cases were analyzed. 1,989 total complications (10%) occurred (see table). Among the three most common types of scoliosis (idiopathic, congenital, and neuromuscular) the total complication rates differed significantly (P<0.001). Neuromuscular scoliosis had the highest overall rate of complication (17.6%), followed by congenital scoliosis (10.4%), and idiopathic scoliosis (6.2%). Rates of neurological deficit also differed significantly based on scoliosis etiology (P<0.001), with the highest rate among congenital cases (2.0%), followed by neuromuscular (1.1%), and idiopathic scoliosis (0.8%). Mortality occurred in 27 patients (~1 per 1,000). Neuromuscular scoliosis had the highest rate of mortality (0.4%), followed by congenital (0.3%), and idiopathic types (0.02%) (P<0.001).

Conclusion: Neuromuscular scoliosis had the highest morbidity and mortality, but relatively high complication rates occurred in all groups. These data may be useful for pre-operative counseling and surgical decision making in the treatment of pediatric scoliosis, as well as providing benchmarks for on-going efforts to improve patient care.

104. Phase II Study for New Medical Techniques in Patients with Chronic Spinal Cord Injury

Henrich Cheng, Jau-Ching Wu, Wen-Cheng Huang

Introduction: This open-labeled phase II clinical trial is designed to evaluate the efficacy of acidic fibroblast growth factor (aFGF) cocktail therapy in chronic spinal cord injury patients. The trial was approved by the Department of Health of Taiwan Government.

Methods: Total 56 patients, mean age 36.5 years, with a male/female ratio of 3, was involved in the study. Level of injury included cervical (n=30, 50%) and thoracolumbar (n=30, 50%). The average time from injury to treatment was 25.1 (1.5–133.6) months. All patients underwent posterior surgery for neurolysis with application of aFGF followed by adjuvant boosters. All participants were designated to rehabilitation program, neurological assessments, and electrophysiological evaluations for 24 months. All subjects were evaluated and scored with Functional Independence Measure (FIM) before surgery and 3 months, 6 months, and 12 months after surgery. A third party was involved as an objective observer and responsible for outcome assessment as well as statistical analysis.

Results: 56 participants completed the study. Among them, 43.3% had improved neurological levels the 1st year and 50% the 2nd year, levels for 1–3. Furthermore, 16.6% of them had ASIA impairment scale upgrade the 1st year and 30% the 2nd year. For FIM, scores of motor items for cervical group improved significantly after surgery except for the item of stairs locomotion. However, for thoracic group, there was no significant improvement in eating, grooming and stairs locomotion due to ceiling effect. Increasing fraction of walking subjects was found in both groups. No clinically significant regimen related adverse effects were observed.

Conclusion: Significant improvement in the ASIA motor and sensory scale scores were observed as 12 and 24 months after the application of the novel strategy. This open labeled Phase II clinical study has demonstrated the safety and benefit of using aFGF for chronic spinal cord injury and should lead to further validation and investigation.

105. FDA IDE Prospective Randomized Comparison of Three Lumbar Artificial Disc Replacements (ADR) with Minimum Three-year Follow-up

Kenneth Pettine

Introduction: To establish safety and efficacy between the Maverick™ (M), Charité™(C), and Kineflex™ (K) A.D.R.’s.

Methods: Followup on three ADR’s performed by two surgeons, at one IDE site were reviewed. There were 25 Maverick, 31 Charité, and 35 Kineflex patients. The majority of A.D.R.’s were performed at L5-S1 vs. L4-L5 (M)19 to 6, (C)19 to 12 and (K)28 to 7. Inclusion/exclusion criteria will be discussed.

Results: Re–operations included: (M) 1 infection, (C) 3 implant complications (K) 1 implant complication. These cases will be presented. ODI results for all groups: Pre-op = (M) 57.6, (C) 63.8, and (K) 61.1; One–year post–op = (M) 16.3, (C) 27.3, and (K) 20.4; Three–year post–op = (M) 14.6 (p<0.001), (C) 20.5 (p<0.001), and (K) 19.3 (p<0.001) VAS results for all groups: Pre–op = (M) 74.1, (C) 85, (K) 83.9; One–year post–op = (M) 27.9, (C) 31.4, and (K) 27.3; Three–year post–op = (M) 20.5 (p<0.001), (C) 33.8 (p<0.001), and (K) 26.9 (p<0.001). FDA. clinical success was met in (M) 90%, (C) 83.5%, (K) 90.5% of patients. Patients with a VAS less than 2 occurred in (M) 68%, (C) 29%, (K) 47%. Patients with an ODI less than 10 occurred in (M) 67% (C) 33%, (K) 52%. Patient satisfaction at three–year follow up was (M) 96%, (C) 84%, and (K) 91%.

Conclusion: All three ADR’s demonstrated safety with a trend to more device related complications with (C) 3 compared to (M) 1 and (K) 1. They all showed efficacy with a statistically significant improvement in ODI and VAS at three year follow–up (p<0.001). F.D.A. clinical success was (M) 90%, (C) 83.8%, (K) 90.5%. This is the only class one data comparing three ADR’s from one IDE site.

106. Acidic Fibroblast Growth Factor in Brachial Plexus Injury and Common Peroneal Nerve Injury

Henrich Cheng, Jau-Ching Wu, Wen-Cheng Huang

Introduction: A clinical trial approved by the department of Health of Taiwan government to evaluate the efficacy and safety of acidic fibroblast growth factor (aFGF) in treatment of brachial plexus injury (BPI) and common peroneal nerve injury (CPNI).

Methods: A single center, open–labeled, prospective clinical study was conducted in Taipei Veterans General Hospital. Treatment included surgical decompression, neurolysis with/without nerve graft, aFGF cocktail therapy, and rehabilitation. Evaluations included clinical evaluations of neurological function and electrophysiological tests. Motor scores are calculated by key muscle power in arms and feet, recorded by British Medical Research Council (MRC) grading system.

Results: 26 patients were enrolled, 20 of BPI and 6 of CPNI, with ages between 16 to
56 years. Males predominated in both groups; 13 (65%) in the BPI group and 4 (66.7%) in the CPNI group. Upon postoperation 48 weeks, average motor score improved from 19.1 to 28.6 in BPI group (p=0.0001); 2.0 to 7.2 in CPNI group (p=0.0625). Average dorsiflexion of palm improved at an average of 18.8 degrees (50.0 to 68.8). Light touch sensory function were also significantly improved in BPI group (+2.9, p=0.0001) but not pin prick (+2.0, p=0.0886). No significance was found in sensory function measurement in CPNI group.

Conclusion: Significant improvement in the motor and sensory scores was observed 48 weeks after treatment in BPI group. This open labeled Phase II clinical study has demonstrated the safety and benefit of using aFGF in such nerve injuries and further investigation is required to corroborate the results.

107. Complications Associated with BMP Use in 11,281 Cases of Spinal Fusion
Brian Jeremy Williams, Kai-Ming G. Fu, Justin S. Smith, David Kojo Hamilton, Joseph Perra, David W. Polly, Jr., Brian Jeremy Williams, Kai-Ming G. Fu, Justin S. Smith, David Kojo Hamilton, Joseph Perra, David W. Polly, Jr., Sigurd Berven, Oheneba Boachie-Adjei, Christopher I. Shaffrey

Introduction: BMP is commonly used in spinal surgery in order to augment fusion; however, there is a dearth of evidence demonstrating its associated complications.

Methods: We performed a retrospective analysis of all fusion cases submitted by members of the Scoliosis Research Society from 2004 to 2007. We excluded all anterior cervical procedures, then censored for use of BMP and evaluated for complications and associated characteristics.

Results: A total of 50,678 procedures were identified and BMP was used in 22% (11,281). There was no significant difference between overall complications (8.4% vs. 8.5%, P=0.5), deep (1.6% vs. 1.3%, P=0.08) or superficial (0.8% vs. 1%, P=0.2) wound infections, epidural hematomas (0.16% vs. 0.21%, P=0.3), or mortality (0.19% vs. 0.12%, P=0.4). When stratified by diagnosis, BMP use in scoliosis procedures was associated with more epidural hematomas (0.1% vs. 0.28%, P=0.015) and overall complications (8.5% vs. 9.9%, P=0.031). (See Table) When stratified by fusion category BMP use in anterior/posterior procedures was associated with more deep wound infections (0.2% vs. 1.1%, P=0.001); however simple approaches had no difference. There were 6,783 revision procedures, and BMP was used in 35% (2,400). BMP use was associated with deep wound infections in revision cases (1.2% vs. 1.8%, P=0.048) but not with superficial wound infection (1% vs. 1.1%, P=0.7) or epidural hematoma (0.2% vs. 0.25%, P=0.6).

Conclusion: Overall BMP use was not associated with more complications than non-augmented fusions. However, BMP use was associated with more complications in specific instances, including scoliosis and anterior/posterior fusions.

108. Rate of Return to Military Active Duty after Single Level Lumbar Interbody Fusion: A 5 year Retrospective Review
Luis M. Tumialan, Ryan Ponton, Anthony L. Riccio, Wayne Gluf

Introduction: The purpose of this study is to identify the rate of return to full, unrestricted active duty after single level lumbar interbody fusion surgery in military personnel and to determine those variables that correlated with a successful outcome.

Methods: The surgical database at a tertiary care military treatment facility was queried for all active duty patients who underwent a single level lumbar interbody fusion over a five-year period. A retrospective chart review was performed to collect patient and procedural data.

Results: A total of 102 patients (91 Male/11 Female) met inclusion criteria. The average age at time of surgery was 34.0 years (range: 19–51 years). The majority of surgeries (59%) were performed for discogenic back pain secondary to degenerative disc disease. Thirty-nine patients (38%) were treated via an anterior approach (ALIF) while 63 patients (62%) underwent fusion via a posterior approach (TLIF or PLIF). The most commonly fused segment was L5-S1 (71%). Fifty-six patients (55%) were able to return to full, unrestricted active duty service. The return to active duty rate was significantly higher in older patients and those ranking E7 and above (85%). No statistically significant differences in ability to return to full duty were found between differencing fusion techniques, the presence of tobacco use, differing surgical indications, or any other variables. Backwards stepwise logistical regression analysis demonstrated that age provided the best quality prediction for outcome.

Conclusion: Fifty-five percent of the service members who underwent a single level lumbar interbody fusion in our study returned to unrestricted full duty. Greater age and higher rank are statistically significant positive predictors of a successful return to active duty (85% rate of return). This information may be useful to military spine surgeons when selecting patients for surgical intervention or counseling preoperative patients.

109. Loss of Correction Does Not Influence Clinical Outcome following Anterior Cervical Fusion: Final Clinical Results of a Multicenter Randomized Controlled Study
Tobias Pitzen

Introduction: Within the first part of a multicenter randomized controlled trial we have shown (and already reported elsewhere), that the use of dynamic vs. rigid plates in cervical spine surgery results in faster fusion and lower implant complications if dynamic plates are used. A secondary objective of this study was to investigate loss of correction (segmental lordosis and height) as well as clinical outcome measurements and to analyse if clinical outcome depends of loss of correction.

Methods: 132 patients were included and assigned by randomization to one of the groups in which they received a routine anterior cervical discectomy and autograft fusion with either a dynamic plate or a rigid plate. At discharge, after three and six months and finally after two years, loss of lordosis, loss of segmental height, Visual Analogue Scale (VAS) for neck pain and for arm pain and Neck Disability Index (NDI) were recorded. An independent radiologist performed all radiographic measurements.

Results: The loss of segmental lordosis with respect to intraoperative X-ray was 1.3° at discharge and 4.3° after two years for the study group. For the control group, these values were 0.9°, 0.7°. The difference at two years was significant (p = 0.003). The loss of segmental height with respect to intraoperative X-ray was 0.8 mm at discharge and 2.9 mm after two years for the study group. For the control group, these values were 0.5 mm and 1.3 mm (p = 0.001). However, clinical postoperative outcome was not different for any of the asked parameters between the two groups through the postoperative follow-up and there was no significant correlation (as expressed by Spearman’s rho and p-value) for loss of segmental height or lordosis vs. any of the clinical parameters.

Conclusion: Loss of segmental lordosis and loss of segmental height are significantly higher if dynamic plates are used. This, however, does not result in differences regarding clinical outcome between dynamic and constrained plates.
Multivariate logistic regression indicated presence of bone fragment(s) within the comminution fracture (P = 0.0341) and degree of angulation (P = 0.0023), correlation of VAI with traumatic correlation between fracture types and VAI. 18 (17.8%) had VAI by MRI/A. There was no C2 fracturesthat met inclusion criteria, and fractures, based on fracture angulation and commination, and the occurrence of VAI.

Methods: Patients admitted to the hospital with C2 fractures between October 2006 and December 2008 to a tertiary care referral center were identified through a prospectively maintained database. CT and MRI/A studies were individually reviewed to evaluate the specific C2 fracture type and the occurrence of VAI. Fracture displacement and angulation were measured. Incidence of VAI was compared between different types and subtypes of C2 fractures. The effects of displacement and angulation of the fracture, morphology of foramen transversarium fracture, patient age, and patient gender on VAI were also analyzed.

Results: 101 patients were identified with C2 fractures that met inclusion criteria, and 18 (17.8%) had VAI by MRI/A. There was no correlation between fracture types and VAI. However, in subtype analysis, there was a correlation of VAI with traumatic spondylolisthesis of axis (TSA) and greater degree of angulation (P = 0.0023), comminution fracture (P = 0.0341) and presence of bone fragment(s) within the foramen transversarium (P = 0.0075). Multivariate logistic regression indicated that age, gender and the presence of fragments within foramen transversarium were associated with greater risk of VAI.

Conclusion: Vertebral artery injuries occurred more likely to occur in C2 fractures with comminuted fractures involving the foramen transversarium, with fractures manifesting bony fragment(s) within the foramen transversarium, or with fractures having greater angulation. These risk factors should be considered when a patient presents with isolated axis fracture.

Cervical Laminoplasty vs. Instrumented Posterior Cervical Fusion for Cervical Spondylotic Myelopathy
Sanjay S. Dhall, Jason M. Highsmith, Regis W. Haid, Jr., Gerald E. Rodls, Jr., Praveen V. Mummaneni

Introduction: Cervical stenotic myelopathy due to spondylosis or OPLL may be treated with a multilevel anterior procedure, cervical laminectomy (with or without fusion), and laminoplasty. A cohort of patients undergoing either laminoplasty or cervical laminectomy with lateral mass fusion was compared to evaluate operative complications, outcome scores, and implant costs.

Methods: 57 patients with cervical stenosis aged 42 to 81 were included in the study with 29 in the laminoplasty group and 28 in the laminectomy with fusion group. Patients who were kyphotic or had spondylolisthesis were excluded. Six patients were lost to follow-up. Pre/post-operative Nurick grades and Modified JOA scores were assigned. Outcomes were also assessed with Neck VAS scores and Odom’s criteria. Post-operative length of stay, complications and implant costs were calculated.

Results: Mean follow up, average age, and hospital length of stay were similar for both groups. Nurick scores were also similar and improved an average of 1.4 points in both groups. Modified JOA scores improved 2.7 points in laminoplasty patients and 3.1 points in fusion patients. Neck pain VAS scores worsened somewhat in the laminoplasty group from 3.04 (±2.77) pre-op to 3.54 (±2.62) post-op. Fusion patients improved from 5.57 (±3.29) pre-op to 2.62 (±1.95) post-op. Excellent/good Odom’s outcomes were observed in 78.6% and 79.2% of the laminoplasty and fusion group respectively. Complications were twice as common in the fusion group while implant costs were nearly three times higher.

Conclusion: Both laminoplasty and laminectomy with fusion patients had similar improvements in Nurick scores, JOA scores, and Odom outcomes. Patients who underwent fusion typically had higher neck pain pre-op, but improved significantly, while laminoplasty patients slightly worsened. Our series suggests cervical fusion reduces neck pain in patients with stenotic myelopathy but at a greater cost and operative risk than laminoplasty.

A Prospective, Randomized Trial Comparing Expansile Cervical Laminoplasty vs. Cervical Laminectomy and Fusion for Multi-level Cervical Compressive Myelopathy
Allan D. Levi, Gizelda T. Casella, Michael Y. Wang, Steven Vanni, Glen R. Manzano

Introduction: A prospective, randomized study comparing open door expansile cervical laminoplasty (ECL) vs. cervical laminectomy and fusion (CLF) with instrumentation for multi-level cervical stenosis and myelopathy was performed to determine clinical, radiological and patient satisfaction outcomes.

Methods: End-points included the SF-36, NDI, visual analog scales for neck, intrascapular and arm pain, myelopathy assessments and radiographic measures of cervical alignment, motion and spinal canal area.

Results: A total of 16 patients consented and were randomized: CLF (n = 7) / ECL (n = 9). There were minimal operative complications in each group but trends toward an increase in operative time, blood loss and length of stay was seen in the CLF group. Both groups (ECL and CLF) showed improvements in their Nurick grade and JOA score postoperatively, but only the improvement in the Nurick grade for the ECL group was statistically significant (p < 0.05). Improvements in neck pain, interscapular, arm pain, SF-36 and NDI were seen in both groups but significant improvements (p < 0.05) between pre- and post-op with-in patients were only seen in the ECL group. There was an increase in cervical kyphosis between C2 and C7 as measured by the neutral curvature index (CI) at 1 year in the ECL (-1.6°) group and to a greater extent in the CLF (-7.4°) group. The CI diff between C3 and C7 was reduced by 82% in the CLF group and by only 21% in the ECL group when comparing pre- and post-op range of motion. The overall increase in canal area was significantly (p < 0.01) greater in the CLF when measured at the 3 most stenotic levels. Conclusion: ECL compares favorably to CLF in all measures. While patient numbers are small, there were significant improvements in pain measures in the ECL group while still maintaining range of motion. Restoration of spinal canal area was superior in the CLF group.

Prospective, Non–randomized, Multi-center Clinical Evaluation of Extreme Lateral Interbody Fusion (XLIF) in the Treatment of Adult Scoliosis

Introduction: Surgical intervention in adult scoliosis has traditionally been by large open anterior and/or posterior procedures, with often unacceptable morbidity and risks to elderly comorbid patients. Minimally invasive treatment of adult scoliosis can be achieved with the XLIF approach.

Methods: A prospective, nonrandomized,
ORAL PLATFORM ABSTRACTS

114. Prospective Randomized Series Comparing Maverick™ Lumbar Total Disc Replacement (TDR) with Anterior Lumbar Interbody Fusion (ALIF) with Five-year Follow-up
Kenneth Peltine

Introduction: Data from an IDE clinical trial with five-year follow-up comparing the Maverick (25 patients) with ALIF (11 patients) was evaluated. All Maverick patients had two-year follow-up and 19 had five-year follow-up. Ten ALIF patients had two-year follow-up and seven had five-year follow-up.

Methods: Patients were randomized 2:1 (Maverick:ALIF). Indications for surgery were similar to lumbar fusion. Inclusion/Exclusion criteria and demographics will be discussed.

Results: Maverick pre-op Oswestry Disability Index (ODI) mean was 56; Two years post-op it was 15 for an average improvement of 74% (P<0.001). Five-year ODI was 9.6 (P<0.001). ALIF pre-op ODI mean was 58; at two-years it was 41 for an average improvement of 29% (P<0.05). Five-year ODI was 38.3. Maverick pre-op Visual Analog Scale (VAS) mean was 7; Two-year post-op was 2 for an average improvement of 71% (P<0.001). Five-year VAS was 1.5 (P<0.001). ALIF pre-vas was 8; Two-year was 6 for an average improvement of 25% (P<0.04). Five-year VAS was 6. Fourteen of the 19 Maverick patients had an ODI less than 10 and a VAS less than two at five-year follow-up. Clinical success was achieved in 84% of the Maverick patients and 55% of the ALIF patients. One Maverick patient required reoperation, none in the ALIF group.

One additional ALIF patient is awaiting posterior fusion. Average hospital stay for both groups was 1.6 days. Time to unrestricted activity averaged six weeks in the Maverick group and six months in the ALIF group. Overall patient satisfaction was 95% for Maverick and 78% for the ALIF.

Conclusion: These results simulate those reported by six other IDE sites at two-year follow-up. The combined results of 173 Maverick patients from seven IDE sites indicate statistical superior clinical outcomes compared to ALIF at one-year, and two-year follow-up (P<0.001). Two-year results were unchanged at five-year follow-up.

Jason A. Ellis, Michael Castelli, Peter D. Canoll, Jeffrey N. Bruce, Alfred T. Ogden

Introduction: The biology of intramedullary tumors is not well understood. The most common cycling cells in the adult spinal cord are neural progenitors that reside in the cord white matter, bear the marker NG2, and proliferate in response to PDGF. We have previously shown that PDGF overexpression within the rodent subcortical white matter is capable of driving neural progenitors to form cerebral gliomas; however, the effect of targeted intramedullary PDGF delivery to the spinal cord has not been investigated.

Methods: Wild-type, adult rats were anesthetized and stabilized on stereotactic frames. Exposure of the thoracic cord was achieved by performing one-level laminectomies. PDGF–IRES–GF retrovirus or PNT–GF viral virus was then slowly delivered to the exposed cords by midline intramedullary injections. PNT–GF rats were sacrificed after 2 days; PDGF–IRES–GF rats were sacrificed at the first sign of hindlimb dysfunction. Spinal cords were sectioned and analyzed histologically or processed for cell culture.

Results: PNT–GF labeled cells almost exclusively within the spinal cord white matter. These cells were NG2+Olig2+PDGF+ and phenotypically resembled oligodendroglial precursors. Rats injected with PDGF–IRES–GF became symptomatic from cord tumors between 40–87 days post–injection (dpi). Tumors were highly infiltrative and composed of cells organized within nests and sheets with interspersed vascular septations. Tumors were composed of both retrovirus infected (GF+) and uninfected (GF−) cells suggesting that autocrine and paracrine PDGF signaling play roles in tumor formation and progression. Tumors predominantly consisted of glial progenitor cells with the immunophenotype PDGFRα+/Olig2+. GFAP expression appeared to be limited to entrapped, non-neoplastic cells.

Conclusion: PDGF is capable of initiating the formation of intramedullary gliomas when delivered to the rat spinal cord. PDGF appears to drive spinal glioma formation by stimulating progenitors to proliferate through both autocrine and paracrine growth factor signaling. Using a retroviral approach to PDGF delivery we have created the first syngeneic spinal cord glioma model in a wild-type, non-transgenic rodent.

Peter Campbell, Jennifer Malone, Sanjay Yadla, Mitchell G. Malenfant, Ashwini D. Sharan, James S. Harrop, John K. Ratliff

Introduction: Few studies offer a direct examination of perioperative complications in spine surgery via prospective study. Most prospective assessments in the literature focus upon certain procedures, or limit their assessment to specific spinal implants. While an association between approach and complication incidence is assumed, no prospective study has addressed the impact of choice of approach on incidence of perioperative complications.

Methods: Two-hundred forty eight patients admitted to the neurosurgical service at Thomas Jefferson University Hospital from May to December 2008 were prospectively assessed. Patients were followed by an independent auditor. Data on preoperative diagnosis, demographics, and complication occurrence was analyzed. Medical adverse events were
included as complications. A previously validated binary definition of major and minor complications was employed to stratify the data.

**Results:** Overall complication incidence was 59.4%. Sixteen of 47 (34.0%) patients undergoing an anterior procedure had a perioperative complication; in patients having posterior approach, 64/129 (49.6%) experienced at least one complication. Patients undergoing an anterior/posterior (AP) surgical procedure had a complication incidence of 69.4% (50/72). Differences between the cohorts in the minor and overall complications groups were statistically significant (p=0.0093, 0.0005 respectively, Cochran-Mantel-Haenszel test). There was a lower incidence of minor and overall complications in the anterior alone group as compared to the posterior or AP groups (p=0.0255 and 0.0033 respectively, chi squared) for all spine surgery patients. Instrumented fusions were associated with more overall complications (p=0.0024).

**Conclusion:** A prospective approach and a broad definition of perioperative complications likely increased the recorded incidence of perioperative adverse events and complications. Limiting recall bias via the prospective nature of the study and an expansive definition of perioperative complications may also explain this increased incidence. Complications were more common in patients undergoing instrumented fusions, cervical posterior approaches, and any AP approach.

**117. An Analysis of Postoperative Thigh Symptoms after Transpsoas Interbody Fusion**
Matthew D. Cummock, Steven Vanni, Yong Yu, Michael Y. Wang

**Introduction:** The transpsoas interbody fusion technique requires dissection through the psoas muscle that contains the nerves of the lumbosacral plexus posteriorly and genital femoral nerve anteriorly. Retraction of the psoas is becoming recognized as a cause of transient postoperative thigh pain, numbness, dysesthesia and weakness. However, few reports have described the nature and survival of thigh pain after this procedure.

**Methods:** A single institution retrospective analysis of patients who underwent the transpsoas technique for lumbar spondylytic disease, disc degeneration, and spondylolisthesis treated at an academic medical center. Review of patient charts, including the use of detailed pain diagrams, investigated the survival of postoperative thigh pain, numbness, dysesthesia and weakness of the iliopsoas muscle in the follow-up period.

**Results:** Over a 2.2 year period, 59 patients underwent transpsoas interbody fusion surgery. 71% had thigh symptoms postoperatively. Nature of thigh pain at first follow-up visit: 81% burning, aching or stabbing, 71% numbness, 21% dysesthesia and 45% weakness (relative to preop). Survival analysis showed at 400 days postop, these percentages decreased to 18%, 12%, 10% and 13% respectively. Within the patient sample: 40% had a 1–level and 33% had a 2–level operation; L2/3, L3/4 and L4/5 were the most frequent sites (57%, 60% and 57%). More caudal surgery sites were associated with postoperative thigh weakness (p=0.0286) but not pain, numbness or dysesthesia. The number of levels operated had no clear association with thigh pain, but did correlate directly with surgical time, intraoperative blood loss and length of hospital stay.

**Conclusion:** Lateral interbody fusion is associated with high rates of postop thigh symptoms. While larger, prospective studies are necessary to validate these findings, we found thigh symptoms tend to resolve over a one-year period.
Mayfield Basic Science Award 118.
Role of the Direct and Indirect Pathways in Nerve Allograft Rejection

Introduction: Nerve allograft transplantation provides a temporary scaffold for host nerve regeneration and allows for the repair of significant segmental nerve injuries. The requirement for systemic immunosuppression limits the current clinical utilization of nerve allografts. Characterization of the immunological mechanisms involved in the induction of immune hyporesponsiveness provided by cold preservation and costimulatory blockade will help provide a basis for optimizing immunomodulating regimens or manipulating donor nerve allografts to minimize or eliminate the need for global immunosuppression.

Methods: We utilized C57Bl/10 (B10) mice and MHC class II deficient (MHC-/-) C57Bl/6 mice, as both recipients and donors. A non-vascularized nerve allograft was used to reconstruct a 1 cm sciatic nerve gap. Progressive cold preservation of donor nerve allografts was utilized or Triple costimulatory blockade of the CD40, CD28/B7, and ICOS pathways. Immunohistochemistry and electrophysiology data indicated that the motor axons within the thoracic nerve bridge regenerated into the cat spinal cord and formed functional synapses. Cadaveric surgeries resulted in isolation of sufficient spinal accessory nerve to allow insertion from the C4–C8 levels. Sections of the terminal nerve segment inserted at each level revealed approximately 1400 myelinated axons at each level. The T5–T12 intercostal nerves were similarly inserted into multiple thoracic and lumbar levels. Conclusion: Our results indicate formation of synapses between regenerating bridge motor axons and spinal cord neurons is not species specific. We have further demonstrated anatomic feasibility of this nerve bridge strategy in human cadavers for the treatment of both cervical and thoracic spinal cord injuries. We are currently preparing a clinical trial to examine the potential of this promising therapy in human spinal cord injury.

Mayfield Clinical Science Award 119.
Spinal Accessory and Intercostal Nerves to Bypass Spinal Cord Injury
Raqeeb M. Haque, Michael Kellner, Martin Bauknight, Christopher P. Kellner, Kurenai Tanji, John H. Martin, Christopher J. Winfree

Introduction: Spinal cord injury is a devastating disorder. Previous studies in our lab have demonstrated that it is possible to bypass the site of injury in a rat using a spinal nerve bridge. This nerve bridge consists of a peripheral nerve arising from the spinal cord rostral to the site of injury inserted into the spinal cord caudal to the site of injury. The aim of this study is to translate the nerve bridge procedure into both a cat and human cadaveric model.

Methods: Experiments were conducted in adult cats (n=19) and human cadavers (n=2). Animals were hemisected at the L1 spinal level, and the cut end of the subcostal nerve, arising from the T13 level, was inserted into the L2 spinal cord. Subsequent molecular and functional studies were performed. In human cadavers, the T5–T12 intercostal nerves were inserted into the thoracic and lumbar spinal cord, while the spinal accessory nerve was inserted into the cervical spinal cord.

Results: Immunohistochemistry and electrophysiology data indicated that the motor axons within the thoracic nerve bridge regenerated into the cat spinal cord and formed functional synapses. Cadaveric surgeries resulted in isolation of sufficient spinal accessory nerve to allow insertion from the C4–C8 levels. Sections of the terminal nerve segment inserted at each level revealed approximately 1400 myelinated axons at each level. The T5–T12 intercostal nerves were similarly inserted into multiple thoracic and lumbar levels. Conclusion: Our results indicate formation of synapses between regenerating bridge motor axons and spinal cord neurons is not species specific. We have further demonstrated anatomic feasibility of this nerve bridge strategy in human cadavers for the treatment of both cervical and thoracic spinal cord injuries. We are currently preparing a clinical trial to examine the potential of this promising therapy in human spinal cord injury.

Outcomes Committee Award 120.
Multilevel ACDF with and without BMP: A Comparison of Outcomes and Dysphagia Rates in 150 Patients
Daniel C. Lu, Dean Chou, Gerald E. Rodts, Jr., Praveen V. Murmaneni

Introduction: Reported complications of rhBMP-2 use in ACDF include dysphagia and cervical swelling. To date, there has been no comparison study comparing the dysphagia rates of multilevel ACDF patients treated with allograft spacers to those who underwent ACDF using PEEK cages with BMP. We report the first such comparison between two patient cohorts.

Methods: We retrospectively reviewed 150 patient records. Group 1 (BMP group) consisted of 100 multilevel ACDF with rhBMP-2 (PEEK cage, BMP, plate) patients. Group 2 (allograft group) included a matched control group of 50 multi-level ACDF patients treated with allograft spacers and plate (without rhBMP-2). Patient demographics were not different between the groups. Standard outcome measures were assessed.

Results: Mean follow-up was 35 months for Group 1 and 25 months for Group 2. There was a complication rate of 15.7% in ACDF with BMP cases compared to 9.3% in ACDF with allograft cases (p<0.005). There was no significant difference in overall dysphagia incidence between the two groups (40% vs 44%, respectively). However, there was a significant difference in the severity of dysphagia (dysphagia score) between the two groups: 0.757 for the BMP Group vs 0.596 for the allograft Group 2 (p<0.005). The use of rhBMP-2 significantly increased the severity of dysphagia in 2-level ACDF patients (p<0.005), this was not observed in 3- or 4-level ACDF patients. There was no pseudoarthrosis in Group 1 (BMP group) compared to a 16.9% pseudoarthrosis rate in Group 2 (allograft group) (p<0.05).

Conclusion: The use of rhBMP-2 in 2-level ACDF patients significantly increases the severity of dysphagia (dysphagia score) without affecting the incidence of dysphagia. The use of rhBMP-2 eliminates the risk of pseudoarthrosis. This benefit is most pronounced in 4-level ACDF patients who are smokers.
**ORAL POSTER ABSTRACTS**

Thursday and Saturday, February 18 and 20  Sebastian Ballroom I–182 and L

Five–minute presentations by the primary authors are followed by a short discussion period during these concurrent sessions.

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**200. Minimal Access Surgery for the Correction and Treatment of Adult Degenerative Scoliosis**

Michael Y. Wang, Matthew D. Cummock

**Introduction:** Adult degenerative scoliosis can be a cause of intractable pain, decreased mobility, and reduced quality of life. Surgical correction of this problem frequently leads to substantial clinical improvement, but advanced age, medical co-morbidities, osteoporosis, and the rigidity of the spine results in high surgical complication rates. Minimally invasive surgery (MIS) is being applied to this patient population in an effort to reduce the high complication rates associated with adult deformity surgery.

**Methods:** A retrospective study was undertaken to assess the clinical and radiographic results with MIS thoracolumbar deformity surgery (defined as a Cobb angle $>25^\circ$), and 23 patients were identified with greater than one--year follow-up. All patients underwent a lateral interbody fusion followed by posterior percutaneous screw fixation and TLIF at levels below L4. A mean of 3.87 intersegmental levels were treated (range of 1–7).

**Results:** Mean pre-operative Cobb angle was 41°, corrected to $13^\circ$ at early follow-up, and $16^\circ$ at one year. Mean blood loss was 374 cc and operative time was 310 minutes. Mean VAS improvement for axial pain was 4.7 cm. Clear evidence of radiographic evidence of fusion was seen on X-ray at 80 of 89 treated levels, with no clear pseudarthroses. Complications included two returns to the OR, one for CSF leakage, and one for hardware pullout. One patient had an early screw–rod disarticulation. Medical complications included: postoperative ileus ($47\%$), atelectasis ($13\%$), and UTI ($4\%$). There were no wound infections, pneumonias, DVT’s, and no cases with new neurological deficits.

**Conclusion:** MIS treatment of adult deformities is a promising method for reducing surgical morbidity. Numerous challenges exist, as the surgical technique does not yet allow for all of the correction maneuvers used in open surgery. However, as the techniques are advanced, the applicability of MIS for this population will likely be expanded and affords the opportunity for reduced complications.

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**201. Efficacy and Safety of Large Doses of Tranexamic Acid in Spine Surgery: Randomized Placebo–controlled Study**

Sherif M. El-Watidy, Essam Elgamal, Zain Alabedeen Jamjoom

**Introduction:** Tranexamic acid (TA) is used routinely to reduce bleeding in cardiac, orthopaedic and hepatic surgery, however, its use in neurosurgery is uncommon and only few studies reported the use of antifibrinolytic drugs in spine surgery.

**Methods:** It is a randomized placebo–controlled study included 64 consecutive patients undergoing major spinal surgery at KKUH between June 2005 and December 2006. Drugs were given as A loading dose, followed immediately by continuous infusion during surgery and for 5 hours after the operation. Outcome measures included total (i.e. intraoperative and postoperative) blood loss, amount of blood transfusion, as well as postoperative haemoglobin and haematocrit levels. The data were analysed by means of Statistical Package for the Social Science (SPSS) version 12.0. The results were presented as mean ± SD. Independent t-test was used to compare the two groups and differences were considered significant if the P-value was $<0.05$.

**Results:** 39 males and 25 females, age from 4 to 86 years, mean age was 51 years. The two groups of patients (Tx Acid/placebo) were matching with regard to age, sex, weight, preoperative haemoglobin and haematocrit levels, type of surgery as well as operative time. Patients who received TA had 49% reduction of blood loss ($p < 0.007$) and required 80% less blood transfusion ($p < 0.008$). The hospital stay was shorter in the TA group, but it did not achieve statistical significance. There were no complications related to the use of large doses of TA in this study.

**Conclusion:** Large dose of tranexamic acid is effective, safe and cheap method for reducing blood loss during and after surgical operations. Tranexamic acid reduced not only transfusion related complications but also operative expenses. A multi-center study is required to establish routine use of Tranexamic acid in spine surgery where excessive blood loss is anticipated.

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**202. The Accuracy of Intraoperative Electromyographic Monitoring to Determine the Presence of Malpositioned Pedicle Screws in the Lumbosacral Spine: An Analysis of 2,450 Consecutive Screws**

Scott Parker, Matthew J. McGirt, Anubhav Amin, S. Harrison Farber, Ali Bydon, Daniel M. Scibba, Jean-Paul Volinksy, Ziya L. Gokaslan, Timothy F. Wilham

**Introduction:** Pedicle screws provide efficient stabilization of the spine. However, pedicle screws can be technically demanding to place with malposition rates ranging from 5–10%. Intra-operative electromyographic (EMG) monitoring has the capacity to objectively identify a screw breaching the medial pedicle cortex. The purpose of this study is to describe and evaluate our 7-year institutional experience with intra-operative EMG monitoring during placement of lumbar pedicle screws and determine its clinical utility.

**Methods:** 2450 consecutive lumbar pedicle screws placed in 418 patients between June 2002–June 2009 were retrospectively studied. All pedicle screws were inserted with free hand technique using anatomic landmarks, stimulated at increasing amplitudes (1.0–10.0 mA), and evaluated with CT imaging 24 hours after surgery. Medial pedicle screw breach was defined as $\geq$25% of screw diameter extending outside of the pedicle on CT or intra-operatively confirmed medial breach at time of positive EMG response. The sensitivity/specificity of EMG monitoring at detecting the presence of a medial screw breach was evaluated based on the following definitions: 1) True positive: positive EMG stimulation confirmed as a breach intraoperatively or on post–operative CT. 2) False positive: positive EMG stimulation confirmed as correctly positioned on post–operative CT. 3) True negative: no EMG stimulation confirmed as correctly positioned on post–operative CT. 4) False negative: no EMG stimulation confirmed as a breach on post–operative CT.

**Results:** Screw distribution per spinal level is depicted in Table 1. 115 (4.7%) pedicle screws showed positive stimulation during intra-operative EMG monitoring. At stimulation threshold $>7.0$ mA, specificity
of positive response was only 1.3%. At threshold between 5.0–6.9 mA, specificity of positive response was 15.4%. However, at threshold >5.0 mA, specificity of positive response was 90.1%, Table 2. At thresholds of >7.0 mA, 5.0–6.9 mA, and >5.0 mA, sensitivity to detect medial breach was 63.6%, 59.1%, and 50.0%, respectively.

Conclusion: When utilizing intra-operative EMG monitoring, positive response to screw stimulation thresholds >5.0 mA were highly inaccurate (85% false positives) with marginal sensitivity (59%). Our experience suggests that positive responses to thresholds >5.0 mA warrant immediate intra-operative investigation for a malpositioned screw but may be a poorly sensitive intra-operative screening tool for medial screw breach.

203. Accuracy of Free Hand Pedicle Screws in the Thoracic and Lumbar Spine: Analysis of 6,816 Consecutive Screws
Scott Parker, Matthew J. McGirt, Anubhav Amin, S. Harrison Farber, Anne-Marie Rick, Ali Bydon, Daniel M. Scuibba, Jean-Paul Wolinsky, Ziya L. Gokaslan, Timothy F. Witham

Introduction: Pedicle screws are routinely utilized throughout the vertebral column because of their proven effectiveness in stabilizing all three columns of the spine. However, pedicle screws remain technically demanding to place, particularly in the thoracic region due to the smaller size and more complex morphology of thoracic pedicles. The purpose of this study is to describe and evaluate our 7-year institutional experience with the placement of pedicle screws in the thoracic and lumbar spine utilizing free hand technique.

Methods: We retrospectively reviewed the records of all patients undergoing free-hand pedicle screw placement without fluoroscopy in the thoracic or lumbar spine between June 2002 and June 2009. The incidence and extent of cortical breach by a misplaced pedicle screw was determined by review of post-operative CT scans which were obtained within 24 hours of all surgeries. We defined breach as >25% of screw diameter residing outside of the pedicle or vertebral body cortex, Figure 1.

Results: 964 patients received free-hand pedicle screw placement in the thoracic or lumbar spine at our institution over the period reviewed. The indications for hardware placement are depicted in Figure 2. In total, we analyzed 6816 consecutive pedicle screws placed via free hand technique. The spinal level of placement is depicted in Figure 3. 115 of 6,816 consecutive pedicle screws were identified to breach the pedicle or vertebral body cortex on post-operative CT scan, Figure 4. Breast occurrence more frequently in the thoracic vs lumbar spine (2.5% vs 0.9%, p<0.0001) and was more often lateral (61.3%) than medial (32.8%) or superior (2.5%). These breaches occurred in 87 (9.0%) patients. T4 (4.1%) and T6 (4.0%) experienced the highest breach rate while L5 and S1 had the lowest breach rate. Eight (0.8%) patients underwent a revision surgery to correct a malpositioned screw.

Conclusion: Free hand pedicle screw placement based on external anatomy alone can be performed with acceptable safety and accuracy and allows avoidance of radiation exposure encountered in fluoroscopic techniques. Image-guided assistance may be most valuable when placing screws between T4 and T6 where breach rates are highest.

204. Surgical Factors Associated with Recurrent Back Pain and Cyst Recurrence after Surgical Resection of Spinal Synovial Cysts: Analysis of 160 Consecutive Cases
Scott Parker, Matthew J. McGirt, Risheng Xu, Jean-Paul Wolinsky, Timothy F. Witham, Ziya L. Gokaslan, Ali Bydon

Introduction: Segmental instability is thought to contribute to the formation and recurrence of spinal synovial cysts. The largest reported series to date remains limited to forty patients. Hence, the association between extent of decompression and recurrent back pain and cyst formation remain unknown. Furthermore, the role of fusion remains uninvestigated in this setting.

Methods: We retrospectively reviewed 160 consecutive patients undergoing surgical management of symptomatic lumbar synovial cysts at a single institution. The incidence of post-operative mechanical back pain and recurrent cyst formation was compared between patients undergoing increasing extent of resection; hemi-laminectomy (n=50), laminectomy with facet preservation (n=23), laminectomy with partial medial facetectomy (n=17), and facetectomy and instrumented fusion (n=70) via proportional hazards regression analysis.

Results: 151 (94%) patients presented with radiculopathy, 130 (82%) with mechanical back pain, 30 (18%) with neurogenic claudication, and 4 (2.5%) with bladder dysfunction. Cyst level was L1-2 in 4 (2.5%) patients, L2-3 in 5 (3%), L3-4 in 34 (21%), L4-5 in 98 (61%), and L5-S1 in 24 (15%) patients. Post-operatively, leg pain and back pain improved in 133 (88%) and 118 (91%) patients, respectively. By mean follow-up of 24 months, 53 (33%) patients developed recurrent back pain, 52 (32%) recurrent leg pain, and 5 (3%) recurrent synovial cysts. Spinal level, gender, age, cyst size, smoking, obesity, osteoporosis, and grade I spondylolthesis were not associated with outcome. Fusion was associated with a decrease in recurrent cyst formation (0%) compared to hemilaminectomy (4%) and partial medial facetectomy (17%), p<0.01, Figure 1. Increasing the extent of decompression to involve the medial facet was associated with increased hazard of recurrent back pain (p<0.01), Figure 2. This incidence was reduced with the addition of segmental fusion after medial facetectomy.

Conclusion: The vast majority of patients undergoing decompression and excision of lumbar synovial cysts will experience improvement in back and leg pain. However, by two years after surgery, up to one-third may develop mechanical back pain. Decompression that disrupts the medial facet is associated with increased recurrent back pain and cyst recurrence. In cases requiring medial facetectomy for adequate cyst excision, segmental fusion may reduce recurrent back pain and eliminate recurrent cyst formation.

205. A Revised Spinal Instability Neoplastic Score (SINS): Final Results of a Validity and Reliability Analysis
Daryn R. Fournier, Evan Mark Frangou, Timothy C. Ryken, Charles Fisher

Introduction: Standardized indications and treatment for tumor-related instability is hampered by the lack of a valid and reliable classification system. The Spine Oncology Study Group (SOSG) developed the Spinal Instability Neoplastic Score (SINS), which determines an instability score and treatment recommendation by quantifying several clinical and radiologic factors. The system was recently revised to simplify scoring and include consideration of bone quality and non-mechanical back pain. The objective of this study was to determine the validity and reliability of the revised SINS scoring system.

Methods: Relevant clinical and radiographic data from 30 de-identified cases of spinal tumor were assessed by 24 SOSG members. Consensus opinion of SOSG members was used to categorize each case as stable, potentially unstable,
and unstable. On two separate occasions, each rater scored each case using the SINS. Each numerical score was converted to a 3–category data field, with 0–4 as stable, 5–9 as potentially unstable, and 10+ as unstable. Inter-rater and intra-rater reliability for overall scores was assessed by intra-class correlation (ICC). Validity and reliability of final SINS category were assessed with a kappa statistic.

Results: Overall kappa for agreement between SINS category (stable, potentially unstable, unstable) and the reference standard (validity) was 0.759 (0.714 – 0.803, 95% CI), which is substantial agreement. Inter-rater and intra-rater reliability for overall score were (ICC) 0.846 (0.773 – 0.911, 95% CI) and 0.886 (0.868 – 0.902, 95% CI) respectively. This represents moderate agreement. Inter-rater and intra-rater reliability for final SINS category (kappa) were 0.608 (0.579 – 0.637, 95% CI) and 0.726 (0.677 – 0.775, 95% CI). These represent moderate and substantial agreement, respectively.

Conclusion: SINS appears to be a reliable and valid classification system for spine instability due to tumor. Real-world application of SINS will need to be evaluated in a prospective fashion.

206. C5 Radiculopathy as a Complication of Cervical Spine Surgery
James Richman, Kenneth Defontes, Hasan Zaidi, Timothy Flerlage, Camilo A. Molina, Wesley Hsu, Ali Bydon, Ziya L. Gokaslan, Timothy F. Witham, Jean-Paul Wolinsky, Daniel M. Sciubba

Introduction: C5 radiculopathy is an uncommon occurrence after cervical spine surgery. The risk factors for the development of this complication are unclear. We sought to elucidate the incidence and risk factors for this complication based on consecutive cases performed at a single institution. We also sought to determine risk factors influencing the clinical severity of C5 radiculopathy.

Methods: 972 consecutive cases of cervical spine surgery performed at a single institution between 2002–2008 were reviewed. Demographic data, details of surgery, and complications including post-operative C5 radiculopathy were collected for each patient. C5 radiculopathy was classified based on clinical features (motor–dominant vs. sensory–dominant) and degree of severity (mild, moderate, severe).

Results: Of the 972 cervical spine cases, 48 patients (4.9%) developed postoperative C5 radiculopathy with a median onset of 4 days. C5 weakness was found in 30 patients (3.1%) with a median onset of 1.5 days. Of the 30 cases of radicular weakness, 27%, 50% and 23% were of a mild, moderate and severe degree, respectively. The risk of C5 weakness in cases involving only the anterior approach was .7% compared to a risk of 4% in cases involving the posterior approach. The relative risk of postoperative C5 weakness in the posterior approach compared to the anterior approach was 5.6 (95% CI = 1.3 – 23.2). Presence of instrumentation was not associated with increased risk of C5 radicular weakness. Severity of C5 weakness was independent of both surgical approach and presence of instrumentation.

Conclusion: A retrospective review of a large, single–institution series of patients undergoing cervical spine surgery suggests that post-operative C5 radiculopathy is an uncommon occurrence. Risk of C5 radiculopathy may be higher in patients undergoing posterior compared to anterior surgery, and the use of instrumentation was not a risk factor for developing radiculopathy. In patients who developed C5 radiculopathy, the surgical approach or presence of instrumentation had no influence on the severity of symptoms.

Elias Rizk, Jonas Sheehan, G. Timothy Reiter, James McInerney, John Paul Kelleher

Introduction: Surgical treatment of odontoid fractures is recommended by many spine surgeons to prevent sudden neurologic injury or progressive myelopathy. Less aggressive approach to the treatment of odontoid fractures has been advocated by some authors especially in the elderly or frail population. Very few reports have followed up patients outcomes following conservative treatment of odontoid fractures.

Methods: 101 patients with traumatic odontoid fracture admitted to the Pennsylvania State Hershey Medical Center between 1998 and 2008. Fractures were defined using a CT scan according to the Anderson D’Alonzo Classification. Conservative treatment was pursued in appropriately selected patients.

Results: Fifty-nine patients were selected to be treated conservatively. Sixteen patients were surgically stabilized secondary to failure of radiographic imaging and continued neck pain. The Forty–three remaining patients had stable imaging studies and with no other complaints. None of the patients developed myelopathic symptoms during the follow–up period.

Conclusion: Our results indicate that a select group of patients with odontoid fracture who are deemed stable on initial evaluation in a cervical orthosis may be effectively managed conservatively. None of the patients who were managed conservatively had clinical worsening during the period of management. The decision to proceed with surgical treatment was based on failure of resolution of neck pain or worsening or concerning instability on imaging studies. However in many patients, even elderly patients in a surgical risks are greater, many odontoid fractures can be safely managed in a cervical orthosis.

208. International Differences in Preference for Timing of Surgical Intervention in Spinal Cord Injury
Doron Rabin, Michael G. Fehlings, William Sears, David W. Cadotte, Bizhan Aarabi

Introduction: The optimal timing of decompressive surgery for acute spinal cord injury is controversial. This study aims to characterize regional differences regarding preference for optimal timing of surgical decompression of the injured spinal cord.

Methods: A 20 question survey was sent to orthopedic and neurosurgical spine surgeons around the world. Response frequencies were compiled based on geographic region. A Chi square statistic was used to compare response frequencies based on geographic region with regards to practice resources and preference for timing of surgery in different acute spinal cord injury scenarios.

Results: A total of 971 spine surgeons responded to the survey. Approximately 27 percent of respondents practiced in North America, 25 percent in Europe, 15 percent in Central/South America, 11 percent in Southeast Asia, 9 percent in the Greater Middle East, 8 percent in Southwest Asia, 3 percent in Australia/New Zealand and 2 percent in Africa. North American and European respondents were more likely to prefer decompressing a complete cervical spinal cord injury within 4 to 6 hours, while Southwest Asian and Central/South American respondents were more likely to prefer decompressing within 24 to 48 hours (p less than 0.001).
209. Biomechanical Comparison of C7 Lateral Mass vs. Pedicle Screws in Subaxial Cervical Constructs
Risheng Xu, Matthew J. McGirt, Edward Grant Sutter, Scott Parker, Daniel M. Scibba, Jean-Paul Wolinsky, Timothy F. Witham, Ziya L. Gokaslan, Ali Bydon

Introduction: Subaxial lateral mass constructs remain one of the most commonly employed means of stabilizing the C-spine, yet no study has investigated the biomechanics of C7 lateral mass vs. pedicle screws in these constructs. Here, we present the first in vitro biomechanical comparison of immediate and post-cyclical rigidities of C7 lateral mass vs. C7 pedicle screws in posterior C4–C7 constructs.

Methods: Ten human cadaveric spines underwent C4–6 lateral mass screw and C7 lateral mass (n=5) vs. pedicle (n=5) screw fixation. Spines were potted in polymethylmethacrylate bone cement and placed on a materials testing machine. Rotation about the axis of bending was measured using reflective markers and motion capture cameras. The motion of C4 relative to C7 in flexion-extension and lateral bending was assessed using fluoroscopy, immediately after instrumentation, and following 40,000 cycles of 4 Nm flexion-extension and lateral bending moments at 1 Hz. The effect of instrumentation and cyclical loading on rotational motion across C4–C7 was analyzed for significance.

Results: Pre-instrumented spines were comparable in bone mineral density and range of motion both in flexion/extension (p=0.33) and lateral bending (p=0.16) for both cohorts. Compared to pre-instrumented spines, lateral mass and pedicle screw constructs significantly reduced motion during flexion-extension (11.3 degrees to 0.26 for lateral mass screws, p=0.002; 10.51 to 0.30 for pedicle screws, p=0.008) and lateral bending (7.38 to 0.27, p=0.003; 11.65 to 0.49, p=0.03) after cyclical loading. Rotation about the axis of bending was increased during flexion-extension (0.26 to 0.68 for lateral mass screws; 0.30 to 1.31 for pedicle screws) and lateral bending (0.27 to 0.39; 0.49 to 0.80) in both groups, although this was not statistically significant (p=0.05). There was no statistical difference in post-cyclical flexion/extension (p=0.20) and lateral bending (0.10) between lateral mass vs pedicle screws.

Conclusion: Both C7 lateral mass and C7 pedicle screws allow for equally rigid fixation of subaxial lateral mass constructs ending at C7. Both immediately and within a simulated six-week post-fixation period, C7 lateral mass screws may be as effective as C7 pedicle screws in biomechanically stabilizing long subaxial lateral mass constructs.

210. Treatment of Gait and Sensory Changes in Experimental Disc Herniation Radiculopathy by Local and Sustained Anticytokine Delivery
Mohammed F. Shamji, Kyle D. Allen, Mosfata Gabr, Samuel B. Adams, Brian Mata, Jannu Chen, Liufang Jing, William J. Richardson, Lori A. Setton

Introduction: Disc–herniation induced radiculopathy may arise from mechanical compression and biochemical inflammation of apposed neural elements. This study evaluated how local administration of anticytokine treatment affects established gait and behavioral changes in an animal disc–herniation disease model. The selected agent was a tumor necrosis factor (TNF) soluble decoy receptor (sTNFRII). We also observed the efficacy of this treatment co-administered with an in–situ forming chitosan carrier sustaining drug release over time.

Methods: Sprague–Dawley rats underwent surgical procedure including harvesting autologous nucleus pulposus (NP) from a tail intervertebral disc and exposure of the L5 dorsal root ganglion (DRG). Control animals (n=6) underwent exposure only, and experimental animals received NP placement onto the DRG with no treatment (n=6), local delivery of sTNFRII (n=6), local placement of chitosan (n=6), and combined delivery of sTNFRII with chitosan (n=6). Animals were evaluated at one week for mechanical allodynia by Von Frey testing, for stance symmetry by incapacitance meter measurement, and for gait symmetry by digitized video analysis.

Results: Persistent mechanical allodynia was observed in rats subjected to NP stimulation compared with controls, with 50% withdrawal threshold dropping from 15g preoperatively to 3g postoperatively (Figure 1). This heightened sensitivity had the functional consequence of stance asymmetry in the injured group, with animals preferentially loading the contralateral hindlimb (Figure 2). Treatment with sTNFRII alone or in combination with chitosan reversed the mechanical allodynia and restored stance symmetry. Such effects were not observed with the drug carrier alone.

Conclusion: Non–compressive disc herniation leads to mechanical allodynia and altered stance symmetry in an animal disease model. Such changes are effectively reversed by local immunomodulator treatment, alone or when administered with a sustained-release carrier, further implicating pro-inflammatory cytokines in this phenotype. Further work will elucidate the benefits of locally sustained drug release in this model.

211. Treatment with Combined Immunomodulatory Therapy Results in Early Bladder Recovery after Experimental Spinal Cord Injury
Daniel J. Hoh, Christopher A. Iannotti, Hai–Hong Jiang, Ran Harel, Megan Clark, John H. Shin, Nico van Rooijen, Margol Damaser, Michael P. Steinmetz

Introduction: Spinal cord injury (SCI) results in devastating neurolologic impairment. While motor and sensory deficits may improve, loss of bladder function after SCI is associated with worse prognosis. Recently, we demonstrated that immunomodulatory therapy with either peripheral macrophage depletion or cAMP elevation improved motor function following experimental SCI, with combined treatment showing even greater recovery. To assess whether the same immunomodulatory strategy is neuroprotective of bladder function, we performed bladder physiologic testing in control and treated animals following SCI.

Methods: Rats were subjected to T9 weight–drop spinal cord contusion. Post–SCI, animals underwent treatment with either: A) control, B) cAMP elevation, C) peripheral macrophage depletion, D) combined therapy. External urethral sphincter electromyography (EUS–EMG) and transurethral bladder pressures (TU–BP) were recorded during filling cystometry (5ml/h) on post–injury days 1, 7. Bladder function was compared to non–SCI animals.

Results: Non–SCI animals demonstrated stable baseline TU–BP and coordinated EUS–EMG response with large amplitude, low frequency bladder contractions (Figure 1). Post–injury day 1, all SCI animals (controls, treated) showed weak EUS–EMG response with low amplitude,
high frequency bladder contractions (Figure 2A). During filling cystometry, SCI animals demonstrated increasing baseline TU-BP, signifying incomplete bladder emptying (Figure 2B). Post-injury day 7, animals treated with immunomodulatory therapy still had low amplitude, high frequency bladder contractions. Combined treatment, however, showed larger amplitude contractions than single treatment. Treated animals also demonstrated return of EUS–EMG response (Figure 3A) with bladder contractions, and stable baseline TU-BP (Figure 3B) signifying bladder function in process of recovery. Controls had no improvement at the same time-point (Figure 4).

Conclusion: Loss of bladder function after experimental SCI is characterized by low amplitude, high frequency bladder contractions and incomplete bladder emptying. Neuroprotection with immunomodulatory therapy results in early recovery of bladder function by post-injury day 7, despite continued abnormal amplitude and frequency bladder contractions. Further evaluation at later time-points may demonstrate return to normal bladder contraction pattern.

212. Clinical and Radiographic Outcomes of C2 Translaminar Screw Fixation
Ian G. Dorward, Neill Marshall Wright

Introduction: C2 translaminar screws offer similar biomechanical stability as other C2 fixation methods, but with greater technical ease and limited risk to neural and vascular structures. To advance the understanding of C2 translaminar screw fixation, we report our experience with the technique since 2002.

Methods: 52 consecutive patients with cervical disorders requiring axis stabilization were treated with C2 translaminar screws by a single surgeon between 2002 and 2009. All patients underwent preoperative plain radiographs and CT scans to confirm feasibility of screw placement. Patients were followed with serial flexion/extension radiographs and/or CT scans to assess fusion; indicators of fusion included absence of motion on dynamic radiography and evidence of bony bridging across instrumented levels.

Results: Average age at surgery was 58.1 years (range 15.8–90.8). Surgical indications included trauma (63%), degenerative (17.3%), congenital (7.8%), inflammatory (5.8%), and other (5.8%). A total of 103 C2 translaminar screws were placed (average length 28.9 mm, diameter 3.5 or 4 mm). No vascular or neurologic injuries occurred. Ventral cortical disruption occurred with 2 screws, without CSF leak, and was managed by placing shorter (20mm) screws. Fusion was augmented in some cases with structural grafts (19 patients) or bone morphogenetic protein (21 patients). 40 patients had sufficient follow-up (average 13.3 months) to evaluate fusion; 1 possible pseudoarthrosis was identified in a patient with fractured C1 screws, though imaging indicated successful bony fusion and no revision was required. Other surgical complications included one durotomy and one C2 distribution dysesthesia. 5 patients (average age 78.7 years) died within 2 months of surgery from complications related to medical comorbidities.

Conclusion: This study reports on 103 C2 translaminar screws, the largest single-surgeon series to date. The findings suggest that C2 translaminar screws are a technically feasible, low-risk, robust option for C2 fixation, with a 97.5% fusion rate in this series.

213. Functional Organization and Behavioral Significance of the Rostral Spinocerebellar System in Primates
Ran Harel, Nofya Zinger, Oren Cohen, Yifat Prut

Introduction: The spinocerebellar pathways inform the cerebellum the state of the periphery as well as the excitability of lower motor centers. This motor-related feedback is necessary for several cerebellar functions such as error correction, motor learning, reflex gain regulation and multi-joint coordination. Forelimb information is delivered via the cuneocerebellar tract (CCT) and the rostrocerebellar tract (RSCT). While the anatomy of these pathways was extensively studied, information about their function was derived mainly from reduced preparation. Hence, the functional contribution of these pathways to motor control is yet unknown.

Methods: Two monkeys were trained to perform an isometric wrist task with two hand postures (pronation and supination). Stimulating electrodes were chronically implanted in the ipsilateral superior cerebellar peduncle (SCP). Spinal chamber was implanted above the cervical spinal cord (C5-T1). Spinal, cortical and muscle activity was recorded during task performance.

Results: We found a substantial number of spinal neurons located at the deep dorsal horn which were antidromically activated by SCP stimulations. A smaller proportion of spinal neurons were activated post-synaptically, possibly via intra-spinal collaterals. RSCT neurons were passively activated by proximal and not distal joints. The task-related firing of these neurons was consistent with a role in movement adjustment and not control of motor actions. Finally, interrupting the flow of information in this route, using deep brain stimulation caused an increased in reaction time while other motor parameters were unchanged.

Conclusion: Our results suggest that the RSCT is a robust pathway which has local and ascending impacts. The response and firing properties of these neurons may indicate their role in inter-joint coordination of motor action. Finally, the information conveyed by this pathway may be necessary for proper timing of voluntary movements.

214. The Result of Early Decompression for Acute Traumatic Central Cord Syndrome
Insoo Kim

Introduction: Acute traumatic central cord syndrome (ATCCS) occurs usually in an older age group, and the timing of surgery is yet more controversial. And ATCCS has been treated conservatively because most patients improved spontaneously. The goal of this study is to assess the safety and efficacy of the patients with ATCCS receiving early decompressive surgery as compared with conservative management.

Methods: A retrospective study was conducted in 49 patients with ATCCS between March 2004 and July 2007. 31 patients were treated with early decompression and 18 patients were treated conservatively. Early decompression was performed within 24 hours after the trauma. All patients were admitted within 8 hours of injury and high-dose methylprednisolone was administered. The following data were collected for each patient: clinical characteristics, complications, motor status, and Walking Index for Spinal Cord Injury.

Results: There were statistically significant differences of improvement between the early decompression and conservative management at 1-month and 3-month follow-ups. There was, however, somewhat significant difference at 6 months and no significant difference in the two groups after 1 year. The average ASIA score of early decompression was increased from 51.2 at admission to 74.5, 79.4, 82.8 and 88.7 at 1, 3, 6 months and final follow-up, respectively. The improvement of ASIA score had a positive correlation with the age at injury. For
patients who were older than 65 years at injury, the improvement of motor function was statistically lower than it was in younger patients. The lengths of hospital stay and rehabilitation were significantly briefer in patients with early decompressive surgery than conservative management.

**Conclusion:** Significant improvement in ASIA scores was achieved during the first 3 months after surgery. A positive correlation was found between age at injury and ASIA score improvement. Early decompression may be associated with rapid neurologic improvement, early mobilization, and briefer periods of hospitalization.

215. Dyneys for Degenerative Spondylolisthesis: Clinical Trial of Dyneys Alone vs. Dyneys with Adjunct Decompression with or without Fusion
Fras Dakhil-Jerew, John Shepperd

**Introduction:** Forward slip of the vertebra above may compromise on the exit foramen and produce nerve root signs, in addition to back pain. Conservative management should be attempted first. However in 10–15% of patients, surgical procedures are required to control symptoms of back pain and radiculopathy. In this study, we compare the functional outcome of Dyneys in patients with degenerative spondylolisthesis categorized in three different trials. The objective is to highlight the successful use of Dyneys in the treatment of degenerative spondylolisthesis.

**Methods:** Seventy-eight patients with degenerative spondylolisthesis were treated with Dyneys. Patients were subgrouped into three trials; Dyneys alone (group 1; n = 31), Adjunct decompression & fusion (group 2; n = 34) and Adjunct decompression (group 3; n = 13). Three main outcome parameters were reviewed: ODI, VAS and the need for further surgeries. Patients follow up was arranged at 2 weeks, 3 months, 6 months, 12 months and annually.

**Results:** Average follow-up was 41 months, 53 months and 60 months in groups 1, 2 & 3 respectively. Patients with Dyneys alone had initial good improvement in ODI and VAS but this was not maintained. Secondary surgery was needed in 32% at 28.2 months. Dyneys with adjunct PLIF showed clinically & statistically maintained ODI and VAS outcome. Secondary surgery rate was 11.7% at 41 months. Dyneys with adjunct decompression group was favored by clinically and statistically improved functional outcome. Second surgery was necessary in 7.6% at 22 months.

**Conclusion:** Dyneys stands out as an innovative device for the treatment of back pain. However, it was associated with greater rate of secondary procedures and less favorable outcome when used as the sole treatment for degenerative spondylolisthesis. Improved outcome was obtained when adjunct decompression with and without fusion were used along with dynesys. Dynesys alone is not recommended for degenerative spondylolisthesis. Dynesys with adjunct decompression (with or without fusion) has superior results and it is recommended.

216. A Retrospective Case–study of Post-traumatic Syringomyelia
Youssef Karam

**Introduction:** This is a retrospective review of patients with symptomatic post-traumatic syringomyelia (PTS) who were treated and followed–up at the University of Iowa Hospitals and Clinics.

**Methods:** Twenty–four patients with post-traumatic syringomyelia were identified, between 1986 and 2008. All data was collected in a retrospective manner using available documentation and radiological images.

**Results:** There is male prevalence preponderance and most of the injuries were sustained in road traffic accidents. Initial spine lesion was most commonly in the thoracic spine. Deficits in pain sensation, weakness, or pain and paresthesias were the most common presenting signs and symptoms. High correlation with spinal stenosis and deformity at the site of initial injury. Shunting alone often required revision with subsequent operations in 57.14% of cases, while duraplasty required revision in only one of nine patients. Lysis of adhesions appears to be most effective when performed with duraplasty.

**Conclusion:** Stenosis and deformity at the initial injury site is high predictor of development of post-traumatic syringomyelia. Shunting alone is an ineffective method for treatment of symptomatic post-traumatic syringomyelia. Duraplasty provides more definitive treatment when compared to shunting alone. Lysis of adhesions is effective when associated with duraplasty.

217. Minimally Invasive Anterior Lumbar Interbody Fusion followed by Percutaneous Pedicle Screw Fixation for Isthmic Spondylolisthesis: Minimum 5-Year Follow-up
Jin-Sung Kim, Won Gyu Choi, Sang-Ho Lee, Sang Soo Eun

**Introduction:** We previously reported the preliminary results of minimally invasive anterior lumbar interbody fusion (mini–ALIF) with percutaneous pedicle screw fixation (PPF) in 2004. Retrospective study with a minimum 5-year follow-up. Sixty-three patients with a mean age of 49 years were included in this study. Each patient had mini–ALIF followed by PPF. Visual analog scale (VAS) pain and intensity (back and leg), Oswestry Disability Index (ODI) scores, and the patient’s return–to–work status.

**Methods:** Of the initial 73 patients who underwent mini–ALIF with PPF between October 2000 and February 2002, 63 patients could be contacted after 5–7 years. Clinical follow–up and radiological follow–up with dynamic lumbar X-ray, three–dimensional CT scans, and lumbar MRI for checking the adjacent segmental disease (ASD) were completed in patients. Radiological results including the intervertebral disc height, the degree of listhesis, segmental lumbar lordosis, and whole lumbar lordosis were analyzed by statistical analysis.

**Results:** The mean follow–up period was 72 months. Among the 63 patients, 56 (88.9%) had an excellent or good clinical result and five (7.9%) had a poor result based on the Macnab criteria. Two (3.2%) patients had a poor result. The last scores of visual analog scale and Oswestry disability index were significantly decreased compared with the preoperative baseline. Radiographs of all patients at the last follow–up showed solid fusion. ASD was proven to be progressing in 6 out of 63 (9.5%) patients, but only two patients (3.2%) had symptoms associated with ASD.

**Conclusion:** The long–term outcome after mini–ALIF with PPF in patients with low–grade isthmic spondylolisthesis was successful. Furthermore, in terms of ASD, there is low incidence of ASD after the procedure.
Methods: We retrospectively identified 14 patients with two-year follow-up who had undergone unilateral VEPTR placement with caudal instrumentation between T11–L2. Pre-op and two year radiographs were analyzed for: thoracic and lumbar Cobb angles, coronal/sagittal balance, lumbar rotation/apical translation, and Lenke modifier. Paired Students T–Test was used to compare preoperative and two-year data.

Results: Mean age of the patients at surgery was 5.2 years with a mean follow-up of 3.3 years. Diagnosis included congenital (10), infantile (3), and neurofibromatosis (1). The thoracic curves improved from $62\pm16^\circ$ to $39\pm15^\circ$ (p<0.001), for a correction of 40%. The lumbar curves improved from $38\pm17^\circ$ to $20\pm10^\circ$ (p<0.001), for a correction of 49%. Overall, coronal balance improved from 3.0±1.8cm to 1.5±1.4cm (p = 0.001). No differences were seen in sagittal balance, rotation, or apical translation.

Conclusion: In the growing child, selective instrumentation of the thoracic curve with VEPTR may result in a compensatory decrease of the lumbar curve. This may spare lumbar motion segments when definitive fusion is performed.

219.
Postoperative Trunk Shift in Lenke 1 Curves: Incidence, Risk Factors, and Correlation with SRS–30
Amer F. Samdani, Jahangir Asghar, Patrick Cahill, David Clements, Darryl Antonacci, Peter Newton, Randal Betz, Harms Study Group

Introduction: Truncal alignment is one of the primary goals of surgery for AIS. No studies have specifically reported on the incidence of postoperative trunk shift (TS), evaluated its impact on the SRS–30, or assessed potential risk factors.

Methods: From a multicenter, prospective database of 1555 patients with AIS, an analysis of pre-op and 2-year post-op radiographs, SRS–30 scores, and clinical data was performed. Inclusion criteria identified 222 patients with AIS and a Lenke 1 curve pattern with minimum 2-year follow-up. TS was measured as follows: identify apical vertebrae and draw horizontal thru it and mark (a) where left trunk ends and (b) where right trunk ends. Determine midpoint of a and b and draw a perpendicular to that line (called the Vertical Trunk Reference Line, VTRL). TS is defined as a >2 cm difference between the VTRL and the center sacral vertical line. ANOVA (p<0.05) was used to compare 2-year radiographic data and SRS–30 scores between patients with and without postoperative TS. Spearman’s correlation and logistic regression analyses (p<0.05) were used to identify pre-op variables associated with postoperative TS.

Results: 28 out of 222 (12.6 %) patients with Lenke 1 curve type demonstrated postoperative TS. 18 of these patients (64.3%) had no preoperative TS and were considered iatrogenic. At two year follow-up, total SRS–30 scores were significantly lower in the patients with TS (3.99 vs. 4.22, p = 0.01). This difference was most evident in the pain, self image, and functional level of activity domains (p = 0.05, 0.03, and 0.01, respectively). The percent correction of the thoracic curve was similar in both groups (TS = 61%, No TS = 65%, p = 0.18), whereas, less correction of the lumbar curve was seen in the TS group (49% vs 60%, p = 0.01). Similarly, % correction of lumbar curve was identified as an independent risk factor for development of postoperative TS (r = 0.14, p = 0.02).

Conclusion: Postoperative trunk shift is not uncommon after surgery for AIS, occurring in 12.6% of patients with Lenke 1 curves. The majority of these are iatrogenically created and significantly lower SRS–30 scores. Less correction of the lumbar curve is an independent risk factor for development of postoperative TS.

220.
Complications of Transforaminal Lumbar Interbody Fusion: A Single Center Experience
Matthew J. Tormenli, Matthew B. Masera, Christopher Michael Bonfield, Peter C. Gerszten, John Jefferson Moosy, Richard M. Spira, Adam S. Kanter, David O. Okonkwo

Introduction: Transforaminal lumbar interbody fusion (TLIF) has grown in popularity as a means for achieving circumferential fusion since its original description by Harms in 1982. We present the complication profile for this procedure based on the experience of a large academic medical center.

Methods: All patients undergoing TLIF procedures at our institution between March 2005 and June 2009 were included in this analysis. A prospectively maintained complication database and electronic operative notes were used to identify complications. Only procedure-related complications were evaluated; medical, non-procedure-related complications were not included in this analysis.

Results: Five hundred thirty-one patients were included for analysis. Of these patients, 244 (46%) had undergone a prior lumbar operation. Interbody grafts were placed at a single level in 317 patients, at two levels in 188 patients, at three levels in 24 patients, and at four levels in 2 patients (Table 1). One hundred fifteen patients (21.7%) had a procedure-related complication (Table 2). The two most common complications were durotomy (n = 74, 13.9%) and infection (n = 20, 3.8%). There was a significant increase in the incidence of complications in patients who had undergone a prior operation (26.2% vs 17.7%, p = 0.018) and those who had multi-level surgery (26.2% vs 18.6%, p = 0.038). The incidence of durotomy was significantly increased in patients who had a prior operation (18% vs 11.7%, p = 0.012). There was no significant difference in durotomy incidence between patients undergoing single-level vs. multi-level interbody fusion. The incidence of infection was not related to a history of prior lumbar surgery nor to the performance of multi-level interbody fusion.

Conclusion: TLIF is a common procedure performed by neurosurgical spine surgeons today. The complication rate in this large series was 21.7%. Durotomy and infection were the two most common complications in this series. The complication rate was higher in patients who had prior surgery and those who underwent multi-level interbody fusion.

221.
Kinematics of Occipitocervical Instrumentation with or without Extension to the Subaxial Cervical Spine
Christopher E. Wolfia, Michael D. Martin, Harlan Jason Bruner, Narayan Yoganandan

Introduction: Kinematic data regarding the effects of extension of occipitocervical instrumentation to the subaxial cervical spine are limited. This study examines whether range of motion (ROM) from the occiput to C2 is altered by subaxial extension of occipitocervical instrumentation constructs.

Methods: Cadaver specimens underwent intact kinematic testing followed by destabilization by odontoid osteotomy. Subsequent kinematic testing was performed of four constructs: occipital plate + C2 pars screws (Construct #1), occipital plate + C2 pars screws + C4 lateral mass screws (Construct #2), occipital plate + C1–C2 translaminar screws (Construct #3), and occipital plate + C1–C2 translaminar screws + C4 lateral mass screws (Construct #4).

Results: All constructs significantly reduced occiput – C2 ROM in all loading modes compared to the intact cervical spine, with one exception (Construct #1, lateral bending). No significant ROM
222. Factors Predictive of Perioperative Morbidity and Mortality after Spinal Deformity Surgery in Patients 75 Years and Older

Frank L. Acosta, Jr., Brian A. O’Shaughnessy, Heiko Koller, Chris J. Neal, Oliver Meier, Christopher P. Ames, Tyler R. Koski, Chris J. Neal, Oliver Meier, Stephen L. Ondra

Introduction: As the population continues to age, relatively older geriatric patients will present more frequently with complex spinal deformities that may require surgical intervention. No study has analyzed factors predictive of complications after major spinal deformity surgery in the very elderly (75 and older).

Methods: Review of the medical and surgical records of 21 patients age 75 and older who underwent thoracic or lumbar fixation across 5 or more levels for spinal deformity. Age, comorbidities, operative data, major and minor complications, and deaths were recorded. Factors predictive of perioperative complications were identified by logistic regression analysis. Postoperative ODI and SRS-22 scores were collected in 10 patients.

Results: Mean patient age was 77 years (14F:7M). Mean follow-up was 41.2 months (range 24–81 months). Fifteen patients (71%) had at least one comorbidity. Average of 10.5 levels were fused. Thirteen patients (62%) had at least one complication, and 8 (38%) had at least one major complication. There were no deaths. Increasing age was predictive of any perioperative complication (P = 0.02, OR 10, 95% CI 1.3–78). Complications were not associated with adverse outcomes by ODI or SRS-22 scores.

Conclusion: Patients age 75 and older undergoing major spinal deformity surgery have an overall complication rate of 62%, with older age increasing the likelihood of a complication. Patients in this age group with a history of hypertension are 10 times more likely to incur a major perioperative complication. Mortality risk for these patients; however, is not increased and complications are not associated with adverse outcomes.

223. Failure of Laminectomy to Adequately Decrease Intramedullary Spinal Cord Pressure in Cervical and Thoracic Kyphotic Deformity: A Cadaveric Study

Brantford A. Curt, Charles Kunz, IV, David B. Pettigrew, Vincent A. DiNapoli, Chad W. Farley, Albert Chavanne, Jeffrey R. Holtz, John Joseph DePowell

Introduction: Patients presenting with cervical or thoracic kyphotic deformity and myelopathy can present a treatment challenge. Spinal cord intramedullary pressure (IMP) has been shown to increase with direct pressure (stenosis) and more recently kyphotic deformity. Using a cadaveric model, the authors investigated the role of posterior decompression for relieving IMP in cervical and thoracic kyphotic deformity.

Methods: Kyphotic deformity was created in 13 fresh human cadavers (8 cervical, 5 thoracic) using an established model. A single-level rostral laminectomy and durotomy was performed to place Codman intraparenchymal monitors in the spinal cord at C2, C4/5 and C7 or at T4, T7/8 and T12. Kyphotic deformities were created. IMP was recorded during the creation of the kyphotic deformity and at maximal kyphosis. Posterior laminar decompression was performed at maximal kyphosis while IMP was monitored. Finally, durotomy and piatotomy were performed while monitoring IMP.

Results: Cervical and thoracic kyphotic deformity resulted in significant increase in IMP. In the cervical spine, laminectomy resulted in a non-statistically significant mean IMP reduction of 21%. Pressures decreased a mean of 30% at C2, 20% at C4/5 and 19% at C7 after laminectomy. In the thoracic spine, laminectomy resulted in a non-statistically significant mean IMP reduction of 12%. IMP decreased by 7% at T4/5, 9% at T7/8 and 19% at T11/12 after laminectomy. Subsequent durotomy and piatotomy significantly reduced IMP in both the cervical and thoracic spine.

Conclusion: In this cadaveric study, posterior laminar decompression inadequately decreased IMP in cervical and thoracic kyphotic deformity. This cadaveric study may help explain the failure of posterior decompressive procedures without kyphotic deformity correction, the higher neurological risk associated with treating cervical and thoracic kyphotic deformity, and the need for maintaining adequate blood pressure during surgical treatment of kyphotic deformity.

224. Lumbar Decompression followed by CoflexTM Interlaminar Implant vs. Pedicle Screw Posterior Lateral Fusion for Treatment of Stenosis

Kenneth Pettine

Introduction: To compare the clinical safety and efficacy of Coflex™Interlaminar Fixation vs. instrumented fusion following standard decompression for lumbar stenosis.

Methods: A prospective randomized comparison of Coflex vs. fusion from four FDA IDE sites are reported. Randomization was 2:1 Coflex vs. fusion. Every patient underwent one or two level decompression followed by placement of a Coflex Interlaminar implant vs. pedicle screw fixation with posterior lateral bone graft. Inclusion and exclusion criteria will be discussed along with patient demographics. FDA clinical success was based on Improvement of at least 15 points in the ODI at 24 months compared to baseline, no re-operations, revisions, removals or supplemental fixation and no major device-related complications. Follow up was completed at 6 weeks, 3 months, 6 months, and one year with physical exam, SF–12, VAS, ODI, and radiographic analysis.

Results: 28 one level surgeries (19 Coflex and 9 fusion) and 11 two level surgeries (8 Coflex and 3 Fusion). Average pre-op ODI in the Coflex group was 55 (range 40 to 70). Average pre-op ODI in the fusion group was 59 (range 42–72). Post-op ODI in the Coflex group was 10.5 (range 0–40) a 81% improvement. Post-op ODI in the fusion group was 34.8 (range 14–56) a 41% improvement. Pre-op VAS in the Coflex group was 74.2 (range 56–94). Average pre-op VAS in the fusion group was 73.5 (range 64–90). Post-op VAS in the Coflex group was 15.2 (range 0–68) a 80% improvement. Post-op VAS in the fusion group was 34.2 (range 11–66) a 53% improvement.

Conclusion: Both the Coflex and the fusion groups demonstrated safety with no device related complications and no
reoperations or revisions. Both groups showed statistical improvement in ODI and VAS at follow up. The subjects randomized to Coflex demonstrated statistical superiority in all clinical measurements compared to fusion.

225. Bone Marrow Concentrate with Allograft Equivalent to Autologous Iliac Crest Bone for Instrumented Lumbar Spine Fusion: A Prospective Study

Robert G. Johnson

Introduction: Iliac crest bone autograft (ICBG) is the gold standard for bone grafting. However, donor site morbidity, limited second harvest, and the limited supply of one patient make alternative options attractive. Recent studies demonstrate that bone marrow aspirate concentrate (BMAC®) from the iliac crest increases bone healing in tibial non-unions. BMA collection is less invasive and provides a reusable source of cells and growth factors that facilitate osteogenesis. These promising results support the hypothesis that BMAC will also facilitate osteogenesis in spinal fusion.

Methods: This randomized, IRB-approved study enrolled 25 consecutive patients ages 18 to 65 years undergoing one to three level posterior lumbar fusions without significant deformity. Exclusion criteria included previous ICBG procedure or surgical procedure at the levels being fused, active systemic infection and neoplasia. The right and left side of the spine were randomized to receive either BMAC with allograft or ICBG. BMA from the posterior iliac crest was concentrated in the operating suite using a commercial kit. Sixteen mLs of BMAC was mixed with 30 mLs of crushed cancellous allograft. Either 30 mL of BMAC or ICBG was placed in the lateral gutter onto the decorticated transverse processes and into the facet joints. Cell types and counts (nucleated cell count, CD-34, CFU-F) were measured by an independent lab. Fusion rate was the primary outcome measurement. CT scans were evaluated for degree of spinal fusion by blinded radiologists at one year post surgery.

Results: All patients obtained some degree of fusion on both sides and in the facet. Percent fused were similar for all sites regardless of whether the site was treated with BMAC or ICBG. There was no significant difference (p > 0.05) in outcome between BMAC- and ICBG-treated sites by Kruskal-Wallis 1-way ANOVA on ranks (non-parametric).

Conclusion: This is the first clinical study comparing the gold standard to BMAC for spinal fusions and demonstrates BMAC with allograft is equivalent to ICBG for facilitating spinal fusion.

226. Prospective Randomized Controlled Study of Repairing the Anulus Fibrosis after Lumbar Discectomy: A Single Surgeon’s Experience

Alexander S. Bailey, Julie M. Messer

Introduction: The current practice of leaving an open defect in the anulus fibrosus at the conclusion of a micro-discectomy may lead to an increased potential for recurrent herniation requiring additional surgery. Repair of this defect appears a reasonable, logical approach to mitigate this outcome and potentially reduce the incidence of recurrent herniation.

Methods: Sixty-six patients were screened for study enrollment. Informed consent allowed for intra-operative randomization following the micro-discectomy to either: anular repair with Xclose™ TRS or no repair. In this ongoing study, patient outcomes were evaluated pre and post-operatively using appropriate pain and disability assessments.

Results: Of the 66 screened patients, 3 were excluded intra-operatively and 3 had unsuccessful anular repair (ATT). Successful patient randomizations resulted in 44 with Repair and 16 Control (no repair). Patient outcomes showed a significant improvement in both groups following surgery that was maintained throughout the follow-up periods. Average time from surgery was 14.6 months (range: 2.3 to 23.8 months). Overall, seven cases required additional surgery (11%). The ATT group had one reoperation (3.3%) and the Control group had two reoperations (12.5%). In both these groups, the reoperations were for recurrent herniation; same level, same side, same location (true recurrent herniation). Four patients in the Repair group required additional surgery (9%) however, only two were for true recurrent herniation (4.5%). The third was a new far lateral herniation remote from previous herniation site while the fourth was fusion for post-laminectomy syndrome, resulting in a 64% decrease in reoperation for true recurrent herniation and a 28% reduction in the need for additional surgery.

Conclusion: Anular repair using Xclose Tissue Repair System can be successfully accomplished in greater than 90% of cases if the discectomy is performed with the ultimate goal of repair being appreciated. Repairing the anulus fibrosus was shown to be beneficial by reducing the need for additional surgery, in particular those re-operations for true recurrent herniation.

227. Acute and Chronic Changes in Spinal Diffusion MRI Measurements Distal from Traumatic Lesion May Reflect Changes in Overall Spinal Cord Function

Shekar N. Kurpad, Benjamin M. Ellingson, Brian Schmit

Introduction: Most studies that have used diffusion MRI to characterize spinal cord injury (SCI) have focused on the traumatic lesion, despite recent evidence that structural changes (1), functional changes (2–3), and DTI changes (4) may occur large distances from the traumatic lesion. Clinically, monitoring overall spinal health by examining regions distal from the lesion may be beneficial because the lesion is typically heterogeneous, can be difficult to assess due to spinal stabilization hardware, and clinical MR head coils provide a higher signal–to–noise. We hypothesize that changes in diffusion MR measurements occurring large distances from the lesion epicenter may be useful in assessing the overall spinal cord health following injury.

Methods: A total of sixty-six Sprague–Dawley rats and twenty-three human research subjects participated in this study. Animals were divided into a control (uninjured) group, 2, 5, 10, 15, 20, and 25–week post-injury groups. The cervical spine was scanned both in vivo and ex vivo using imaging protocols described previously on a 9.4T MR scanner (4–6). Human participants were divided into a control (uninjured) group and a chronic SCI group and had their cervical spine scanned using a clinical 1.5T MR scanner (7).

Results: Animal studies indicated a transient decrease in mean diffusion (MD) within the cervical spinal cord during the first 2 weeks after injury, likely due to a decrease in extracellular water in response to the increase in extracellular water (edema) at the lesion (i.e. fluid homeostasis). This decrease was normalized for the next 10–15 weeks, when a slow decrease in MD began to form. Histology confirmed structural changes within the spinal cord from 15–25 weeks. A similar degree of decreased MD was observed in chronic human SCI participants compared with control subjects.

Conclusion: DTI in distal segments from traumatic SCI can be used to infer overall spinal cord condition and function.
228. Evaluating the Effects of rhBMP–2 on an Intravertebral Human Breast Adenocarcinoma Rat Model
Camilo A. Molina, Timothy Flerage, James Richman, Wesley Hsu, Anthony Gregory, Ziya L. Gokaslan, Ali Bydon, Timothy F. Villem, Jean-Paul Wolinsky, Daniel M. Scibba
Introduction: Recombinant human bone morphogenetic proteins (rhBMPs) were approved for specific spinal fusion procedures, but have been used off-label for extended clinical applications. Importantly, the impacts of rhBMPs on the tumor resection bed are unknown, and their use is contraindicated for patients who have undergone surgery for the treatment of spine tumors. Such patients are at increased risk for non-union due to poor prognostic factors associated with the treatment and syndromes of neoplastic processes. This study evaluates the effects of rhBMP–2 on tumor growth via an intraosseous human tumor rat-model.
Methods: Twenty-one female nude athymic rats were randomized into three groups. Group 1 (n=7) underwent transperitoneal exposure and implantation of human breast adenocarcinoma MDA–231 tissue on the L6 lumbar spine, followed by local treatment with rhBMP–2. Group 2 (n=7) underwent exposure and tumor implantation on the lumbar spine, but no local treatment with rhBMP–2. Group 3 (n=7) solely underwent exposure of the lumbar spine. The Basso–Beattie–Bresnahan (BBB) scale was used to monitor daily motor function regression and time to paresis (BBB score ≤ 7).
Results: All animals in Group 1 were parietic by day 16 (median BBB score of 0, p=0.0223) with a mean time to paresis (±SD) of 14±1.9 days. All animals in Group 2 were parietic by day 16 (median BBB score of 0, p=0.0024) with a mean time to paresis (±SD) of 13.5±1.4 days. Time to paresis was not significantly different between Group 1 and Group 2 (p=0.3587). Group 3 (control) exhibited no neurological motor deficit.
Conclusion: This study suggests that the administration of local rhBMP does not inhibit tumor growth, but more importantly it does not exacerbate tumor growth. Thereby providing preliminary evidence that patients undergoing spine surgery for treatment of a tumor may benefit from the fusion promoting benefits of rhBMP, without promoting the re-growth of the resected tumor.

229. Changes in Coronal and Sagittal Plane Alignment following Minimally Invasive Direct Lateral Interbody Fusion for the Treatment of Adult Degenerative Lumbar Disease
Frank L. Acosta, Jr., John C. Liu, Nicholas P. Slimack, David J. Moller, Stephen L. Ondra, Richard G. Fessler, Tyler R. Koski
Introduction: The lateral transposa approach for lumbar interbody fusion is a minimal-access technique that has been used by some to treat lumbar degenerative conditions. No study, however, has analyzed its effect on segmental, regional, and global coronal and sagittal alignment in patients with degenerative lumbar disease.
Methods: Review of the radiographic records of 36 patients with lumbar degenerative disease treated via direct lateral interbody fusion (DLIF). 35 patients had supplemental posterior fixation to maintain correction. Pre- and postoperative standing AP and lateral lumbar radiographs were taken of all patients for measurement of segmental and regional coronal and sagittal Cobb angles. Standing AP and lateral 36-inch films were also obtained in 23 patients for measurement of global coronal (center sacral vertebral line) and sagittal (C7 plumb line) balance.
Results: Mean preoperative coronal segmental Cobb was 4.5 degrees and 1.5 degrees postoperatively (p<0.0001). Mean pre- and post-operative regional lumbar coronal Cobb was 7.6 and 3.6 degrees, respectively (p<0.0001). In 8 patients with degenerative scoliosis, mean pre- and postoperative regional lumbar coronal Cobb was 21.4 and 9.7 degrees, respectively (p<0.0004). Mean preoperative global coronal alignment was 19.1mm and postoperatively was 12.5 mm (p<0.05) (Figure 1). In the sagittal plane, mean segmental Cobb angle measured 5.3 degrees preoperatively and 8.2 degrees postoperatively (p<0.0001). Mean pre- and postoperative regional lumbar lordosis was 42.1 and 46.2 degrees, respectively (p<0.05). Mean global sagittal alignment was 41.5mm pre- and 42.4mm postoperatively (p=0.7) (Figure 2).
Conclusion: DLIF significantly improves segmental, regional, and global coronal plane alignment in patients with degenerative lumbar disease. Although DLIF increases the segmental sagittal Cobb angle at the level of instrumentation, it does not improve regional lumbar lordosis or global sagittal alignment.

230. Perioperative Nutrition Status in Spine Surgery: Preliminary Results
David M. Panczykowski, Matthew B. Maserati, Richard M. Spiro, David O. Okonkwo
Introduction: Impaired perioperative nutritional status has been found to be an important parameter of surgical morbidity and overall outcome. Serum prealbumin is the earliest marker of nutritional deficiency and has become a preferred marker of malnutrition because of its correlation with outcomes in a variety of clinical settings. Few studies, however, have examined serum prealbumin as a surrogate marker of nutrition in those undergoing reconstructive spinal surgery. The aim of this study was to review perioperative nutritional status of patients undergoing reconstructive spine surgery who later developed post-operative wound infections.
Methods: We performed a retrospective review of all patients who developed post-operative wound infections after undergoing reconstructive spine surgery at University of Pittsburgh Medical Center from February 2008 through March 2009. Patients were analyzed for demographics, diagnosis requiring surgery, type of surgery, perioperative serum prealbumin level, onset of wound infection, number and type of debridement procedures, and length of hospital stay.
Results: Sixteen patients were treated for post-operative wound infection, with a mean age of 57 (range 18–75). Patients presented an average of 20 days post-op (range 9–33; 95% CI17–24) with an infection extending below the lumbar dorsal fascia in 93.7%. Surgical treatment for the infection required an average of 4 debridements (range 1–10; 95% CI 2.3–5.3); 8.8% of patients required revision with removal of instrumentation. Hospital stays were extended by an average of 18 days (95% CI 12, 23.3). Malnutrition defined by perioperative prealbumin <15mg/dL was observed in all 16 patients (mean 10.3; 95% CI 8.5–12.1); 56.3% were severely malnourished (prealbumin <10mg/dL).
Conclusion: This preliminary case series reveals an alarming incidence of perioperative malnutrition in patients who went on to develop post-operative wound infection after elective spine surgery. These results have provided the impetus for an ongoing, prospective investigation of perioperative nutritional status and its influence on outcome after elective spinal surgery.
231. Does Minimal Exposure Spine Surgery Increase or Decrease Complications in Spinal Decompression or Fusion Surgery?
Daryl R. Fourney, Joseph Dettable, Daniel Norvell, Mark B. Dekutoski
Introduction: Patient demand and marketing for minimally invasive spinal procedures is driven by the perception of better outcomes. The purpose of this review was to answer two questions: 1) Does minimal access tubular assisted surgery (MAS) decrease the rate of complications in thoracolumbar posterior spinal decompression and/or fusion surgery compared with traditional open techniques? 2) What strategies to reduce the risk of complications in MAS have been shown to be effective?
Methods: A systematic review of the English language literature was undertaken for articles published between 1990 and July 2009. Electronic databases and reference list of key articles were searched to identify published studies comparing minimal access tubular assisted surgery (MAS) with open or conventional microsurgery in patients undergoing thoracolumbar decompression or fusion. Two independent reviewers assessed the strength of literature using GRADE criteria assessing quality, quantity, and consistency of results.
Results: From the 361 articles identified, 13 met a priori criteria and were included for review. Operation time, hospital length of stay, and blood loss was variable across studies. Among patients receiving discectomy, reoperation, dural tear, CSF leak, nerve injury, and infections occurred in similar proportions between MAS and open surgery. Among patients receiving fusion, length of hospital stay was generally slightly shorter following MAS vs. open surgery. Reoperation, dural tear, CSF leak, nerve injury, and infections occurred in similar proportions between MAS and open surgery. Some data suggests that the rate of complications may decrease with experience.
Conclusion: Reoperation, dural tear, CSF leak, nerve injury and infections occurred in similar proportions between MAS and open lumbar surgery. There is no evidence to assess the effectiveness of strategies to reduce the risk of complications in MAS for lumbar or thoracic surgery.

232. TcEMEP Monitoring Improves Detection of Iatrogenic Nerve Root Injury During Cervical and Lumbar Spine Surgery
Bikash Bose, Anthony K. Sestokas, Daniel M. Schwartz
Introduction: Spinal nerve root injury is a significant complication of cervical and lumbar spine surgery. The purpose of this study was to compare the sensitivity/specificity of intraoperative transcranial electric motor evoked potentials (tcEMEP) and spontaneous electromyography (spEMG) for detection of iatrogenic nerve root injury during instrumented fusion of the cervical or lumbar spine.
Methods: The study is based on a retrospective review of 238 cervical and 333 lumbar spine fusions performed by one neurosurgeon consecutively. Intraoperative monitoring was performed by a professional-level neuromonitoring practice using a standardized multimodality protocol. Spinal nerve roots were monitored with spEMG in all cases. SpEMG monitoring was supplemented by tcEMEPs in 100% of the cervical procedures and 56% of the lumbosacral procedures. Neuroradiology alerts were triggered by one or more episodes of neurologic spEMG activity and/or >50% attenuation of tcEMEPs from baseline amplitudes.
Results: The incidence of new postoperative spinal nerve root deficits was 5.1% in the cervical series and 3.3% in the lumbar series. The sensitivities of tcEMEPs for intraoperative detection of evolving nerve root injury in the cervical and lumbar series were 91% and 100%, respectively. By comparison, the corresponding sensitivities of spEMG were 42% and 55%, respectively. TcEMEP specificities in the cervical and lumbar series were 89% and 90%, respectively, whereas spEMG specificities were 74% and 83%, respectively.
Conclusion: The results of this study suggest that tcEMEPs are significantly more sensitive than spEMG in detecting evolving iatrogenic spinal nerve root injury in both cervical and lumbar spine procedures. Intraoperative monitoring of spinal nerve root function with tcEMEPs may facilitate more timely therapeutic intervention in the event of injury than that afforded by spEMG alone. This resulted in improved outcomes and prevented long-term serious neurological deficits in this group of patients.

233. Changes in Trunk Muscle Cross-sectional Area following Posterior Lumbar Surgery
Lacey E. Bresnahan, Silviu Diaconu, Steven Quinn, Richard G. Fessler
Introduction: Microendoscopic surgical approaches for posterior spine surgery have been shown clinically to reduce muscular disruption. However, there is a lack of data that provides physiologic measurements of this disruption. This study aims to provide a quantitative assessment of posterior muscle disruption following lumbar surgery.
Methods: Twenty patients were enrolled who had undergone posterior decompression for single level lumbar stenosis. 10 of these patients received the standard open posterior approach and 10 received a minimally invasive approach. Postoperative scans were obtained 6–30 months after their surgery date (mean scan date was 16.6 months post-op in MEDS, 16.3 months post-op in OPEN). T1-weighted images of 2 mm axial sections were obtained with a 1.5T magnet and gadolinium contrast agent. Image Processing and Visualization (NIH, USA) was used to process and collect data by two blinded observers. Images were thresholded to remove contributions of higher-intensity non-muscle tissue from measurements of muscle cross-sectional area (CSA) and segmented. Each of the paraspinal muscles (iliocostalis, longissimus, multifidus) were segmented bilaterally and the CSA was averaged from the cephalad to caudal endplate of the surgical segments.
Results: Change in muscle CSA was compared between the patient’s pre- and post-op MRI. The results show that following surgery using the open posterior approach CSA of the muscles in the right and left erector spinae decreased by 4.5 and 11%. Whereas, following the minimally invasive approach these same muscles actually increased in CSA by 11.5 and 12% respectively. Therefore, following the minimally invasive approach the erector spinae muscles had a statistically significant increase (P<0.05) in muscle CSA when compared to patients who received the open approach.
Conclusion: Iatrogenic damage is significant, both anatomical and functional studies show that damage to the paraspinal muscles during posterior surgery can result in post-operative back muscle dysfunction.

234. Tuberculosis of the Thoracic Spine: A Study of 22 Surgically Treated Children
Rabi Narayan Sahu, Ashok Mahapatra, Raj Kumar, Sanjay Behari, Vijendra K. Jain, Awadhesh K. Jaiswal
Introduction: Tuberculosis (TB) of the spine (Pott’s disease) is most dangerous form of TB in children. There is a recent upsurge of the disease, due to immune compromise states and multi drug resistant strains. Delay in diagnosis and management cause spinal cord...
compression and late spinal deformity. We will present a series of 22 pediatric patients treated surgically in a tertiary neurosurgical center.

**Methods:** This is a retrospective study between year 2001 to 2008; involving twenty-two children treated surgically. All patients’ clinical data and radiology were recorded and follow up notes analyzed with respect to the preoperative neurological status and postoperative course.

**Results:** The mean age was 11.8 years with an age range of 3 to 18 years. The male to female ratio was 0.8. Constitutional symptoms such as cough, fever and weight-loss were present in 13 (59.1%) patients. Local pain and limping gait weakness are most common symptoms, present in 20 (90.9%) and 18 (81.8%) cases respectively. Preoperative motor function was calculated by MRC (Medical Research Council) grade. Eight patients (3.6%) presented with complete paraplegia (Grade 0). The upper thoracic vertebrae involved in five (22.7%), middle in six (27.3%) and the lower thoracic vertebrae were involved in 11 (50%) cases. Single segment vertebrae was involved in ten (45.5%) patients whereas two and three segment- vertebrae were involved in eight (36.4%) and four (18.2%) patients respectively. Surgery was done with anterior approach in seven (31.8%) patients. Posterior and postero-lateral routes were used in 15 (68.2%) patients. Spinal instrumentation was done in 14 (63.6%) patients. At thirty-six months follow-up period 21 patients (95.5%) had improvement in motor function. Wound infection, cerebro spinal fluid leak and instrument failure are complications of surgery occurred in two (9.1%) patients. Seventeen (77.3%) patients showed early signs of neurological improvement (either motor or sensory) during the same hospitalization. There were no mortality.

**Conclusion:** A thoracic spine involvement in tuberculosis poses a tough task in children, due to a growing skeleton. Timely surgical interventions help in early improvement of neurological status of thoracic TB in children.


Luis M. Tumialan, Ryan Ponton, Wayne Gif

**Introduction:** To identify the difference in time to return to active duty between a posterior cervical foraminotomy and an anterior cervical disectomy with fusion. The cost effectiveness of these two procedures will also be reviewed.

**Methods:** Retrospective review of 34 patients who underwent surgical management of unilateral cervical radiculopathy with either PCF or ACDF was performed. Successful outcome was determined by return to full, unrestricted active duty military service. The difference in time to return to active duty was compared between the two groups. A cost analysis, consisting of direct and indirect costs, was used to compare the PCF group to the ACDF group.

**Results:** A total of 19 levels were operated upon in each group. The average age at the time of surgery was 42.6 (27-56) and 40.4 years (27-54) for the PCF and ACDF groups respectively. Complications included an incomplete decompression in the PCF group and 2 cases of transient recurrent laryngeal nerve palsy in the ACDF group. The average time to return to unrestricted full duty was 4.6 weeks (1-8) for the PCF group and 20.5 weeks (12-32) for the ACDF group, a difference of 15.9 weeks. Direct costs were $3,493 and $10,101 for the PCF and ACDF groups respectively, a difference of $6,608. Total cost (indirect + direct) ranged from $21,100 – $32,256 greater in the ACDF group.

**Conclusion:** In the management of unilateral cervical radiculopathy for military active duty personnel, posterior cervical foraminotomy offers a benefit relative to ACDF in immediate short-term direct and long-term indirect costs. The indirect cost of a service member away from full, unrestricted active duty 15.9 weeks longer in the ACDF group was the main contributor to this difference.

236. Two Year Results from Five IDE Study Sites: CerviCore® Intervertebral Disc vs. Fusion


**Introduction:** Anterior cervical disectomy and fusion (ACDF) is a highly successful procedure for radiculopathy, but it reduces motion and may accelerate adjacent segment level degeneration. This study compares the CerviCore® Intervertebral Disc to the gold standard of ACDF, for single-level treatment of cervical radicular symptoms, C3-C7.

**Methods:** Functionality was assessed with NDI and neck pain was measured using VAS. At our 5 sites, data is available for: 44 CerviCore® patients and 43 ACDF patients at baseline and 21 CerviCore® and 21 ACDF patients at 2 years. A signed rank test and a Kruskal-Wallis test were used to test for statistical differences.

**Results:** Within each treatment group, the mean NDI and Neck VAS results were significantly different from pre-op at all visits up to 2 years (p<.0001). Other differences between and within groups were not significant. (CerviCore® vs. fusion): The mean NDI scores were: 56.2 vs. 52.7 at pre-op. At 2 years, mean scores were 14.5 vs 19.3 (p=0.1772 b/w treatments). The mean VAS scores were: 71.5 vs. 68.3 at pre-op and 13.2 vs. 22.3 (p=.0894 b/w treatments).

**Conclusion:** Although not statistically significant, CerviCore® clinical results, both NDI and neck VAS, showed greater improvement as compared to ACDF. These preliminary results suggest that the CerviCore® Intervertebral Disc may be an alternative treatment for radiculopathy. Full study data is needed to confirm the findings of this small sample size.

237. The Surgical Treatment of Charcot Spinal Arthropathy

Bradley Jacobs, Carlo Bellabarra, Richard Bransford, Jens Chapman

**Introduction:** Charcot spinal arthropathy (CSA) is an uncommon disorder that causes vertebral joint degeneration, pain, and deformity. CSA occurs in conditions with decreased protective sensation to the vertebral column. A modern series of CSA patients will add to the understanding of this complex disorder. Further, our institution has trended towards a CSA treatment paradigm of aggressive intralesional debridement, circumferential fusion and quadruple lumbo pelvic rod fixation. The overall objective of this study is to analyze our clinical experience and determine whether this paradigm has improved clinical outcome for CSA over the course of our study, and in comparison to historical controls.

**Methods:** Retrospective review of clinical/radiographic records for CSA patients treated by the Spine Service at the University of Washington from 1997 to 2009.

**Results:** Twenty-three patients with CSA were identified. The mean age at presentation was 43.1 years and mean latency between SCI and CSA diagnosis was 19.6 years. Mean follow-up was 33.1 months. Pain and new deformity were the major presenting symptoms. Concomitant infection was identified in 26% of patients. CSA patients were noted to have long initial fusion constructs, spanning an average of 8.4 vertebral levels. CSA joints
developed within one level of the caudal end of the construct in 70%. Hardware failure/pseudoarthrosis developed in 35%. Failure rates significantly decreased over the course of our study, with 66% of patients operated on before 2002 experiencing at least one failure, in comparison to 14% of those treated afterwards. Nine of our cohort underwent quadruple rod fixation. No hardware failure occurred in this subgroup.

**Conclusion:** This study represents the largest modern surgical series of CSA. Infection is associated with CSA in a minority of cases. Treatment of CSA should not be delayed for antimicrobial therapy. Our treatment paradigm of circumferential fusion and quadruple rod fixation dramatically reduced hardware failure in comparison to historical series.

**238. Stereotactic Radiosurgery Delays Paraparesis in an Animal Model of Metastatic Epidural Spinal Cord Compression**

Wesley Hsu, James Richman, Timothy Flerage, Michael Armour, Kristen Redmond, Lawrence Kleinberg, Eric Ford, Michael Lim, Ziya L. Gokaslan, Daniel M. Scuibba

**Introduction:** Stereotactic radiosurgery (SR) is increasingly utilized in the treatment of metastatic spine disease. Current evidence suggests that SR is at least equivalent to conventional fractionated radiotherapy (CFR) with respect to pain control, arresting tumor growth, and stabilizing neurologic function. We have developed The Small Animal Radiation Research Platform (SARRP), a SR device designed for small animals. Conceptually, this device is a smaller version of SR devices currently employed in the treatment of human patients. The goal of this study is to provide proof of principle that the SARRP device may be a valid model for further investigation of SR in metastatic spine disease.

**Methods:** Twenty-four female Fischer rats were implanted with CRL-1666 mammary adenocarcinoma into the L6 vertebral body. Group 1 (n=8) received 20 Gy of stereotactically targeted radiation to the L6 vertebral body using the SARRP device on post-implantation day 7. Group 2 (n=8) received five consecutive days of CFR (8 Gy daily) starting on post-implantation day 7. Group 3 (n=8) received no further intervention. Post-operatively, animals were functionally assessed daily via the Basso-Beatie-Bresnahan scale.

**Results:** Animals receiving SR or CFR had a statistically equivalent median onset of functional hind limb paraplegia (13.0±1.6 days vs. 13.0±1.4 days, respectively, p=0.6442.) Animals receiving SR or CFR demonstrated a statistically significant delay in time to functional hindlimb paraplegia compared to the control group (10.4±1.4 days, p=0.002 and 0.0027, respectively).

**Conclusion:** In a rat model of metastatic epidural spinal cord compression, both SR and CFR resulted in a statistically significant delay in neurological decline. This study suggests that, at biologically equivalent doses, SR and CFR may be equivalent in treating metastatic spine disease. This study provides proof of principle that the SARRP device may be a valid model for further investigation of SR in metastatic spine disease.

**239. Smoking Negatively Impacts Generic and Disease-specific Outcomes following Anterior Cervical Disectomy and Fusion: Analysis of a Prospective Multi-center Randomized Clinical Trial**

Michael G. Fehlings, Rick Sasso, Paul M. Arnold

**Introduction:** There is evidence to suggest that smoking affects fusion rates in spinal fusion surgery. However, the impact of smoking on objective patient-reported outcomes after spine surgery is less clear. In this research study, we have examined the effect of smoking on outcomes of anterior cervical disectomy and fusion (ACDF). This study is a part of a large, randomized, controlled, multi-center, prospective FDA IDE study to assess safety and efficacy of i-FACTOR™ Bone Graft (Cerapedics, Inc. Westminster, CO) in single-level ACDF procedures. Patients received i-FACTOR bone graft (a 15 amino acid resudue of Type 1 collagen) or local autologous bone inside a structural allograft.

**Methods:** Currently, 89 patients (60% females; average age 47 years (sd = 10)) have been enrolled at 3 sites. Outcomes assessments include NDI, pain assessment, SF-36v2 Mental and Physical Component Scores (MCS and PCS). One year follow-up data currently are available for 60 subjects, 50 (83%) nonsmokers and 10 (17%) smokers. A series of stepwise regression analyses was used to evaluate the impact of smoking on treatment success.

**Results:** Smokers did less well on all outcomes than nonsmokers (p less than 0.05). NDI improvement was 7.12 points lower in smokers than nonsmokers; Arm Pain improvement was 2.48 points lower in smokers than nonsmokers; Neck Pain improvement was 3.15 points lower in smokers than non-smokers; SF-36v2 PCS was 6.44 points lower in smokers than nonsmokers and SF-36v2 MCS was 6.55 points lower in smokers than nonsmokers.

The negative association of smoking and patient-reported outcomes remained significant after adjusting for potential confounders.

**Conclusion:** We report for the first time that smoking is a strong negative predictor of patient-reported outcomes following ACDF. Based on our study, we postulate that stopping smoking before spinal reconstructive surgery may improve outcomes.

**240. DuraSeal™ Spinal Sealant as an Adjunct to Sutured Dural Repair in the Subaxial Spine: Results of a Prospective, Multi-center, Randomized Controlled Study**


**Introduction:** Following surgery for intradural spinal pathology, CSF leakage may present significant morbidity if waterleak dural closure is not achieved. Currently, dural closure consists of suture, with autologous patch grafts sometimes necessary. Other products have been used in an off-label manner as an adjunct to this primary closure. DuraSeal™ is a synthetic, absorbable sealant intended as an adjunct to sutured dural repair.

**Methods:** A prospective, multicenter, randomized IDE pivotal study evaluated DuraSeal™ Sealant compared with standard techniques as an adjunct to sutured dural repair in spinal patients undergoing intentional durotomy. The primary endpoint was intra-operative watertight closure. Secondary endpoints included post-operative CSF leak or infection. The entire study included Chiari malformations, but this subset analysis focuses only on the subaxial spine.

**Results:** 118 patients were treated at 24 centers. 80 received DuraSeal™, 38 received standard of care. Demographics were similar. The diagnosis in both groups was predominantly intradural tumor, followed by arachnoid cyst, syringomyelia, and tethered cord. Patients treated with DuraSeal™ Sealant had a higher rate (100% vs. 55.3%, p<0.001) of watertight closure tested with Valsalva maneuver (Table 1). In sixteen Control subjects (42%) the primary dural repair needed to be reinforced with buttressing materials such as fibrin sealant, duraplasty materials...
241. Development of a Novel Intravertebral Human Breast Adenocarcinoma Rat Model for the Study of Intravertebral Metastatic Spine Disease
Camillo A. Molina, Wesley Hsu, Anthony Gregory, Timothy Flerlage, James Richman, John Thurston, Mikhail Gorbounov, Ziya L. Gokaslan, Ali Bydon, Timothy F. Wilham, Jean-Paul Wolinsky, Daniel M. Sciubba

Introduction: Despite the high incidence of spinal metastatic tumors among breast cancer patients, a practical and reproducible model of spinal metastatic disease using human breast cancer tissue has not been reported. Prior models of metastatic spine disease utilize rat-derived, as opposed to human derived, tumor cell lines. This study reports the development of an athymic rat model of metastatic epidural spinal cord compression using a human breast cancer cell line.

Methods: Fourteen female nude athymic rats were randomized into two groups. Group 1 (n=7) underwent a transperitoneal approach to the lumbar spine followed by implantation of human breast adenocarcinoma MD–231 tissue into the L6 vertebral body. Group 2 (n=7) consisted of a control group which underwent a transperitoneal approach with exposure of the L6 vertebral body without tumor implantation. Postoperatively, animals were functionally assessed daily via the Basso-Beattie-Bresnahan (BBB) scale. Animals were euthanized immediately following paresis, and spines were harvested for histopathologic analysis. Data was statistically analyzed via the Wilcoxon signed-rank test.

Results: All animals in the experimental group (Group 1) were paraparetic by day 16 (median BBB score of 0, p = 0.0024). In contrast, animals in the control group (Group 2) did not at any point demonstrate any decline in neurological motor function (day 20 median BBB score of 20). Time to paresis was determined by animals with a BBB score less than 7, and mean time to paresis ± SD among animals in the experimental group (Group 1) was 13.5 days ± 4.4 days. Histopathological analysis of Group 1 demonstrated extensive tumor growth and impingement upon the cord.

Conclusion: This study demonstrates a novel model of metastatic spine disease using a human breast cancer cell line. Functional, radiographic, and histopathologic data provide evidence of the practicality and reliability of the model as the basis for future experiments.

242. How Does Age and Body Mass Index Impact Length of Stay and Hospital Cost in Spine Surgery?
Mohammad Sami Walid, Edward R. M. Robinson, Joe S. Robinson, III

Introduction: The rationale behind this study is the observation that more and more interventions are being done on the spine of older and heavier patients which may affect length of stay and hospital cost.

Methods: The charts of 578 random spine surgery patients were retrospectively reviewed. These included 154 lumbar microdiscectomy patients (LMD), 297 anterior cervical decompression and fusion (ACDF) and 127 lumbar decompression and fusion patients (LDF). Three age-groups, < 50, 50–69, and ≥70 and three thresholds of BMI 30, 35, and 40 were studied in connection with length of stay and hospital cost.

Results: The average age in the LMD group was 60, in the ACDF group 53, and in the LDF group 54 years old. 34.1% of spine surgery patients were <50 years old, 52.8% were between 50 and 69 years old, and 13.1% were ≥70. There were statistically significant differences in length of stay and hospital cost in the LDF group between patients <50 and ≥70 that amounted to $13,000. The mean BMI for LMD patients was 30, for ACDF patients 29, and for LDF patients 31. 49.4% of spine surgery patients had BMI =30, 14.9% =35, and 7.7% =40. There was significant difference in hospital cost in the ACDF group between patients with BMI ≥35 and those with BMI =35 that amounted to $7,000. Univariate analysis with age and BMI as predictors of length of stay and cost controlling for type of surgery showed that age and BMI were significant predictors. The interaction of age and BMI was significant for hospital cost only and did not reach significance for length of stay.

Conclusion: Older age and higher BMI are associated with increased length of stay and hospital cost in the more invasive types of spine surgery.

243. Correlation of Clinical Outcomes and Change in Segmental Sagittal Alignment after Anterior Cervical Discectomy and Fusion Surgery
Sigita Burneikiene, Alan T. Villavicencio, Jason Babuska, Ewell Lee Nelson, Alexander Mason

Introduction: The purpose of the study was to establish whether the maintenance or enhancement of segmental sagittal alignment was predictive of a higher degree of improvement in clinical outcome scores.

Methods: A total of 85 patients that underwent ACFD were divided into two groups: 68 patients that had improved or preserved sagittal alignment 17 patients that had a loss of sagittal alignment at the surgical level (SSA).

Results: Patients that had maintained or improved SSA had statistically significant (P=0.036) and higher degree of improvement in SF–36 PCS (mean change 10.1 vs. 4.0) and NDI scores (–10.7 vs. –5.4, P=0.037). Although, there was a higher degree improvement in neck VAS (–3.2 vs. 1.9) and SF–36 MCS (4.5 vs. 1.3) scores, it did not reach statistical significance. To compare the effect of the change in SSA on the change in cervical segmental analysis (CSA), a regression analysis was conducted to evaluate the amount of CSA change that could be attributed to the change in SSA. As can be predicted, the regression analysis found that a change in SSA was a significant predictor of a change in CSA (R² = 0.25, b = 0.37, F(1,83)= 27.73, p = 0.0001). However, changes in CSA did not correlate with the changes in clinical outcome scores.

Conclusion: Maintaining a consistent segmental sagittal alignment or increasing segmental lordosis was related to a higher degree of improvement in clinical outcome scores compared to decreasing segmental lordosis.

244. High Fusion Rates with Synthetic Bone: Anterior Cervical Arthrodesis Using Beta–tricalcium Phosphate with Local Bone Marrow Aspirate in Over 100 Patients
Neill Marshall Wright, Wilson Zachary Ray

Introduction: Autograft remains the standard for ACDF, but donor site morbidity is significant. Allograft provides equivalent fusion rates without morbidity, but there have been concerns about safety
and availability. In 2005, CDC recall of some allograft tissue led to public apprehension about its safety. Osteoconductive synthetic bone substitutes have been studied as a replacement graft, providing a scaffold for attachment, proliferation, and differentiation of osteoprogenitor cells. The addition of osteoinductive/osteogenic bone marrow aspirate (BMA) further increases the potential success.

**Methods:** 123 consecutive patients considered low-risk for pseudarthrosis underwent plated ACDF at 1–3 levels using a PEEK spacer containing osteoconductive putty (90% porous beta tricalcium phosphate/collagen) reconstituted with 2.5 mL of BMA aspirated from the adjacent vertebral body. Patients were prospectively followed to evaluate fusion. Radiographs were obtained at 6 and 12 weeks, and dynamic radiographs at six months. Fusion was assessed by an independent, blinded radiologist.

**Results:** 181 levels were treated in 123 patients. 101 patients were followed at least six months, with 153 levels treated in this group. At six months, all 101 patients showed bridging bone on plain radiographs. However, 11 (10.9%) had more than 2 degrees of motion on dynamic radiographs and were followed to 12 months with repeat dynamic films and/or computed tomography scans. 8 of these 11 patients were subsequently confirmed as fused. 98 patients (97.0%) demonstrated fusion in 150 levels (98.0%). Two of the patients with failed fusion were three–level cases, with solid fusion at two levels; one was a single–level case. None of the three patients with fusion failure were symptomatic.

**Conclusion:** These results demonstrate that an osteoconductive ultraporous beta–TCP scaffold, along with osteoconductive and osteogenic bone marrow aspirate, provides a safe, FDA–approved alternative to autograft and allograft for certain spinal surgery applications.

245. **Biomechanical Advantage of the Index Level Screw in Thoracolumbar Fracture Fixation**


**Introduction:** Unstable fractures at the thoracolumbar junction often require extended, posterior, segmental pedicle fixation. Some surgeons have reported good clinical outcomes with short–segment constructs if additional pedicle screws are inserted at the fractured level. The goal of this study was to quantify the biomechanical advantage of the index level screw in a fracture model.

**Methods:** Seven human cadaveric T10–L4 specimens were tested. A three–column injury at L1 was simulated and 4 posterior constructs were tested as follows: one–above–one–below with/without index level screws (short–construct), and two–above–two–below with/without index level screws (long–construct). Pure moments were applied quasi–statically while three–dimensional motion was measured optoelectronically. The range of motion (ROM) at L1/2 was measured during flexion, extension, left and right lateral bending, and left and right axial rotation.

**Results:** All constructs significantly reduced ROM in the fractured specimens (p<0.05, RM–ANOVA). Without index level screws, the long–segment constructs provided more stiffness when compared to short–segment constructs in all modes (90% vs. 63% in flexion, 87% vs. 57% in extension, 48% vs. 24% in left axial rotation, 48% vs. 17% in right axial rotation, 97% vs. 50% in left lateral bending, 98% vs. 58% in right lateral bending, p<0.05). When index level screws were added to the short–segment constructs, the ROM reduction when compared to the long–segment construct was equivalent except in flexion (75% vs. 90%, p = 0.033), right lateral bending (72% vs. 98%, p = 0.002) and left lateral bending (73% vs. 97%, p = 0.018).

**Conclusion:** In a fracture model, adding index level pedicle screws to short–segment constructs improves stability, yielding comparable stiffness to long–segment constructs in some of the measured modes. Highly unstable fractures, however, likely require extended, long–segment constructs for optimum stability.

246. **Preoperative ASA Grade Predicts Complication and Mortality Rates in Patients Undergoing Spinal Surgery**

Kai–Ming G. Fu, Justin S. Smith, Christopher I. Shaffrey, Joseph Perra, David W. Polly, Jr., Sigurd Berven, Oheneba Boachie–Adjei

**Introduction:** Providing patients with appropriate counseling regarding operative risk is imperative for obtaining informed consent. Previous studies have demonstrated the operative risks for populations undergoing spinal surgery. However, a patient’s risk assessment should be tailored to their individual circumstances, including preoperative comorbidities. In this study we analyzed the multi–center and multi–surgeon Scoliosis Research Society (SRS) Morbidity and Mortality (M&M) database to determine if a patient’s American Society of Anesthesiologists (ASA) grade is a predictor of increased morbidity and mortality in spinal surgery.

**Methods:** The SRS M&M database was reviewed for the year 2007, the first year in which ASA grade was recorded. Patients without recorded ASA grades were excluded. 22857 patients were included in this study.

**Results:** Patients assigned higher ASA grades were reported to have statistically significant (p<0.05) higher rates of complications and death, with the distribution as follows: Grade 1 (n=11101)–5.7% complications, 0.03% mortality; Grade 2 (n=7408)– 9% complications, 0.1% mortality; Grade 3 (n=3879)– 14.4% complications, 0.3% mortality; Grade 4 (n=463)– 20 % complications, 2.2% mortality; Grade 5 (n=6)–50% complications, 33.3% mortality. Complications such as PE, DVT, wound infections, and hematomas also increasingly occurred in patients with higher ASA grades.

**Conclusion:** Higher ASA grades correlate with increased perioperative morbidity and mortality in spinal operations. An accurate ASA grading can be useful in counseling patients on the risk/benefit ratio of surgery. These data confirm the increased risk of performing spinal surgery on patients with increased risk factors and comorbidities and suggest the utility of the ASA grade in quantifying these risks among spine patients.

247. **Incidence of Heterotopic Ossification after Cervical Disc Replacement: Is X-ray Good Enough to Tell?**

Wen–Cheng Huang, Tsung–Hsi Tu, Jau–Ching Wu, Heinrich Cheng

**Introduction:** Increasing popularity of cervical total disc replacement (TDR) changed the care of cervical disc diseases in neurosurgery. But the true incidence of heterotopic ossification (HO) after cervical TDR remained unclear. This study was designed to evaluate incidence of HO after cervical TDR by both computed topography (CT) and plain radiograph in single or bi–level Bryan Disc arthroplasty.

**Methods:** Authors retrospectively reviewed 53 patients underwent single or two–level arthroplasty with Bryan disc. Interpretation of the pre– and post–operative plain films and postoperative CT scans for determination of the presence and grading of HO were conducted by radiologists and neurosurgeons. Findings of CT were regarded as the final
Oral poster abstracts

Vertebroplasty Fracture after Percutaneous Onset Adjacent Vertebral Compression Teriparatide for the Treatment of New-Onset Adjacent Vertebral Compression Fractures after Percutaneous Vertebroplasty

Emma F. Scully, Michael E. Greenwald, Michael A. Pels, Matthew J. Matchikian, Daniel K. Resnick

Introduction: Percutaneous vertebroplasty is a well-established treatment for osteoporotic compression fracture; however, clinical studies suggest that it may provoke fractures in adjacent, non-augmented vertebrae. Subsequent fractures can occur much sooner and more frequently after operative treatment. Treatment with daily subcutaneous injections of teriparatide is effective in increasing spinal bone mineral density and in decreasing vertebral fracture risk in patients with osteoporosis.

Methods: This comparative study evaluated the effectiveness of teriparatide for treating new adjacent vertebral fractures after vertebroplasty

Results: In group A (administration of teriparatide), there was a significant increase in bone mineral density after administration of teriparatide. The mean DXA T-score prior to treatment was -3.86 ± 0.79. At 18-month follow-up, however, the score increased to -2.7 ± 0.49. (Fig. 1) In addition, at 18-month follow-up, mean visual analogue scale scores had decreased from 7.92 ± 0.93 to 1.04 ± 0.62 and mean Japanese orthopaedic association lower back pain scores had decreased from 8.42 ± 2.95 to 2.54 ± 2.45. (Fig. 2) Only one new-onset adjacent vertebral compression fracture (VCF) occurred in group A during the mean follow-up period of 21.75 months. In group B (no treatment for osteoporosis), 11 (19.64%) patients developed new-onset VCFs after the second percutaneous vertebroplasty (PVP) and 5 patients developed new VCFs after third PVP. One patient suffered from major bone cement extravasation requiring decompressive laminectomy.

Conclusion: Teriparatide treatment of new vertebral compression fractures after vertebroplasty is effective for pain relief and preventing new compression fractures.

249. Traumatic Spondylolisthesis of the Axis: Analysis of Treatment and Outcome in 40 Cases

Tao Ding, Mitchell G. Maltenfort, James S. Harrop

Introduction: Traumatic spondylolisthesis of the axis (TSA), also called a “hangman’s fracture,” is the second most common fracture of axis following odontoid fractures. This retrospective study reports a consecutive series of 40 patients with TSA treated in a single institution, with the specific attention on the association between the radiographic and clinical factors and the probability of successful management, fusion of fracture, with a conservative treatment algorithm.

Methods: All patients had radiographic studies including three-view cervical spine plain radiograph and high resolution computed tomography (CT). Magnetic resonance imaging (MRI) and angiography (MRA) were available in 83% (33/40) patients to assess cervical canal compression or spinal cord injury and vertebral artery integrity. Thirteen patients had significant concurrent injuries. Concomitant spinal fractures were present in 11 (28%) patients, included the contiguous upper cervical spinal injuries in two patients. Four patients had associated spinal cord injuries (ASIA score D) on admission. The neurological examinations all improved to normal (ASIA E) during the follow-up period in all patients.

Results: Bony union occurred in 33/37 (89%) primarily conservatively treated cases at three months follow-up evaluation. Bony union was obtained in all (3/3) primarily surgically treated cases. After primarily conservative treatment 3/10 patients who were chronic tobacco users (CTU), compared with 1/27 non-CTU, failed to heal (p=0.0324). 3/7 patients classified as Francis grade V fractures had failed unions with primarily conservative treatment, vs. 1/30 in patients with Francis grades I-IV (p=0.0081). Multivariate logistic regression identified as risk factors for non-union: age (odds ratio 1.13 per year), initial translation (OR 1.62/mm), and chronic tobacco use (OR 65.99) in patients primarily treated with conservative treatment.

Conclusion: The overall prognosis of this fracture subtype is excellent and it is apparent that the majority of these fractures can be treated conservatively.

250. To Fuse or Not To Fuse: Lumbar Synovial Cysts

Bashir Mohan Agrawal, Daniel K. Resnick

Introduction: Synovial cysts of the lumbar spine may cause radiculopathy or low back pain. Segmental instability and facet arthropathy have been postulated as mechanisms for synovial cyst formation. While decompressive surgery is effective, recurrences are not uncommon. Concomitant fusion still remains controversial.

Methods: A single surgeon series of patients operated upon for lumbar synovial cysts between 1998–2009 was analyzed for clinical presentation, surgical technique, reoperation, and clinical outcome. Preoperative back and leg pain were assessed using a visual analogue scale. Follow-up data was acquired prospectively via phone interview or retrospectively via chart review in patients who were unable to be contacted.

Results: Twenty-seven patients were surgically treated for symptomatic lumbar synovial cysts. All patients presented with moderate to severe radiculopathy or neurogenic claudication. The most commonly affected level was L4–5 (56%). Seven patients had previous lumbar surgery, and five (71%) of these patients had either a new or recurrent (2/7) synovial cyst at the same level of their surgery. Nine patients had spondylolisthesis and one patient had severe degenerative scoliosis. All patients underwent laminectomy and resection of cyst. Fifteen (40%) patients had concomitant spinal fusion, including all patients with malalignment and previous surgery at the index level. Average follow-up was twenty-eight months. Three patients (25% non-fused patients) had recurrent synchronous level cysts; each was treated with resection and fusion. There were no recurrent cysts in fused patients. Twenty-five (93%) patients had excellent or good outcomes.

Conclusion: Patients undergoing resection of synovial cysts are at risk for early recurrence even with normal spinal alignment and no previous history of spinal surgery. While fusion may not be required in every case, patients should be...
counseled regarding a high risk of recurrence without fusion. Recurrence is exceedingly rare in patients treated with fusion, and patients with any evidence of spinal instability should be offered a concomitant fusion.

251. The Patient with Myelomeningocele: Is Untethering Necessary Prior to Deformity Correction?
Amer F. Samdani, Sookdeep Sagoo, Shailja Shah, Patrick Cahill, David Clements, Randal Belz

Introduction: Tethering of the spinal cord is thought to increase the chance of neurologic injury when spinal deformity correction is undertaken. All patients with myelomeningocele (MM) are radiographically tethered, and untethering procedures carry significant morbidity including worsening neurologic function and wound complications. No guidelines exist concerning untethering patients with MM prior to deformity correction.

Methods: We retrospectively identified 17 patients with MM who 1) had no evidence of a clinically symptomatic tethered cord, 2) had undergone a spinal fusion for deformity correction, and 3) had not been untethered for at least one year prior to surgery. Minimum follow up after fusion was 2 years. Charts and radiographs were reviewed for neurologic or shunt complications intraoperatively and within 3 months of surgery.

Results: Mean age of the patients with MM was 12.4 years with the following neurologic levels: <= T12; 7, L1: 3, L2: 3, L3: 2, L4: 2. All were radiographically tethered as confirmed by MRI. 14 of the patients (82%) had a ventriculoperitoneal shunt. The mean Cobb angle was corrected from 82°±28 to 39°±13 postoperatively, for a 57% correction. All patients underwent neuromonitoring of their upper extremities, with some having obtainable lower extremity monitoring. Postoperatively, no patient experienced new cranial nerve palsies, shunt malfunction, or upper extremity weakness/sensory loss. One patient had transient lower extremity weakness which returned to baseline within one month of surgery.

Conclusion: Our results suggest that spinal cord untethering may not be necessary in patients with MM undergoing spinal deformity corrective surgery who do not present with clinical symptoms of a tethered cord, even though they are tethered radiographically.

252. Rate of Return to Military Active Duty after Single Level and Two Level Anterior Cervical Discectomy and Fusion: A 4-year Retrospective Review
Ryan Ponton, Wayne Gluf, Angelina N. Garvin, Luis M. Tumialan

Introduction: The purpose of this study is to identify the rate of return to full, unrestricted active duty after single and two-level anterior cervical discectomy and fusion surgery in military personnel and evaluate for variables that correlated with a successful outcome.

Methods: The surgical database at a single tertiary care military treatment facility was queried for all active duty patients who underwent a single or two-level ACDF over a four-year period. A retrospective chart review was performed to collect patient and procedural data to include indication for surgery, fusion level, tobacco use, age, and military rank. Fisher’s Exact and Wilcoxon Rank Sum tests were used to identify statistically significant differences in the rate of return to active duty based on a given variable.

Results: A total of 135 anterior cervical discectomy and fusions were performed over the study period. Of these, 132 patients met inclusion criteria. The average age at time of surgery was 38.2 years (range: 21-57 years). The majority of surgeries (50%) were performed for radicular pain secondary to a herniated nucleus pulposus. The most commonly fused segments were C5–6 (34%). One hundred sixteen patients (88%) were able to return to unrestricted full active duty, while the remaining sixteen were separated from the military for continued pain. The return to active duty rate was significantly higher in service members with a rank of E7 or above (99%) than those E6 and below (73%). No statistically significant differences in ability to return to full duty were found between age, single or two-level surgery, level of fusion, or any other variables.

Conclusion: Eighty-eight percent of the service members who underwent an ACDF returned to unrestricted full duty. This information may be useful to spine surgeons when counseling or selecting military patients for management of cervical spondylosis or radiculopathy.

253. Clinical and Radiographic Outcomes in Myelomeningocele Patients Undergoing Spinal Fusion for Neuromuscular Scoliosis
Mohammad S. Shukairy, Peter F. Sturm

Introduction: Myelomeningocele patients invariably suffer from spinal cord tethering and scoliosis. Spinal fusion for neuromuscular scoliosis aims to improve patients’ pulmonary function by minimizing chest collapse and improving patients’ sitting ability by straightening the spine and minimizing pelvic obliquity. It is unknown whether or not spinal cord tethering prior to spinal fusion surgery affects neurological or clinical outcomes. Secondly, spinal cord untethering purportedly improves scoliosis, although data are not definitive. Furthermore, a safe time frame between spinal cord untethering and scoliosis corrective surgery is not well-established.

Methods: We undertook a retrospective chart review of all patients with myelomeningocele and neuromuscular scoliosis requiring spinal fusion at one institution from 1990 to 2007. We reviewed their presentation, number of untetherings prior to spinal fusion, time between untethering and spinal fusion, post-operative clinical outcomes, including complications and symptomatic improvement, pre-operative and post-operative radiographic data including Cobb angles, kyphosis, pelvic obliquity over time.

Results: 48 patients with myelomeningocele underwent spinal fusion surgery for scoliosis. Average follow-up was 2.5 years. Average correction of major scoliotic curve was 55.2% over the follow-up term. Complications included wound breakdown/infections (20%) and hardware failure/loosening (40%). Neurological worsening, such as bowel/bladder dysfunction, motor strength, ambulation and sensory changes, was extremely uncommon. We found the majority of patients are untethered prior to scoliosis surgery. Untethering did not prevent progression of scoliosis nor obviate the need for scoliosis surgery in our series.

Conclusion: Myelomeningocele patients undergoing spinal fusion surgery for neuromuscular scoliosis have a high rate of complications, including wound infections and hardware failure, but low rate of neurological worsening. Most patients are untethered prior to scoliosis correction. Patients who were not untethered prior to surgery did not appear to suffer higher rates of complications. Prospective studies are needed for further validation of results.
electromyographic testing has become a common tool for assisting in the confirmation of proper placement of pedicle screws during spine surgery. HA coated screws have recently come to market as a means of increasing "pullout" strength. The manufacturer has recommended that HA coated screws not be stimulated due to inconsistent stimulation thresholds. There is no published data to confirm this recommendation.

Methods: Resistance measurements were obtained from a random sampling of ten HA coated pedicle screws and ten non-coated screws. All screws were the same diameter (6.5mm) and length (45mm). Resistance measurements were taken from the Hexagonal Head slot through the shank of the screw to simulate surgical conditions, as well as at each thread. Surface Resistivity measurements were also taken for each screw, to determine voltage drop over its entire length. 

Results: The non-Hydroxypatite coated screws tested showed low resistive properties and proved to be an ideal conductor of electrical current. The resistive properties associated with the HA coated pedicle screws were found to be similar to those of commonly used insulators removing the effectiveness of evoked electromyographic responses.

Conclusion: Based on test results, this data suggest that the increased resistance value of the HA coated screw is large enough to prevent modern IOM equipment from delivering the necessary current through the shank of the screw to create an electromyographic response safely. Any response that would be produced would be due to shunting of electric current from the non-coated head of the screw in to adjacent tissue and not through the shank of the screw. These study results suggest that HA coated screws should not be stimulated to assist in determining the accuracy of pedicle screw placement.

255.

A Quantitative Value Analysis Formula Designed for Comparison of Spine Interventions Based on Outcome, Success Rate and Cost Data
James B. Macon

Introduction: Despite literature references to value (Ref. 1–2), no accepted quantitative method of value measurement is available for comparison of various spine treatment modalities. A pilot study has been performed to test a quantitative value formula with data entry applied to spine treatments.

Methods: Health Care Value has been defined by Porter and Teisberg as health care outcomes per dollar spent (Ref.1–2). A comprehensive value equation (Fig. 1) is proposed to provide quantitative value data displayed in spreadsheet format for comparison of group study results. In the denominator, cost is defined as payment (DK) received by all providers for the treatment constrained to a minimum of $100. In the numerator, outcome (Ok) is defined by % improvement (0–100) of lower extremity radicular pain intensity measured by a standard numerical pain scale three months post treatment. Calculated successful outcomes (Ok$ where $s = 1) are defined in a range (70–100) which requires no subsequent interventional treatment after three months. No value is given for outcomes < 70 (where $ = 0). A total of 20 patients with acute lumbar radicular pain due to disc herniation without radiculopathy were evaluated prospectively to test the value formula. Lumbar epidural steroid (10) and microdiscectomy (10) results were compared. Patients who had unsuccessful outcomes with epidural steroid treatment were allowed to cross over to microdiscectomy after 3 months.

Results: This value formula is a quotient of summation series which provides quantitative results allowing a comparison of both the individual and collective value of treatments (Fig. 1). For the group of epidural steroid injections for lumbar radiculitis at three months success was 70%, with cost $9,045 and value 44 (Fig. 2). By contrast, the success rate for the group of lumbar microdiscectomies at three months was 90%, with cost $93,750 and value 8 (Fig. 3). After cross over to microdiscectomy the initial three epidural steroid group outcome failures converted to 100% success, with added cost $29,600 (total $38,645) and value 21 (Fig. 4).

Conclusion: This study demonstrates that the quantitative value formula provides a unique perspective concisely summarizing value, success rates and costs in a format applicable to larger clinical studies.

256.

XLIF for Grade II Spondylolisthesis at L4–5: The “Worst Case” Scenario
W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: The XLIF technique is an MIS alternative to traditional spinal fusion. However, concerns are raised about neural complications with the lateral approach, particularly at the L4–5 level where access is most difficult due to the lumbar plexus. Significant anterolisthesis at this level exacerbates this risk. Outcomes from a series of these “worst case scenario” patients treated with XLIF are reported.

Methods: 52 patients with Grade–II spondylolisthesis at L4–5, w/ and w/o concomitant stenosis, DDD, post-laminectomy instability, HNP, and/or scoliosis, were treated with XLIF. Clinical and radiographic data were reviewed to assess comorbidities, surgery details, hospital stay, complications, pain scores, changes in disk height and alignment, and fusion, and satisfaction scores at 12 months postop.

Results: Ages ranged from 25–87 yrs (ave 65.8 yrs). Comorbidities were common (present in 83%). The L4–5 level was accessible in all cases. All cases included supplemental posterior fixation. LOS averaged 1.22 days. Complications included 1 pulmonary embolism requiring anticoagulation, 1 late-term hardware failure (screw fracture at 1 year), and one postop transfusion. No neural deficits were noted. In 25 patients at 12 months, VAS pain scores improved from 8.6 to 1.8. Average disk height improved from 5.4mm at pre-opto to 10.5mm post-op, with 1.6mm settling at 12 months. Slip improved from 10.7mm at pre-opto to 3.2mm and was maintained at 12 months. Lenke fusion scores averaged 1.9 at 3 months, 1.5 at 6 months, and 1.2 at 12 months. Eight patients underwent a CT scan at 12 months; all were judged as fused by an independent reviewer. 89% of patients were satisfied with the procedure and would do it again.

Conclusion: Grade–II spondylolisthesis at L4–5 can be treated successfully with a minimally invasive lateral approach. Results indicate good outcomes, few complications, and high satisfaction even in the most difficult situation. Careful attention to technique is paramount.

257.

Performance of the TM–100 Cervical Fusion Device in a Prospective, Randomized, Controlled Trial
Robert G. Louis, Mark Edwin Shaffrey

Introduction: Trabecular metal, an open-celled tantalum lattice, has been used successfully in surgical applications since 1997. The objective of the clinical investigation was to compare ACDF using TM–100 with a concurrent, randomized, control group receiving bone allograft.

Methods: The study population consisted of patients aged 18–70 with one or two adjacent level(s) of cervical radiculopathy and/or myelopathy from C3–C4 to C7-T1. A total of 231 subjects were randomized to either the investigational arm (141) or the
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allograft intertumormaintofusion.

surgical procedures, and was superior to

ofefficacy, required fewer additional

device and control groups and there were

statistical differences at any assessment.

Conclusion: The TM-100 Cervical Fusion Device is non-inferior to allograft in terms of efficacy, required fewer additional surgical procedures, and was superior to allograft in terms of time to fusion.

258. Clinical and Radiographic Outcome of the NeoDisc Cervical Total Disc Replacement (TDR) at One-year Follow-up Kenneth Pettine

Introduction: The NeoDisc cervical TDR consists of a compliant elastomeric core encased in an embroidered polyester jacket with anterior fixation phalanges attached via screw fixation. This data is from one FDA IDE site with minimum one-year follow-up.

Methods: Sixty-one patients were randomized 1:1 (Neodisc:fusion with allograft and plating) The surgical technique included complete removal of the posterior longitudinal ligament and annulus from foramen to foramen. Demographics and inclusion/exclusion criteria will be presented.

Flexion/extension radiographs were evaluated pre-operatively and at six and twelve-months post-operatively. Medical Metrics Inc. made all measurements independently. One-year follow-up was completed in 28 of 31 ACFD patients and 30 of 32 NeoDisc patients.

Results: NDI clinical success was achieved in 72% of control patients and 89.3% of the NeoDisc group (P<0.027). NDI was less than 20 in six control patients at three months and eight patients at one year. Twelve control patients had a VAS less than 2 at three months and twelve at one year. Seventeen patients had a NDI less than 20 at three months, and 18 were less than 20 at one year. Seventeen NeoDisc patients had a VAS less than 2 at three months, and seventeen were less than 2 at one-year follow-up. Reoperations occurred in three of the control group and one of the NeoDisc group. Pre-operative range of motion averaged 10.7º. NeoDisc range of motion averaged 8.4º at six months and 8.2º at one-year follow-up. Longer-term radiographic follow-up is necessary to ascertain the clinical significance of endplate radiographic changes observed in some patients.

Conclusion: One-year minimum follow-up was completed in 84% of the control group and 94% of the NeoDisc group. These results included a maintained range of motion and a statistically significant superior NDI (P>0.026) and VAS (P<0.043) in the NeoDisc group compared to the one-level ACFD group.

259. Treatment of Intramedullary Spinal Cord Tumors with Stereotactic Radiosurgery Timothy Flerlage, James Richman, Camilo A. Molina, Wesley Hsu, Eric Ford, Michael Lim, Ziya L. Gokaslan, Ali Bydon, Timothy F. Witham, Jean-Paul Wolinsky, Daniel M. Sciubba

Introduction: Intramedullary spinal cord tumors are relatively rare lesions. Surgical resection is the standard of treatment for these tumors, though prognosis remains poor. The efficacy of radiosurgery for the treatment of these tumors is inconclusive. We have developed The Small Animal Radiation Research Platform (SARRP), a stereotactic radiosurgery (SR) device intended for use on small animals. Conceptually, this device is a smaller version of SR devices currently employed in the treatment of human patients. The goal of this study is to determine if SR has the ability to delay the onset of paralysis in a previously described model of intramedullary spinal cord tumors without creating radiation-induced spinal cord injury.

Methods: Sixteen female Fischer rats were injected with 100000 9L gliosarcoma cells in a process described previously by Caplan et al. (1). Animals were randomized into control (n=8) and experimental groups (n=8). The experimental group received 14 Gy of stereotactic radiation to the site of tumor implantation on post-operative day five using the SARRP machine. After irradiation, both control and experimental groups were assessed functionally using the Basso–Beattie–Bresnahan scale.

Results: The average onset of paralysis in the control group was 11.75 days (SD=3.24 days) post implantation, whereas the average latency of paralysis in the experimental group was 13.62 days (SD=3.88 days). There were no complications associated with direct radiation to the spinal cord.

Conclusion: In a rat model of intramedullary spinal cord tumors there was no significant difference between control animals and experimental animals treated with 14 Gy of radiation delivered stereotactically to the site of the lesion. However, it appears that SR shows a trend towards delaying the onset of paralysis without creating radiation-induced spinal cord injury. Future studies will focus on increasing the statistical power of this study and raising the total dose delivered to the lesion site, correlating tumor control with dose.

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300. The Evaluation of the Inverted Supinator Reflex in Asymptomatic Individuals
Paul Kielty, Joseph F. Baker, Sven O’Hireamhoin, Darren Lui, Brian Devitt, Alan Walsh, Ashley Poynton, Keith Synnott

Introduction: Myelopathy is the presentation of cord compression secondary to cervical spondylosis. A number of signs can be elicited on clinical exam to support this diagnosis. Among these is the inverted supinator reflex, considered to be pathognomonic of cervical stenosis at C5/6 causing cord compression. However, there is no data available documenting the accuracy or otherwise of this reflex. We aimed to establish initially the incidence of this reflex in the normal, asymptomatic population.

Methods: Over a 6-month period patients attending our trauma clinic were invited to participate in the study. In addition to the inverted supinator reflex, patients were tested for Hoffman’s sign, the finger escape sign, Babinski’s sign and Romberg’s sign. Patients were excluded if they had any history of neurological disease, spinal or neurosurgery, neurological symptoms or if their active trauma treatment precluded full clinical exam.

Results: We examined 279 patients (male 145, female 134), average age 71 years. 75 (27%) had a positive inverted supinator reflex and 9 (3%) a positive Hoffman’s sign. There was no significant difference between male and female groups (p = 0.05). When age groups were analyzed the proportion of individuals testing positive decreased with increasing age (Pearson correlation co-efficient 0.81).

Conclusion: The inverted supinator reflex is a classical sign of myelopathy secondary to cervical spondylosis. We have shown that a substantial number of asymptomatic individuals test positive. It therefore must be interpreted with caution. However, the likelihood of a ‘false positive’ reflex reduces with increasing age and in this patient group we advise appropriate clinical correlation with other signs and symptoms.

301. Outcome of Lumbar Fusion in Patients with Predominantly Leg Pain
Abdul Baker, Steven D. Glassman, Leah Y. Carreon

Introduction: For most patients undergoing lumbar fusion, back pain is a significant component of the preoperative symptom complex, and their outcome is judged in part on the resolution of their back pain. Occasionally, patients with predominant leg pain and minimal or no back pain undergo a fusion procedure based on radiographic parameters or anticipated postoperative instability. The purpose of this study is to report on prospectively collected clinical outcome measures for patients with predominant leg pain and minimal back pain who undergo lumbar arthrodisis.

Methods: Diagnostic categorization and clinical outcome measures were prospectively collected by six spine surgeons at a single tertiary spine center. Four-hundred-and-twenty-eight patients with complete two-year ODI and SF-36 data formed the primary cohort. Of this group, only twenty-four patients met the inclusion criteria of numeric rating scale (0–10) of 3 or less for back pain. ODI, SF-36, and numeric rating scales for back and leg pain were used as objective outcome measures. Paired t-tests were used to determine significant differences between preoperative and two-year postoperative scores.

Results: There were 14 males and 10 females with a mean age of 62.4 years. Preoperative diagnosis included spondylolisthesis (n = 13), instability (n = 2), stenosis (n = 2), disc pathology (n = 4) and post-discectomy (n = 3). There was a statistically significant improvement in leg pain from pre-op to two-years post-op (p = 0.0001). However, there was no statistically significant change in back pain from pre-op to two-years post-op (p = 0.191). There was a statistically significant improvement in ODI and SF-36 PCS pain from pre-op to two-years post-op (p = 0.0001).

Conclusion: Patients undergoing lumbar arthrodisis for predominant leg pain with minimal back pain had acceptable outcomes, with no increase in back pain after surgery. Substantial improvements were noted for both disease specific function (ODI) and generic HRQOL measure (SF-36).

302. Evaluation of Change in Muscle Activity as a Result of Posterior Lumbar Spine Surgery
Lacey E. Bresnahan, Richard G. Fessler, Raghu N. Natarajan

Introduction: A study was designed to evaluate how the graded resection of the lumbar paraspinus muscles that occurs during surgery affects postoperative muscle activity for a variety of movement tasks. Due to the limitations that exist with current in vivo methods no study to date has been able to quantitatively examine how the function of the individual muscles in the lumbar spine change in response to different levels of injury.

Methods: A commercially available musculoskeletal model of the lumbar spine was modified to study the change in muscle activation as a result of posterior lumbar surgery at L3–4 and L4–5 segments. The musculoskeletal model measures muscle activity using a parametric examination of change in the cross-sectional area of muscles affected by posterior lumbar surgery.

Results: This study shows that the reduction in muscle cross-sectional area as a result of posterior lumbar surgery at L3–4 and L4–5 results in a change in trunk muscle activity where the greatest change occurs during axial rotation and lateral bending. The results suggest that preservation of the posterior paraspinus musculature results in greater preservation of the normal muscle activity than traditional open techniques.

Conclusion: Preservation of the paraspinous musculature associated with minimally invasive surgical approaches to the lumbar better preserve postoperative muscle activity. This study suggests that there is a positive correlation between the reduction of paraspinous muscle cross-sectional area following posterior lumbar spine surgery and the alteration in trunk muscle activity.

303. Changes is Lumbar Lordosis and Foraminal Height following Extreme Lateral (XLIF) and Transforaminal (TLIF) Lumbar Interbody Fusion
Matthew J. Tormenti, Matthew B. Masera, Christopher Michael Bonfield, David O. Okonkwo, Adam S. Kanter

Introduction: Interbody fusion has become a popular adjunct in the treatment of many degenerative conditions of the lumbar spine. It has been shown to improve fusion rates and clinical outcomes. Numerous techniques for the deployment of interbody grafts have evolved. We compare radiographic parameters of the
304. Curve Correction in Adult Scoliosis Utilizing Extreme Lateral Interbody Fusion (XLIF) and Posterior Pedicle Screw Instrumentation
Matthew J. Tormenti, Matthew B. Maserati, Christopher Michael Bonfield, David O. Okonkwo, Adam S. Kanter
Introduction: Radiographic curve correction has been associated with improved clinical outcomes. We have recently employed a combined minimally-invasive extreme lateral (transpsoas) approach with interbody fusion and open posterior segmental pedicle screw instrumentation with transforaminal lumbar interbody fusion (TLIF).
Methods: Five consecutive patients underwent combined extreme lateral and posterior approaches for correction of thoracolumbar scoliosis. A total of 42 (mean=8) levels underwent posterior arthrodesis with posterior segmental instrumentation. A comparison group of patients who underwent a posterior only (TLIF and PLIF approaches) was included. Preoperative and postoperative T12-L4 and L1-L4 Cobb angles were measured on digitized upright thoracolumbar scoliosis films. Preoperative and postoperative assessments of coronal balance, and apical vertebral translation were also performed.
Results: The mean preoperative T12-L4 and L1-L4 Cobb angles were 32.4°±9.9° and 35°±11.3° respectively (ranges 18°-41° and 18°-46°). The mean postoperative T12-L4 and L1-L4 Cobb angles were 9.6°±8.1° (p=0.005) and 10.6°±9.2° (p=.002) respectively (ranges 2°-22° and 2°-24°). Mean percent curve correction was 72.2% and 72.8%, respectively. Preoperative mean coronal balance was 1.2cm from the center sacral vertebral line. This did not change significantly after surgery (0.8cm, p=0.374). The apical vertebral translation was significantly reduced from 2.4cm preoperatively to 1.5cm (p=0.04). Lumbar lordosis went from a mean of 48° to 50° (p=0.71). A comparison group of 4 patients who underwent a posterior only correction was included (Table-1). There were no significant differences in any of the measured variables between the two treatment groups.
Conclusion: Radiographic outcomes such as Cobb angle and apical vertebral translation were significantly improved in patients who underwent a combined XLIF/TLIF approach. Coronal balance was also improved, however, the difference did not reach statistical significance. Combination of extreme lateral and TLIF/posterior segmental instrumentation techniques may lead to less blood loss and to radiographic outcomes that are comparable to traditional AP approaches.

305. Accuracy of Intraoperative CT-based Image Guidance Compared to Fluoroscopy in Thoracolumbar Pedicle Screw Placement
Matthew J. Tormenti, Dean B. Kostov, Adam S. Kanter, Richard M. Spiro, David O. Okonkwo
Introduction: Misplacement of thoracolumbar pedicle screw instrumentation using anatomic landmarks and fluoroscopy has been reported as high as 30%. The use of image guidance improves this accuracy. We employed a novel intraoperative CT-based image guidance technique for placement of posterior thoracolumbar instrumentation and compare it to instrumentation utilizing fluoroscopy.
Methods: From December 2007 to July 2008, 12 patients underwent posterior spinal instrumentation for spinal deformity correction using intraoperative CT-based image guidance. An intraoperative CT scan of the sterile surgical field was obtained after decompression and before instrumentation. Instrumentation was placed and a post-instrumentation CT scan was obtained before wound closure to assess the accuracy of instrumentation placement and the potential need for revision. The accuracy of pedicle screw placement was later reviewed and recorded by independent observers. A comparison group of 14 patients during the same time period who underwent thoracolumbar instrumentation utilizing fluoroscopy and who had postoperative CT scans was evaluated and included in this analysis.
Results: In the intraoperative CT-based image guidance group, a total of 164 thoracolumbar pedicle screws were placed. Two screws were found to breach the pedicle wall (1.2%). Neither screw was deemed to need revision due to misplaced. In the comparison group, 211 pedicle screws were placed. Postoperative CT scan revealed that 11 screws (5.2%) had breached the pedicle. One patient in the fluoroscopy group woke with a radiculopathy attributed to a misplaced screw which required revision. The difference in accuracy was statistically significant (p=0.031).
Conclusion: Intraoperative CT-based image guidance for placement of thoracolumbar instrumentation has an accuracy that exceeds reported rates using other image guidance systems, such as virtual fluoroscopy and 3-D isocentric C-arm based stereotactic systems. Furthermore, with the use of intraoperative CT, a post-instrumentation CT scan allows the surgeon to evaluate the accuracy of instrumentation before wound closure and revise as appropriate.

306. Biomechanical Comparison of Anterior, Posterior and Circumferential Fixation following One-level Anterior Cervical Corpectomy in the Human Cadaveric Spine
Youssef Karam
Introduction: Anterior corpectomy is a surgical procedure that is used for anterior decompensation of the spinal cord in different pathologies such as vertebral body fractures, degenerative disease with spondylotic myelopathy, OPLL, spondylitis due to infection, vertebral body tumor, and others. A graft is placed and stabilized
anteriorly by plating. However, there is little data on the direct comparison of biomechanical stability provided by anterior, posterior, or circumferential fixation following one level corpectomy, with and without posterior capsular disruption.

Methods: Nine cadaveric cervical spines were pooled at C2 rostrally and T1–T2 distally, and tested in six directions (flexion, extension, right lateral bending, left lateral bending, clockwise axial rotation, and counterclockwise axial rotation), with pure moments of 0.5, 1.0, and 1.5 Nm, in 5 consecutive conditions. Condition 1: intact spine. Condition 2: C5 corpectomy, anterior Bengal cage grafting and C4–C6 plating (Skyline). Condition 3: C4/C5 and C5/C6 capsular and interspinous ligament disruption. Condition 4: C4, C5, and C6 posterior mass screw fixation (Mountaineer). Condition 5: removal of the anterior graft and plating. Using the Motion Analysis System, angular motions of C4 relative to C6 were measured. Tukey’s test was used to determine significance or not between different steps.

Results: There was no significant improvement in stability between anterior cage/plating alone vs. circumferential fixation when the facet capsules and posterior ligaments were intact. Significant increase in range of motion between anterior cage/plating and circumferential fixation was noted after capsular and posterior ligament disruption, in axial rotation and lateral bending testing, but not in flexion and extension testing. Posterior fixation alone failed to limit the cervical spine motion mainly in extension testing, but not in axial rotation or lateral bending testing. The previous results emphasize the importance of facet capsules or posterior lamina fixation in limitation of excess motion in axial rotation and lateral bending.

Conclusion: Anterior cage/plating after one level corpectomy is comparable biomechanically to circumferential fixation if the facet capsules are intact. Posterior lamina fixation should be considered in case of facet capsule disruption. Circumferential fixation provided the greatest level of stability in case of one level corpectomy with facet capsule disruption.


James S. Harrop, Mitchell Gil Malfenfort, John K. Ratliff, Ashwini D. Sharan

Introduction: There are numerous reports describing the radiographic features of cervical spondylotic myelopathy, however, no publication specifically describes the association between the physical signs of cervical myelopathy and the presenting imaging findings. Our objective was to correlate the clinical findings associated with cervical myelopathy to the presence of spinal cord compression or cord signal abnormalities on magnetic resonance imaging (MRI).

Methods: We performed a retrospective analysis of a cohort of patients, diagnosed with cervical degenerative disease, and treated between April 2006 and January 2008. Myelopathy was defined as the presence of greater than one long tract sign localized to the cervical spinal cord (Hoffman or Babinski signs, clonus, hyperreflexia, crossed abductor sign and/or gait dysfunction) on physical examination in the absence of other neurologic condition(s). The presence of these signs, MRI imaging features of spinal cord compression and hyperintense T2 intraparenchymal cord signal abnormality, and patient demographics were recorded.

Results: 103 patients met inclusion criteria (age > 18, symptomatic cervical degenerative disease and complete neurologic assessment). Fifty-four of these had clinical findings of cervical myelopathy. Radiographic features of cord compression were present in 62% of patients, and 84% had myelopathy on examination. No patients without cord compression presented with myelopathy [p<0.0001]. Thirty-five percent of the patients presented with hyperintense signal on T2 MRI within the spinal cord parenchyma. This finding correlated with the presence of myelopathy [p<0.0001]. Multivariate analysis on the subset with cord compression indicates that the likelihood of myelopathy increased with the presence of cord signal hyperintensity (odds ratio 11.4), sensory loss (OR 16.9), and age (OR 1.10 per year).

Conclusion: The diagnosis of cervical myelopathy is based upon presenting symptoms and physical examination. This analysis illustrates that radiographic cervical spinal cord compression and hyperintense T2 intraparenchymal signal abnormalities correlate with the presence of myelopathic findings on physical examination.

308. Pelvic Instrumentation Using Intraoperative CT-based Spinal Neuronavigation

Matthew J. Tormenti, Adam S. Kanter, David O. Okonkwo

Introduction: Long fusions to the sacrum in adult deformity surgery are frequently complicated by pseudoarthrosis and instrumentation failure. The addition of iliac fixation has improved fusion rates and limited instrumentation failure by improving construct stiffness and reducing cantilever pullout forces. We describe a novel technique for the safe placement of iliac instrumentation using intraoperative CT-based image guidance.

Methods: Five patients who underwent posterior thoracolumbar deformity correction were included in this analysis. Following standard surgical exposure and decompressive procedures patients undergo placement of fiducial markers and an intraoperative CT scan. Fiducials are registered with an image guidance computer. Posterior instrumentation including iliac screws are placed using image guidance. A post-instrumentation scan is then obtained to confirm the accuracy of instrumentation placement. This scan was reviewed by independent reviewers for assessment of instrumentation accuracy.

Results: Five patients underwent placement of iliac screws using intraoperative CT-based image guidance. Post–instrumentation CT scans revealed 100% accuracy in screw placement. No patients had instrumentation related complications.

Conclusion: Intraoperative CT-based image guidance is an accurate and safe technique for placement of iliac instrumentation in spinal deformity surgery.

309. The Transpedicular Approach vs. the Anterior Approach: An Analysis of 80 Thoracolumbar Corpectomies

Daniel C. Lu, Darryl Lau, Dean Chou

Introduction: Standard anterior approaches for thoracolumbar corpectomies have commonly been used, but the transpedicular corpectomy is increasingly being undertaken to perform corpectomies from a posterior approach. We wished to analyze whether or not there was a difference in outcomes by comparing transpedicular corpectomies to corpectomies done by standard anterior thoracolumbar approaches.

Methods: 80 patients underwent thoracolumbar corpectomies from 2004 to 2008 by the senior author (D.C.). Medical records were reviewed, and follow-up was noted by clinic visits, radiographs, or telephone. Neurologic outcome, complications, operative times, revision surgery rates, and blood loss were evaluated.

310. Thoracolumbar Corpectomies: The Transpedicular Approach vs. the Anterior Approach

Daniel C. Lu, Darryl Lau, Dean Chou

Introduction: There are numerous reports describing the radiographic features of thoracolumbar corpectomies, however, no publication specifically describes the association between the physical signs of thoracolumbar myelopathy and the presenting imaging findings. Our objective was to correlate the clinical findings associated with thoracolumbar myelopathy to the presence of spinal cord compression or cord signal abnormalities on magnetic resonance imaging (MRI).

Methods: We performed a retrospective analysis of a cohort of patients, diagnosed with thoracolumbar degenerative disease, and treated between April 2006 and January 2008. Myelopathy was defined as the presence of greater than one long tract sign localized to the thoracic horizontal cord (Hoffman or Babinski signs, clonus, hyperreflexia, crossed abductor sign and/or gait dysfunction) on physical examination in the absence of other neurologic condition(s). The presence of these signs, MRI imaging features of spinal cord compression and hyperintense T2 intraparenchymal cord signal abnormality, and patient demographics were recorded.

Results: 103 patients met inclusion criteria (age > 18, symptomatic thoracolumbar degenerative disease and complete neurologic assessment). Fifty-four of these had clinical findings of thoracolumbar myelopathy. Radiographic features of cord compression were present in 62% of patients, and 84% had myelopathy on examination. No patients without cord compression presented with myelopathy [p<0.0001]. Thirty-five percent of the patients presented with hyperintense signal on T2 MRI within the spinal cord parenchyma. This finding correlated with the presence of myelopathy [p<0.0001]. Multivariate analysis on the subset with cord compression indicates that the likelihood of myelopathy increased with the presence of cord signal hyperintensity (odds ratio 11.4), sensory loss (OR 16.9), and age (OR 1.10 per year).

Conclusion: The diagnosis of thoracolumbar myelopathy is based upon presenting symptoms and physical examination. This analysis illustrates that radiographic thoracic spinal cord compression and hyperintense T2 intraparenchymal signal abnormalities correlate with the presence of myelopathic findings on physical examination.
Results: 34 patients underwent transpedicular corpectomies, and 46 patients underwent anterior thoracolumbar approaches. Single-level transpedicular corpectomies appear to be comparable to anterior-only corpectomies with regards to blood loss, operative time, and complication rates. There was a higher complication rate, increased blood loss, and longer operative times with anterior-posterior corpectomies compared to transpedicular corpectomies. Patients undergoing transpedicular corpectomies had a greater recovery of neurologic function compared to patients undergoing anterior-approach corpectomies. Conclusion: The transpedicular corpectomy appears to have comparable morbidity to anterior-only corpectomies, but a lower morbidity compared to anterior-posterior corpectomies.

310. Comparison of Outpatient and Inpatient Spine Surgery Patients Regarding Obesity, Comorbidities and Readmissions for Infection
Joe S. Robinson, III, Edward R. M. Robinson, Brannick B. Benjamin, Mohammad Sami Walid
Introduction: In this study the demographic cohort demarcation, comorbidities and postoperative infectious rates of spine surgery inpatients and outpatients were compared.
Methods: We retrospectively studied 97 spine surgery outpatients and 578 inpatients proceeding through a common surgical venue selection process. Three general classes of spine surgery were assessed: anterior cervical decompression fusion, lumbar microdiscectomy and lumbar decompression with or without fusion. We compared the following variables: age, gender, race, body mass index, comorbidities, and postoperative infections diagnosed before discharge or after discharge and readmission.
Results: No significant differences (P<0.05) in gender, race, obesity rate (46.9% vs. 42.9%), hypothyroidism (9.7% vs. 8.8%), history of stroke (1.9% vs. 2.5%), hip problems (1.7% vs. 1.3%), and smoking (32.5% vs. 26.5%) were observed. However, the prevalence of diabetes mellitus (19% vs. 10%), congestive heart disease (19.7% vs. 13%), coronary artery bypass graft (15.9% vs. 3.8%), chronic obstructive pulmonary disease (11.8% vs. 0%), knee problems (39.8% vs. 7.5%), and depression as determined by use of antidepressants (25.4% vs. 11.6%) was significantly higher (P<0.05) in the inpatient group. Among outpatients, only one case (~1%) of postoperative infection was noted while among inpatients 16 (2.8%) postoperative infections were documented. All seven patients readmitted due to infection were obese (BMI>30). Conclusion: Postoperative infection did not contravene appropriately selected patients for outpatient spine surgery. Despite increased hospital care and observation in the inpatient group, infection rates were higher than in the outpatient group. This could be related to differences in age, comorbidities, nosocomial infections and invasiveness of surgery. Obesity seems to be a predictor of readmission with infection.

311. A New Stand-alone Cervical Anterior Interbody Fusion Device: Early Surgical Experience with Thirty-Seven Consecutive Patients
Daniel G. Nehls
Introduction: Cervical plates in current use, while highly effective at stabilizing the spine and promoting arthrodesis, have been associated with postoperative dysphagia, and implicated in adjacent level degeneration and ossification.
Methods: A review of surgical and immediate postoperative radiographic data was completed for the first 37 patients undergoing anterior cervical discectomy and fusion with a new stand-alone interbody fusion implant.
Results: In each case, the stand-alone intervertebral device was successfully implanted without the need to substitute another method of instrumentation. Device and screw placement were felt to be satisfactory in every case. Devices were inserted adjacent to existing plates or intervertebral devices in eight patients without the need to remove the previous implant. The device was oriented with the medial screws inserted into the more cephalad vertebral body when used in the upper cervical spine, and with the medial screws inserted into the more caudal vertebral body when used in the lower cervical spine. There were no serious complications.
Conclusion: There is a relatively brief learning curve for use of the stand-alone intervertebral device. It is possible to implant the device from C2–T1 with minor modification of the standard surgical technique. Attaining the proper drill angle is a critical step for successful implantation. The device minimizes dissection above and below the treated level, presents a zero profile, and is well-suited for use when a previously implanted device is present.

312. Biomechanical Comparison of Posterior Cervicothoracic Instrumentation Techniques after 1-level Laminctomy and Facetectomy
Mohammed Elaray, Matthias Setzer, Ali A. Baaj, Ioannis Papanastassiou, Bryan P. Conrad, Frank D. Vrionis
Introduction: In vitro biomechanical human cadaveric study of posterior cervicothoracic spine instrumentation techniques after 1-level (C7) laminctomy and bilateral facetectomies. Objective: comparing the biomechanical stability of posterior instrumentation techniques with different rod techniques that cross the cervicothoracic junction after removal of the posterior elements at C7.
Methods: Eight human cadaveric spines (C3–T3) were used. After the intact spine analysis, each specimen was destabilized (C7 laminctomy and facetectomies) and reconstructed as follows: Group 1–Posterior instrumentation C5-T2 with a 3.5 mm rod, Group 2–Posterior instrumentation C5-T2 with a transitional rod (3.5 mm to 5.5 mm), Group 3–Posterior instrumentation C5-T2 with side-to-side rod connector (3.5 mm to 5.5 mm). All reconstructed groups were tested with posterior instrumentation using the Cervifix system. We hypothesized that Group 2 is the most stable.
Results: Following laminctomy, facetectomy and application of the instrumentation, there was a decrease in range of motion for all the treatment groups compared to the intact spine. This trend was observed in all three planes of motion, but was only significant in right/left lateral bending and flexion (for transitional rod only). Although, the instrumented spines were stiffer than the intact spine in right/left axial rotation, flexion and extension, these differences did not reach statistical significance. Based on observation during the testing, it was evident that in the implanted spines, the majority of the motion that occurred was localized at the segments adjacent to the instrumented levels (C4/5 and T2/3), whereas for the intact condition the motion was more evenly distributed across all levels.
Conclusion: Based on the results of this investigation, the biomechanical stability of the transitional rod, side-to-side connector (wedding band) and 3.5 mm rods appear to be similar. Our hypothesis that the transitional rod would be more stable was not supported by the data.
313. Surgical Management of Severe Spondylotic Myelopathy by Successive, Same-day, Posterior and Anterior Decompression with Anterior Fixation and Fusion (PADAF)

Ely Ashkenazi, Michael Millgram, Nahshon Rand, Yizhar Floman

Introduction: ACDF, posterior laminoplasty, and laminectomy and fusion alone in elderly patients with severe progressive cervical myelopathy and critical canal stenosis may carry a significant risk of intraoperative neurological deterioration. Combined posterior and anterior decompression and stabilization may be a safer surgical alternative. We present our experience with posterior decompressive laminectomy followed by anterior decompression (discectomy with/without corpectomies) and anterior spinal reconstruction and fusion under one anesthesia.

Methods: Patients with severe progressive spondylotic myelopathy with radiological evidence of critical canal stenosis and myelomalacia who underwent the above-described procedure in our institute between July 2004 – April 2009 were enrolled.

Results: 43 patients (13 females, 30 males) mean age 65 years (range 55–78) underwent surgery that lasted 130±25 minutes. Transcranial motor evoked potentials (MEPs) improved following anterior decompression in ten subjects, somatosensory spinal evoked potentials and MEP recordings improved following laminectomy in 6 and 8 patients respectively, and transient deltoid weakness resolved in 9. The mean hospitalization stay was 4.2 days (2–11). A follow-up of 12–60 months was recorded. No infections, pseudoarthrosis or hardware failure occurred. All patients with improved intraoperative neuromonitoring recordings demonstrated clinical neurological improvement postoperatively. Overall, 27 patients improved neurologically, 16 remained neurologically stable, and none had neurological deterioration. The average preoperative Nurick score of 3 dropped to 2.1 postoperatively. Hand function improved in seven patients.

Conclusion: Posterior decompressive laminectomy and anterior decompression stabilization and fusion can be performed safely under one anesthesia without significantly extending operating time and possibly providing a neurologically safer approach to severe progressive cervical spondylotic myelopathy and improved neurological outcome.

314. Cost–effectiveness Analysis of Bone Morphogenetic Protein Use in Cervical Spine Fusion

Kevin S. Cahill, John Chi, Arthur L. Day, Elizabeth Claus

Introduction: The use of bone morphogenetic proteins (BMPs) in anterior cervical fusion procedures is controversial. High rates of fusion have been reported for single and multi-level cervical fusion procedures with and without BMP. Additionally, increased rates of local complications have been reported following the use of BMPs in anterior cervical fusions, although the effect may be dose related. Given the upfront cost implications of BMP use, the cost-effectiveness of BMPs in anterior cervical fusion remains to be clarified.

Methods: A decision–analytic model comparing anterior cervical fusion with vs. without BMP was developed. Estimates of fusion rates, postoperative complications, and adjacent level operations were obtained from a literature search. Inpatient costs were obtained from the Nationwide Inpatient Sample database and the Medicare physician fee schedule, while pre and postoperative health states were estimated from previously published models. Using this model, average costs and health benefits were estimated for each strategy; the strategies were then compared using incremental cost-effectiveness ratios (ICERs). Sensitivity analyses were performed on all key variables.

Results: For the base case analysis of single level fusion, over a 10 year period the ICER for BMP use compared to fusion without BMP was $405,597 per QALY, while in multi–level cervical fusion, the ICER associated with BMP use was $38,061 per QALY. Key variables influencing the ICER were the baseline risk of non-union without BMP, the risk of local complications with BMP, the cost of BMP, and the effect of a revision procedure on the rate of postoperative clinical improvement.

Conclusion: In this model, BMP use increased overall costs in both single and multi–level cervical fusions, although scenarios were identified where BMP use could be cost saving. The increased cost of BMP resulted in more benefits in multi–level fusions than in single level procedures. Techniques to reduce BMP associated complications and select patients at a high baseline risk for non-union improved the ICER of BMP. Finally, the ICER of BMP in multi–level procedures, but not single–level fusions, may be comparable to other commonly accepted spinal procedures.

315. Cost–effective Management of Lumbar Synovial Cyst with Resection and Unilateral Facet Fixation

Kaitlin Jean Herald, Daniel Galyon

Introduction: Lumbar synovial cysts typically arise from arthritic degeneration of the facet joint and are frequently accompanied by segmental instability. They are an uncommon cause of painful radiculopathy. Successful management strategies have involved simple resection with nerve root decompression, hemilaminectomies or laminectomies with or without instrumented fusion. The presence of inherent joint instability often necessitates concomitant fixation. A more limited surgical technique utilizing facet based fixation presented here reduces both cost and surgical morbidity compared with larger traditional fixation techniques.

Methods: 5 patients ages 51–70 were operated by the same surgeon for a synovial cyst with radiographic evidence for either degenerative spondylolisthesis or severe facet arthropathy. Symptoms preop included both unilateral radiculopathy and back pain after failed conservative treatment. Surgery involved nerve root decompression followed by unilateral facet stabilization using a single facet screw and arthrodese. Results and costs relative to more extensive stabilization techniques were assessed.

Results: All 5 patients had immediate relief of radicular pain and minimal back pain requiring oral meds only by the time of discharge. Length of stay averaged 1.2 days. At 24 month followup, all patients have maintained excellent pain relief with no radicular symptoms or findings and either no or minimal back pain. Post–op imaging reveals stable anatomy at the operative site. No short– or long–term complications were encountered. Costs of equipment and hospitalization between this technique and standard decompression/stabilization procedures were dramatic.

Conclusion: Synovial cysts can be safely and cost–effectively managed with the simple surgical technique presented. This technique addresses both decompression and stabilization concerns with minimal morbidity and short hospitalizations. Optimal surgical treatment has been achieved in this small series with excellent results documented at 2–year follow–up. This lower cost option provides spine surgeons with an alternate option for successful management of synovial cysts.
316. Transpedicular Corpectomy with Posterior Expandable Cage Placement in Lumbar and Thoracic Spine Tumor Surgery
Mohammed Eleraky, Nam Duy Tran, Ioannis Papanastassiou, Ali A. Baaj, Matthias Setzer, Frank D. Vrionis

Introduction: Surgical management of thoracic and lumbar vertebral body tumors usually requires a vertebrectomy either through a lateral or a posterior approach. Single stage decompression and reconstruction via a posterior-only approach offers the advantage of access to both anterior and posterior elements of the spine and multi-level dorsal fixation. Expandable cages allow insertion in a collapsed position and expansion in situ which allows insertion of the cage without sacrificing any lumbar roots and also allows reduction of a kyphotic deformity.

Methods: 30 patients with thoracic and lumbar spine tumors underwent single stage posterior corpectomy, anterior reconstruction with expandable cage placement and posterior instrumentation. 11 patients had tumors in the lumbar spine and 19 patients in the thoracic spine. Nine cases underwent 2–level corpectomy. Functional outcomes were analyzed using the VAS and ODI scales and the kyphotic angle was measured pre- and postoperative.

Results: Gross total resection was achieved in all cases. All cases improved with regard to functional outcome (mean VAS improved from 92 to 40 and ODI improved from 80 to 30). One case had settling of the cage and underwent revision and another case had a deep infection and was managed by removal of the posterior hardware. One case had radiographic evidence of cage subsidence but it remained stable.

Conclusion: Transpedicular corpectomies in thoracic and lumbar spine tumors allows for circumferential surgery through a single posterior approach. It avoids the morbidity of a combined 360° anterior/posterior approach. In addition, by using expandable cages, correction of kyphosis, restoration of vertebral body height and reconstruction of the anterior column is possible.

317. Biomechanical Evaluation of XLIF Using a PEEK Cage with Integrated Screws and Supplemental Fixation
Andy Cappuccino, Alexander Turner, Bryan Cornwall

Introduction: Lateral–approach interbody fusion has many biomechanical advantages over anterior and posterior techniques including retention of anterior and posterior longitudinal ligaments, and ability to place a large and stable interbody implant spanning the ring apophysis [1,2]. In this study, the biomechanical stability of XLIF reconstruction with a PEEK interbody device having integrated screws are investigated in a human cadaveric model, including the influence of supplemental instrumentation.

Methods: Seven fresh–frozen cadaveric specimens (L1–L5) were subjected to non–destructive multi–directional flexibility testing at ±7.5 N·m. Motion segment kinematics were obtained using an optoelectronic system. After testing the intact spine, the PEEK interbody cage with integrated screws (CoRoent XL–F) was evaluated at L3–L4, followed by the addition of various supplemental pedicle screw (PS) fixation configurations: ipsilateral unilateral PS, contralateral unilateral PS, and bilateral PS. Results were compared using repeated–measures ANOVA and the Holm–Sidak test.

Results: ROM at the L3–L4 index level was significantly decreased with respect to the intact spine for all treated test conditions (p < 0.05). The CoRoent XL–F device with bilateral PS was the most rigid construct in all three loading directions. Ipsilateral and contralateral PS were statistically equivalent, although there was a trend towards slightly more motion when unilateral screws were placed on the contralateral side. ROM with unilateral screws was between the stand-alone interbody device, and bilateral PS.

Conclusion: Substantial reductions in ROM were measured with the stand–alone PEEK interbody device with integrated screws. Predictably, bilateral screws were observed to provide the most rigid construct. Unilateral screws on either the ipsilateral on contralateral side also produced a stable construct when compared with the natural spine. When this level of stability is considered appropriate, ipsilateral pedicle screws may potentially be placed with the patient in the same position as used for the XLIF approach, alleviating the need for repositioning and reducing surgery time.

318. Thoracoscopic Vertebrectomy for Thoracolumbar Junction Fractures and Tumors: Surgical Technique and Evaluation of the Learning Curve
Meic H. Schmidt

Introduction: Evaluation of the surgical technique and learning curve for video–assisted thoracoscopic surgery (VATS) for transdiaphragmatic corpectomy and reconstruction of thoracolumbar junction fractures and tumor with respect to operative time, blood loss, complications and postoperative radiographic results.

Methods: A prospective database has been maintained since the initiation of thorascoscopic spine surgery at the University of Utah in 2003. This study is a retrospective case series of all T12 and L1 thorascoscopic vertebrectomies performed by the same surgeon over a 5 year period from 2003 to 2008. The sample was intentionally limited to the same surgeon and same region of the spine to minimize the variation due to surgeon and anatomical location so that a learning curve could be assessed. The outcome variable of estimated blood loss and the operation time were collected and analyzed using a linear generalized estimating equation (GEE) model with a first order autoregression correlation structure. In addition, complications open conversions and immediate postoperative radiographic results were recorded.

Results: Thirty patients with thoracolumbar junction fractures and tumors were identified. OR time decreased significantly in particular after the first 3 operations. OR time continued to decrease by 4.4 minutes per surgery (p<0.001). EBL, complications and conversions remained the same.

Conclusion: Thoracoscopic vertebrectomy at the thoracolumbar junction has a relatively long learning curve. OR time improves dramatically after the first 3 cases but subsequently continues to improve. The learning curve can be accomplished without increased blood loss, complications, conversion rates or misplaced hardware compared to other studies.

319. Clinico-radiological Rationale of Anterior Approach for Cervical Spinalyotic Amyotrophy
Junichi Mizuno, Yoshitaka Hirano, Kazuo Watanabe, Sadayoshi Watanabe, Tadao Matsuhashi, Akiko Nishino

Introduction: Muscular atrophy in the upper extremities with insignificant sensory loss is occasionally caused by cervical discogenic or ligamentous diseases, and this condition is called cervical spondylotic amyotrophy (CSA). Whether the pathogenesis of this syndrome is selective damage to the ventral nerve roots or to the anterior horns is still controversial. In addition, instability of the cervical spine due to degeneration may play an important role to enhance the syndrome. We report 10 surgical cases of
Methods: Ten CSA patients were treated with anterior fusion. All patients were men, with the mean age of 66 years. No case showed slow progression while only 1 patient deteriorated relatively rapidly. Four cases showed proximal muscular atrophy, whereas distal muscular atrophy was noted in 6 cases. Slight sensory disturbance was present in all cases, but myelopathy was negative. Preoperative MR images disclosed significant compression on nerve roots in 2 cases, spinal cord in 1 and both nerve roots and spinal cord in 7. Intramedullary high-signal lesion was noted in 3 out of 8 cases with cord compression. Routine anterior decompression and fixation were performed in 2 levels.

Results: Postoperatively, muscle weakness and atrophy were either unchanged or slightly recovered with improvement of sensory disturbance.

Conclusion: Due to absence of or insignificant sensory loss, CSA is sometimes confused with motor neuron disease (MND). Although both clinical conditions show muscular atrophy, CSA showed segmental muscular atrophy whereas MND showed diffuse muscular atrophy with occasional neck ptosis. Pathogenesis of CSA is considered combination of compression on either nerve roots or spinal cord and instability.

Three important points of decompression are spinal cord, the portion where nerve roots penetrate the dura mater and lateral recess. Therefore, anterior approach is procedure of choice in CSA, because optimal decompression and stabilization can be achieved.

320. The Outcome of Surgery for Lumbar Disc Herniation a 1–22 Years Follow-up Using Standard Laminectomy, Microsurgery, Endoscopic Techniques

Maged A. El-Hefnawi

Introduction: Low back pain and sciatic pain has been one of the most common and disabling spinal disorders recorded in medical history. The treatment of lumbar disc disease has challenged spine surgeons since the first case in 1929 by Dandy. This study was performed to evaluate the outcomes after standard laminectomy, microdiscectomy and endoscopic discectomy.

Methods: Between 1989 and 2009 we came across (2,112) operated cases of lumbar disc, we used the standard laminectomy from 1987 to 2000 in 1,248 cases. We started microsurgical technique for most cases after 2000 in (576) cases, from 2006 we started the endoscopic technique using Dastanue techniques in (288), we had follow-up for (990) of standard laminectomy (330) microsurgery and (108) of endoscopic technique, the patients clinical history, preoperative assessment, intraoperative findings, complications and outcome were assessed, the outcome criteria described by Odom was applied. We evaluated and compared the three techniques with regard to the primary and secondary outcome gain including, the length of incision, amount of blood loss, turning over while lying in bed, time out of bed, duration of hospital stay and complications.

Results: 58% male, 42% female, ages from 19 to 65, average 37 years. All patients complained of leg pain not responding to conservative measurements. Motor weakness was present in 20%, the affected level L4–L5 48%, L5–S1 in 39%, L3–L4 in 10%, L2–L3 in 3%. The final clinical and neurological results were similarly satisfactory in the three groups but the endoscopic technique was superior with regard to the size of incision, less blood loss, length of hospital stay, the immediate postoperative pain, early ambulation and return to daily activities, early return to work, and less complications.

Conclusion: The endoscopic discectomy is a safe and effective technique in appropriately selected patients. It is a minimally invasive procedure as useful as standard laminectomy and microdiscectomy and offers several advantages mainly the early ambulation and early return to work.


Sanjay Yadla, Peter Campbell, Jennifer Malone, Mitchell G. Maltenfort, Ashwini D. Sharan, James S. Harrop, John K. Ratliff

Introduction: To accurately assess perioperative morbidity in spine surgery patients, a prospective analysis of all patients who underwent spine surgery by the neurosurgical service at a large tertiary care center over a six-month period was conducted. Correlation between preoperative diagnosis and postoperative complications was assessed.

Methods: Data on 248 consecutive patients undergoing spine surgery from May to December 2008 was prospectively collected. Patients were followed and complications recorded by an independent examiner. A standardized definition of minor and major complications was applied. Clinical follow-up on discharge was completed at a single site; outpatient complications were reported and included. Data on diagnosis, complications, and length of stay was assessed using stepwise multivariate analysis.

Results: Average age of patients was 55.1 years; average BMI was 29. The majority of procedures were performed for degenerative pathologies (64.9%) and consisted of fusion procedures (81.9%) with a mean of 3.3 levels fused. 58 patients (23.4%) underwent revision surgeries. A trend towards increased incidence of overall complications in patients who underwent surgery for neoplasm (75.0%) or infection (63.16%) was found (p=0.08). In the thoracolumbar patients, preoperative diagnosis correlated with presence of a complication and number of complications, with infection and neoplasm patients more often affected by isolated and multiple complications (p=0.05 and p=0.02). Preoperative diagnosis correlated with occurrence of minor complications (p=0.02). LOS was greater for patients with minor complications at 10 days (p=0.001) and greater still for patients with a major complication at 14 days (p=0.001).

Conclusion: The incidence of complications found in the current study is higher than previous reports, possibly due to a greater accuracy of record-keeping, absence of recall and selection bias, and application of a rigorous definition of complications. Complications were more common in infections and neoplasms, with LOS adversely affected by complication occurrence.

322. Coflex® Dynamic Interlaminar–Interspinous Distraction Stabilization Device for Lumbar Degenerative Diseases (Initial Experience)

Mohamed Mohi Eldin

Introduction: The purpose of this study was to assess the safety and effectiveness of Coflex® Dynamic Interlaminar–Interspinous Distraction Stabilization (DIDS) device in treating patients with degenerative diseases of the lumbar spine (DDLS), especially lumbar canal stenosis (LCS), to confirm its indications for implantation, and to evaluate the short-term clinical outcomes of patients.

Methods: A total of 14 patients underwent placement of a coflex implant for various lumbar degenerative indications by one neurological spine surgeon. The mean follow-up was 7.5 months. The original indications for implantation were
segmental form of stenosis, mild degree of degenerative retrolisthesis, or minimal first degree of degenerative spondylolisthesis. Preoperatively and postoperatively, patients were asked to grade their low-back and leg pain using the numeric verbal rating (NVR) scale for pain. Patients were asked about their satisfaction with the surgical procedure, using the validated Oswestry Disability Index Questionnaire (ODI). Follow-up radiographs were taken to determine any device-related issues.

**Results:** The most prevalent diagnoses for implantation were spinal stenosis. The mean severity of LBP decreased by 66% (from moderate to mild) at 3-month follow-up, and mostly disappear at the 1-year follow-up. Postoperatively 14 (100%) patients could walk >1000m. The results of pain relief throughout the study were best at late follow-up visits. Follow-up visits did show an increase of patients’ satisfaction. 13 patients (93%) stated that they would undergo this surgery again. Based on the follow-up radiographs, no patients had device-related issues.

**Conclusion:** The data provided have demonstrated that the coflex implant provides pain relief in indicated DDLS cases. Despite the limitations, the current study provides evidence that immediate pain relief and increase in function can be provided by the Coflex Device with a very low rate of morbidity.

323. Lumbar Decompression/Microlaminectomy Augmented with the Implantation of the Coflex Device (Comparative Study with other Common Lumbar Decompressive Surgeries: Initial Experience)
Mohamed Mohi Eldin

**Introduction:** The concept of motion segment preservation and soft tissue preservation and the increasing number of patients with degenerative spinal disease warrant the need of new approaches and devices.

**Methods:** This study is a multi-center, prospective, controlled study that compares the 1-year clinical results of lumbar minimally invasive decompression augmented with the implantation of the coflex device as compared to the other common surgical approaches in treating patients with LCS.

**Results:** The interspinous device was helpful in alleviating pain and improving daily life activity performance in selected patients with lumbar spinal stenosis. Moreover, it did show a significant benefit when used with microdecompression surgery as compared to other decompressive traditional procedures.

**Conclusion:** The treatment with coflex as a method of dynamic stabilization after neural decompression allows to reduce low back pain without fusion. We could demonstrate that the implantation of coflex is safe and effective when combined with microlaminectomy/microdecompression, in properly selected cases.

324. Bilateral Pedicle Screw Fixation vs. Unilateral Pedicle and Contralateral Facet Screws for MIS TLIF: Clinical Outcomes and Cost Analysis
John H. Shin, Daniel Refai, Basem Ibrahim Awad, Daniel J. Hoh, Tom Mroz, Michael P. Steinmetz

**Introduction:** Tranforaminal lumbar interbody fusion (TLIF) is used for degenerative conditions of the lumbar spine. With development of minimally invasive surgical (MIS) techniques, it is suggested that less tissue disruption leads to better outcomes. Recent in vitro biomechanical studies have compared bilateral pedicle to unilateral pedicle and contralateral facet screws. Facet screw constructs demonstrate no difference in stiffness or range of motion in flexion/extension, lateral bending, and axial rotation compared to bilateral pedicle screws. These systems have not been compared clinically. We compare the clinical outcomes between these and make an argument for implant cost savings with the facet screw construct. With increasing scrutiny on the rising cost of health care, an argument for reduced cost could be made if comparable clinical efficacy is found between these two systems.

**Methods:** Retrospective review of 26 consecutive patients who had single-level MIS TLIF was performed. Patients with bilateral pedicle screws were compared to those with unilateral pedicle and contralateral facet screws. Outcome measures include length of stay, operative time, and Odom’s criteria. Fisher’s exact and t-test were used for statistical analysis. Implant costs were obtained from the vendor.

**Results:** No associations were found between construct and length of stay (p=0.4574), operative time (p=0.1519), or Odom’s criteria (p=0.6804). 79% of patients in the facet screw group had good or excellent outcomes. 71.5% of patients in the pedicle screw group had good or excellent outcomes. There were no complications. Implant costs for the pedicle screw group was 35% greater than the facet screw group.

**Conclusion:** MIS TLIF with unilateral pedicle and contralateral facet screws is clinically equivalent to bilateral pedicle screws for single-level lumbar disease. This is the first series to demonstrate comparable outcomes with either construct, supporting in vitro biomechanical data. These facet screw constructs cost significantly less than bilateral pedicle screws and are just as effective.

325. Syringomyelia with Chiari Type 1 Malformation: Analysis of Spinal Cord Parenchymal Changes and a Hypothesis for Syrinx Formation
Izumi Koyanagi, Tomohiro Murakami, Takahisa Kaneko, Yukinori Akiyama, Kiyohiro Houkin

**Introduction:** The pathogenesis of syringomyelia associated with Chiari type 1 malformation is still unknown in spite of accumulation of the clinical evidences. Edema-like appearance of the spinal cord was recently reported as a presyrinx state. However, the role of the presyrinx state in syrinx formation in Chiari type 1 malformation was not determined. In this study, we retrospectively studied magnetic resonance imaging (MRI) findings of 21 patients who underwent foramen magnum decompression in our institute were reviewed. There were 8 men and 13 women, aged from 6 to 79 years.

**Results:** Fifteen patients showed large expanding syrinx, while 6 patients had small syrinx suggesting enlarged central canal or collapsed syrinx. No patients showed a communication between the syrinx and fourth ventricle. Ten patients showed parenchymal hyperintensity areas around the enlarged central canal or base of the posterior white columns adjacent to the syringomyelic cavity on T2-weighted images. These areas markedly diminished with reduction of the syrinx after surgery and were considered to be interstitial edema.

**Conclusion:** The distribution of the syringomyelic cavity was consistent with the results of clinicopathological studies. The centrifugal pattern of the interstitial edema suggests disturbed absorption mechanism of the interstitial fluid, not the penetration mechanism from the subarachnoid space. Considering the known evidences, reduced compliance of
the posterior spinal veins due to the decreased compliance of the spinal subarachnoid space may result in disturbed absorption of the extracellular fluid through the intramedullary venous channels and formation of syringomyelia.

327. Comparison of Polymethylmethacrylate vs. Expandable Cage for Reconstruction of the Anterior Vertebral Column in Thoracic and Lumbar Spine following Posterior Extracavitary Corpectomy
Nam Duy Tran, Mohammed Elaraki, Ioannis Papanastassiou, Ali A. Baaj, Frank D. Vrionis

Introduction: Advance surgical techniques allow complete tumor resection and corpectomy from a posterior extracavitary approach; however, stabilization of the anterior vertebral column remains a significant challenge. Surgical options include reconstruction with polymethylmethacrylate (PMMA) or expandable cage. The aim of this study was to compare the efficacy of anterior spine reconstruction using a posterior approach.

Methods: We retrospectively reviewed 32 consecutive patients with pathologic fractures due to thoracic and thoracolumbar tumors. All patients underwent a single stage posterior extracavitary tumor resection, corpectomy, segmental instrumented pedicle screw fixation, and anterior reconstruction with PMMA or expandable cage (EC). Reduction in kyphosis (decrease in Cobb’s angle), functional ODI scale, and complications were evaluated between the two groups using ANOVA.

Results: On presentation, the PMMA group had a mean Cobb’s angle of 16.36 ± 9.10 degrees. Postoperatively, we demonstrated a mean Cobb’s angle of 10.91 ± 10.57, with a 5.45 ± 5.79% reduction in kyphotic angle. In contrast, the EC groups presented with mean preoperative and postoperative Cobb’s angles of 20.53 ± 13.42 and 10.49 ± 11.56 degrees, respectively. This group showed 10.04 ± 11.18% improvements in kyphotic deformity. No statistical differences were observed between the two groups in preoperative (p>0.31), postoperative (0.91) or reduction in kyphotic angulation (p>0.16). Additionally, no difference in functional outcome improvements were observed (p>0.05).

Conclusion: The use of PMMA or expandable cage presents viable techniques for reconstruction of the anterior vertebral column following tumor resection and corpectomy. Both approaches allow for correction of the kyphotic deformity, and stabilization of the anterior vertebral column with similar functional outcomes and low risk of perioperative morbidity.

328. The Role of Combination Surgery and Radiotherapy in Ambulatory Patients with Metastatic Spinal Cord Compression: An Evidence-based Review
Lola Y. Blackwell, Richard L. Lebow, Prasad Reddy, Kurt M. Eichholz

Introduction: The vertebral column is the most common site of bony metastasis, and the management of these lesions is challenging and controversial. Historically, radiation therapy alone was considered the standard of care for many types of vertebral metastases. However, advances in surgical technique have led to a larger spectrum of operative interventions for tumor resection, spinal cord decompression, and spinal stabilization. Several recent publications indicate combination surgical and radiation therapy offers improved functional outcomes. We analyzed recent and historical data to form management guidelines for patients with metastatic spinal cord compression who are ambulatory at presentation.

Methods: A PubMed search was performed for articles from 1965 – 2008 containing key words “metastatic spinal cord compression” or “spinal metastasis” or “vertebral metastasis” and “combination therapy” or “radiation therapy” or “surgical decompression.” The initial results were narrowed to articles comparing combination therapy to radiation alone in patients who were ambulatory at presentation. This yielded ten articles which were analyzed for data class, methods, results and conclusions and summarized in an evidentiary table which will be provided.

Results: One class II study and nine class III studies were identified. In four studies the sole method of surgical decompression was via a posterior laminectomy, and results showed no difference in functional outcome between ambulatory patients treated with combination therapy vs. radiation alone. In six studies anterior, lateral or posterior surgical decompression was performed according to tumor location. These results indicated that ambulatory patients had a better functional outcome following combination treatment than following radiation alone.

Conclusion: Current evidence supports a level III recommendation that combination therapy for metastatic spinal cord compression should be considered in ambulatory patients with the understanding that the selection of surgical approach is critical and should be based on the anatomic location of the tumor.
The Role of Preoperative Embolization for Spinal Metastases: An Evidence-based Review

Lola Y. Blackwell, Prasad Reddy, Richard L. Lebow, Kurt M. Eichholz

Introduction: The vertebral column is the most common site of bony metastasis. Certain tumors such as renal cell and thyroid carcinoma have a predilection for metastasis to the spine and are well-documented to be hypervascular in nature. With the advent of super-selective angiography, preoperative selective arterial embolization has become a commonly utilized technique to facilitate the resection of such metastases with goals of reducing intraoperative blood loss and improving operative visualization. We performed a review of the evidence-based literature on the use of preoperative embolization for spinal metastases to formulate guidelines for the use of this technique.

Methods: A PubMed search of articles published in English from 1966 - 2008 was performed with the key words “vertebral metastasis” or “spinal tumor” and “embolization.” 196 results were then reviewed and only articles addressing preoperative embolization of metastatic spinal tumors were retained. This yielded 7 articles which were analyzed for data class, methods, results and conclusions and summarized in an evidentiary table.

Results: There were no class I or class II studies identified. Conclusions from the class III studies indicated that preoperative embolization significantly reduced operative blood loss and its associated morbidity in these patients. Three studies also indicated that operative visualization was improved after preoperative embolization. There were no studies comparing the efficacy of different embolic agents. There were no studies analyzing timing between embolization and operative intervention, though most patients in these studies underwent embolization procedures 24–48 hours prior to resection.

Conclusion: Current evidence supports a level III recommendation that preoperative embolization is a treatment option that may be beneficial in reducing operative blood loss during resection of hypervascular vertebral metastases. Further studies including randomized trials are needed to support a higher level recommendation.

Feasibility of Outpatient Interbody Lumbar Fusion

Alan T. Villavicencio, Ewell Lee Nelson, Alexander Mason, Sigita Burneikiene

Introduction: Prolonged hospital stays are directly associated with rising healthcare costs and increased risk of complications. The purpose of this study was to evaluate the safety and efficacy of outpatient lumbar interbody fusion.

Methods: All consecutive, one-level TLIF procedures performed on an outpatient basis were selected. Surgeries (n = 52) were performed at an ambulatory surgical center (ASC) or hospital outpatient departments (HOD). There were 9, 23 and 20 procedures performed using minimally invasive, mini-open and standard open surgical approaches, respectively. The minimally invasive approach was associated with the longest operative times; 235 min (172 – 191), followed by open – 175 min (108 – 236) and mini-open – 131 min (95 – 182) approach. The mini-open approach was also associated with the lowest mean blood loss – 66 mL (25 – 100), followed by minimally invasive – 71 mL (25 – 150) and open approaches – 203 (50 – 1000). Patients remained on average for 21.5 hours (14.5 – 23.0) and 4.4 hours (2.7 – 6.7) at HOD and ASCs, respectively.

Results: There were no cases of pneumonia, UTI, DVT and antibiotic resistant wound infections in this patient group. Preoperative back pain was 74.5 (0 - 100) compared to 18.8 (0 – 90) postoperatively. Preoperative leg pain was 54.2 (0 – 100) compared to 9.1 (0 - 60) postoperatively. Patient satisfaction was 84.4% (0 – 100).

Conclusion: This is the first study of its kind and further confirmation is needed, but our data strongly suggests that it is both safe and efficacious to perform lumbar interbody fusions as outpatient procedures.

High Cervical Coronal–plane Spondyloptosis: The Importance of Early Diagnosis in Patients at Risk and Aggressive Surgical Intervention

Shakeel A. Chowdhry, Sunil Manjila, Nicholas Bambakidis, Ronald I. Apfelbaum, David J. Hart

Introduction: Traumatic spinal instability requires diligent attention to acute stage immobilization. The outcome for patients with progressive deformity and worsening neurologic deficit is generally poor with supportive care. The authors report a case of traumatic high cervical injury with delayed development of poorly controlled neck pain and worsening tetraparesis; imaging revealed coronal spondyloptosis with partial auto-fusion and right vertebral artery occlusion. The patient had a favorable outcome with arterial bypass, circumferential stabilization, and fusion.

Methods: A middle-aged man suffered traumatic high cervical fracture and ASIA A spinal cord injury. He was managed with rigid cervical orthosis, then discharged to inpatient rehabilitation without surgical follow-up. He developed painful neck deformity and ascending motor weakness. Imaging revealed coronal C2–3 spondyloptosis and right vertebral artery occlusion. Traction was unsuccessful. A two-stage operation was planned beginning with right occipital to vertebral artery bypass, bilateral C2–3 osteotomies and C1–4 posterior screw fixation. Stage 2 consisted of C2–3 partial corpectomies, deformity reduction, interbody grafting and plate fixation followed by posterior hardware connection and lateral mass/facet fusion.

Results: Cerebrospinal fluid leakage was encountered during deformity reduction; this was successfully treated with postoperative lumbar drainage. Flow was preserved within the left vertebral artery. Significant reduction was obtained, and imaging one year post–surgery demonstrated evidence of fusion with maintenance of correction. The patient retained his limited upper extremity function and after diaphragm pulse stimulator implantation became ventilator-independent.

Conclusion: Acute stage immobilization in traumatic spinal injury with neurologic compromise is paramount. Without proper stabilization, progressive delayed deformity may occur with possible neurologic compromise. Acute management without surgical stabilization mandates diligent follow-up. Delayed coronal–plane high cervical spondyloptosis is a rare sequela with risk of progressive neurologic decline and vascular compromise. Aggressive surgical intervention in this late stage, while technically more challenging, can successfully preserve neurologic function and re-establish stability.

Biomechanical Comparison of Pro-Disc L at L5–S1 with Distributed and Non-distributed Endplate Angles

Parmenion Tsitsopoulos, Bartosz Wojewnik, Leonard Voronov, Robert Havey, Braden McIntosh, Julia Zelenakova, Gerard Carandang, Susan Renner, Celeste Abjornson, Avinash Patwardhan

Introduction: In total disc arthroplasty at L5–S1, there is controversy regarding whether the lordosis should be incorporated in one prosthesis–endplate...
or distributed between the two. We hypothesized that kinematics of the reconstructed segment will not be significantly affected by the differences in the distribution of the lordosis angle between the two prosthesis-endplates. **Methods:** Four combinations of superior/inferior lordosis angles were assessed: 6º/0º, 3º/3º, 11º/0º, 8º/3º. Twelve lumbar spines (age: 51.3 ± 9.8 years) were assigned to either 6º or 11º prostheses (ProDisc-L), depending on the native lordosis. Specimens were tested: (1) intact; (2) reconstruction using prosthesis of one lordosis distribution; and (3) insertion of prosthesis with the same lordosis but different distribution. Steps 2 and 3 were randomized. Segmental motions were measured in flexion–extension (FE), lateral bending (LB) and axial rotation (AR). Paired comparisons with Bonferroni corrections were made within each lordosis angle group (6º or 11º).

**Results:** Prostheses of 6º lordosis were used in 7 specimens. Prostheses in which lordosis was distributed between the two endplates (3º/3º) caused a small, non-significant decrease in FE motion compared to the intact segment and the non-distributed (6º/0º) design (8.9 ± 2.2, 8.1 ± 2.8, 7.0 ± 2.8, p > 0.05). In LB, both designs yielded significantly less motion than intact (5.4 ± 1.2, 3.3 ± 1.5, 2.7 ± 1.4, p < 0.05), with no difference between the two designs. In AR, the distributed design had significantly less motion than intact (2.6 ± 1.0 vs. 1.6 ± 0.8, p = 0.007), but no significant difference between the two designs. The remaining 5 specimens were implanted with 11º prostheses. There was no difference between the two prosthesis designs in FE, LB, or AR. Both designs restored motions to intact levels (p > 0.05) with the exception of LB in which the distributed design yielded smaller motion compared to intact (p = 0.036).

**Conclusion:** The quantity of motion of the reconstructed segment was not affected by the distribution of lordosis among the two prosthesis–endplates.

### 333. Superparamagnetic Iron Oxide Nanoparticles for Identification of Schwann Cells in vivo after Transplantation in a Porcine Model of Spinal Cord Injury

Ann Margaret Parr, Howard B. Levene, Allan D. Levi

**Introduction:** Although recent research has suggested many promising treatments for spinal cord injury, translating these to clinical practice in humans has proven to be a challenge. There is a need for large animal models for translation of basic science research to clinical trials. Our laboratory currently utilizes a porcine model of spinal cord injury to investigate Schwann cell transplantation therapy. We plan to label these cells in vitro such that they can be identified in real-time by magnetic resonance imaging (MRI) in order to assess survival and migration. **Methods:** Data was accumulated from a literature review, and studies are currently underway. The focus of the review was on cell labeling for identification of cells using MRI, both in vitro and in vivo after transplantation into the porcine injured spinal cord. **Results:** There are two main types of cell labeling commonly used. The first involves superparamagnetic iron oxide (SPIO) nanoparticles that are endocytosed in culture, and the second utilizes external cell labeling with a contrast agent with antibodies to cell surface markers. We have opted to investigate SPIO nanoparticles because the technique involves fewer steps and therefore may be simpler to use. Other suggested advantages of SPIO nanoparticles include providing the greatest signal change (particularly on T2), they are soluble and stable, they can be identified in real-time by MRI, both in vitro and in vivo, and they can be identified in real-time by MRI, both in vitro and in vivo after transplantation into the porcine injured spinal cord. **Conclusion:** SPIO nanoparticles can be used to label cells for identification with MRI. Protocol optimization will be discussed.


Sarah Balseiro, Eric W. Nottmeier

**Introduction:** Vertebral osteolysis has been reported as a complication of off-label rhBMP-2 use in transforaminal lumbar interbody fusion (TLIF) (1,2). The authors present two cases in which vertebral osteolysis occurred after TLIF in which rhBMP-2 was used. In each case, the osteolysis originated from subchondral cysts that were present on preoperative computed tomographic (CT) scans. **Methods:** Two patients underwent instrumented TLIF using INFUSE on a collagen sponge carrier. In each patient, approximately 4mg of rhBMP-2 was placed anteriorly in the disc space with 0.1mg of rhBMP-2 being placed inside a PEEK interbody cage. Morcellized allograft bone was mixed with demineralized bone matrix putty and also placed in the disc space and cage. The remaining rhBMP-2 was placed posterolaterally on the contralateral side. Each patient presented with worsening back pain approximately 3–months postoperatively. Workup in each patient included CT scans that revealed osteolysis affecting the L4 and L5 vertebral bodies, which appeared to be an expansion of preoperative vertebral defects caused by subchondral cysts (Figs 1 and 2).

**Results:** One patient underwent removal of the interbody cage at the L4–5 level and revision of the fusion with iliac crest autograft. At 15–month follow-up, he had no complaints of back pain and CT scanning revealed solid fusion across the L4–5 disc space (Fig 3). The other patient was offered revision of his fusion, but declined any further surgery. At 2-year follow-up, that patient had persistent back pain, but still declined any further surgery. A CT scan revealed unchanged osteolysis at the L4 and L5 levels.

**Conclusion:** It has been proposed that vertebral osteolysis occurring in TLIF procedures in which rhBMP-2 is used may be secondary to endplate violation during disc preparation or overdosing of rhBMP-2 (1). Though overdosing may have also contributed to vertebral osteolysis in our 2 cases, the endplate violation from subchondral cyst formation that was present on preoperative CT scans seemed to be the origin of the osteolysis suggesting that this complication can result from endplate defects that are present before surgery.
Introduction: Large series based upon ICD–9 complication and hospital-acquired-condition (HAC) chart reviews have not been validated via prospective comparison with rigorous independent assessment of complication occurrence. To assess the validity of ICD–9 based assessments of perioperative complications in spine surgery, we compared a prospective assessment of perioperative complications with ICD–9 HAC data.

Methods: A prospective assessment of complications in spine surgery over a six-month period (May 2008 – December 2008) was completed using an independent auditor and a validated definition of perioperative complications. All medical events were included in the assessment. All patients undergoing spine surgery were eligible for the study; the only exclusionary criterion employed was availability of the auditor. One hundred patients were randomly extracted for further review: in these patients ICD–9 based HAC data was obtained though review of coder data. The same definition of perioperative adverse events and inclusion of medical adverse events were used in the ICD–9 assessment.

Results: Ninety-two patients had adequate records for ICD–9 assessment. Overall complication incidence between the groups was very similar, with incidence of major complications in the ICD–9 group 17.4%, compared with 22.4% in the prospective assessment, with minor complication incidences of 43.8% and 42.9%, respectively. ICD–9 based assessments included many medical events not deemed complications by our auditor. Rates of specific complications were consistently underreported by ICD–9 based assessment. Incidence was underreported in cases of infection, need for reoperation, deep wound infection, pulmonary complications, DVT, and new neurological deficits (p=0.003, p=0.0001, p=0.0001, p=0.003, p=0.0025, p=0.04).

Conclusion: ICD–9–based coding demonstrated overall complication incidence similar to a prospectively executed measure of perioperative complications. In multiple categories of major perioperative complications, ICD–9–based recording significantly underestimated complication incidence. This finding illustrates another significant weakness and source of inaccurate in use of population–based ICD–9 complication recording.

Conclusion: The MIS TLIF procedure is just as effective as the standard traditional open technique. We believe it represents a shorter operative time, less blood loss, and decreased hospital LOS. To a vast extent, these factors contribute significantly reducing the potential consequences of prolonged hospital stay, excessive blood loss and operative time. These include but are not limited to increased hospital costs, increase pain, wound infection, deep vein thrombosis, and impaired tissue healing.

337. Minimally Invasive TLIF with Pedicle Screws for the Treatment of Degenerative Lumbar Spinal Disorders
Jacinto Manon, Cara Sedney, James Mills, John R. Orphanos, Terrence D. Julien

Introduction: TLIF is a procedure indicated primarily for several degenerative processes that culminate with instability involving the lumbar spine. The objective of the surgery is to relieve pain and nerve root irritation/compression.

Methods: We retrospectively identified 30 patients who underwent the procedure from December 2007 to June 2009 in our institution. Main indications for surgery included Spondylolisthesis Grade I and II, Degenerative Disc Disease, Retroisthesis, recurrent disc disease, and spine instability. All of our patients had posterior facet arthrodesis with Vitoss. The majority of the TLIF procedures were single–level with or without decompressive laminectomies for stenosis. Out of the 30 patients, 14 (46.6%) involved the L4-L5 interspace with six having concomitant single level decompression, 14 (46.6%) involved the L5–S1 interspace, one (3.3%) included the L2–L3 interspace, and one (3.3%) was a 2–level TLIF.

Spondylolisthesis was the main indication for surgery in this series. Grade I spondylolisthesis involved 18 (60%) patients, Grade II, five pts. (16.7%), and recurrent disc disease in four pts. (13.3%) respectively. Other indications included: Retroisthesis, Degenerative Disc Disease, and Spinal instability one patient (3.3%) each.

Results: The average operating times were available for 29 patients for an average of 233 minutes, estimated blood loss for 27 patients with an average of 409 ml, and the length of hospital stay was 3.6 days. We had four complications in total. Two (50%) involved misplaced pedicle screws, one (25%) was a dural abrasion, and one (25%) involved a full thickness wound infection.

Conclusion: The MIS TLIF procedure is just as effective as the standard traditional open technique. We believe it represents a shorter operative time, less blood loss, and decreased hospital LOS. To a vast extent, these factors contribute significantly reducing the potential consequences of prolonged hospital stay, excessive blood loss and operative time. These include but are not limited to increased hospital costs, increase pain, wound infection, deep vein thrombosis, and impaired tissue healing.
syndrome affecting primarily one level. A positive lumbar MRI, independently read by a board-certified neurosurgeon and a radiologist, demonstrated evidence of a contained lumbar disc protrusion with without associated posterior or lateral annular tear(s) and facet arthropathy and/or facet effusions at the same anatomic level, served as fundamental inclusion criteria. Intra-articular facet joint block was employed to achieve diagnostic confirmation in a select group when deemed necessary. Patient exclusion criteria included central or foraminal stenosis, disc extrusions, advanced spondylosis or segmental instability.

**Results:** Fifty patients were evaluated with a mean follow-up of twelve months, utilizing the modified Macnab’s criteria. Clinical outcomes were good to excellent. Findings included no pain or occasional low back pain with strenuous activities to being able to return to work with minimal modifications. The overall success rate was 90% with no significant complications.

**Conclusion:** Percutaneous Endoscopic Discectomy and Arthroscopic Laser Facet Ablation in carefully selected patients can provide favorable clinical outcomes if strict clinical and radiological criteria are followed. A randomized clinical trial is needed to confirm previously published studies.

**339. Biomechanical Comparison of Traditional Parallel Rod to Cross Rod Constructs at the Thoracolumbar Junction**


**Introduction:** Segmental posterior fixation with pedicle screws and parallel rods is a widely employed technique. We sought to determine whether re-orienting the rods in a crossed pattern would offer a biomechanical advantage.

**Methods:** Five human cadaveric T10-L4 specimens were tested. A three-column injury at L1 was simulated and 2 posterior constructs were tested as follows: one–above–one–below fixation with parallel rods and one crosslink (traditional construct), and one–above–one–below with crossed rods and two side crosslinks (X–rod construct). Pure moments were applied quasistatically while three-dimensional motion was measured optoelectronically. The range of motion (ROM) at L1/2 was measured during flexion, extension, left and right lateral bending, and left and right axial rotation.

**Results:** Both parallel and cross–rod constructs provided equivalent stiffness. There was no statistically significant difference in the mean ROM reduced relative to the fracture condition between the cross–rod and parallel rod constructs in flexion (66% vs. 63%), extension (63% vs. 57%), left lateral bending (46% vs. 50%), right lateral bending (52% vs. 58%), left axial rotation (36% vs. 24%), and right axial rotation (33% vs. 17%); p > 0.05 (RM–ANOVA).

**Conclusion:** Crossing the rods instead of placing them in parallel in posterior pedicle fixation constructs provides equivalent biomechanical stiffness. Whether there is enhanced load sharing with a cross–rod construct and whether such a construct has advantages in terms of simplified hardware or ease of insertion is yet to be determined.

**340. Management of Paraspinal Thoracolumbar Neuroma: The Experience in National Taiwan University Hospital**

Ying-Chih Chen, Fon–Yih Tsuang, Yong–Kwang Tu, Darning Denning Lai

**Introduction:** Neuroma is originated from the Schwann cell progenitor and can be categorized into five subgroups based on its anatomical position. We hereby presented our data as a preferred operational method for the removal of paraspinal neuroma, where the majority is located extradurally and extended through the intervertebral foramen.

**Methods:** We reviewed the chart and image from 1998 to 2009. The patient with image revealed paraspinal neuroma and received retropleural or retroperitoneal approach was included.

**Results:** 8 cases of paraspinal neuroma spanned from 1998 to 2009 were studied. 5 cases with the neuroma located at the thoracic level underwent surgeries via retropleural approach, and 3 cases with neuroma located at the lumbar spine under went surgeries via retroperitoneal approach. Total tumor resection in 8 of the 9 cases was achieved. Post–operative Magnetic Resonance Imaging (MRI) data showed no tumor recurrence was observed. Improvement in neurological status was observed with no morbidity and mortality case reported. Mean case follow–up time was 5 years.

**Conclusion:** Based on our experiences, we are proposing retropleural/retroperitoneal approach as alternative methods to remove extradural tumors extending through the intervertebral foramen and a preferred procedure for paraspinal neuroma management.
Introduction: An increasing number of elderly patients are undergoing operative treatment for degenerative lumbar disease. The reported morbidity of performing decompression and arthrodesis in this population varies widely in the literature, with recent reports showing high rates of major complications. The primary advantages of the minimal disruptive techniques over open surgical approaches are less tissue trauma, smaller incisions, less blood loss, reduced operative times, lessened postoperative pain, and shorter hospital stays. The objective of this work is to describe the perioperative complications and clinical outcomes in a series of elderly patients who underwent multi-level extreme lateral interbody fusion (XLIF) and instrumentation with lateral plates.

Methods: Medical charts of 45 patients, age 65 and older, that underwent multi-level extreme lateral interbody fusion (XLIF) and instrumentation with lateral plates were reviewed. The occurrence of any complication (major and minor), the need for transfusion, estimated length of stay, and disposition at discharge were noted.

Results: There were no major complications. The mean length of stay was 6 ± 2.4 days, the operative time 45 ± 15 minutes per level, the estimated intraoperative blood loss 90 ± 30 mL. There was transient iliopsoas weakness in 3 cases and 5 patients had postoperative numbness along the anterior aspect of thigh. There were no infections and no deaths. There were no blood transfusions. Fusion/instrumentation of 3 or more segments was not significantly associated with the occurrence of a major complication.

Conclusion: Multi-level XLIF with lateral plate instrumentation is safe in the elderly population.

343. The Use of a Single Incision for the Extreme Anterolateral Lumbar Interbody Fusion Approach (XLIF): Experience in 100 Consecutive Cases
Ali A. Bajaj, Fernando L. Vale, Juan S. Uribe
Introduction: A lateral retroperitoneal, transposa approach to the anterior disc space allows for complete discectomy, distraction, and interbody fusion without the need for an approach surgeon. The minimally disruptive extreme lateral approach (XLIF) usually requires two separate skin incisions to provide a safe retroperitoneal dissection. The objective of this study is to report the surgical results of the XLIF procedure using a single skin and facial incision.

Methods: The authors describe the XLIF approach in a step-wise manner using a single skin/fascial incision for retroperitoneal access and report their experience in a retrospective series of 100 consecutive cases.

Results: Single X-ray guided horizontal skin incision (mean length 5 cm, range 4-6 cm) was successfully performed in all cases. No case required conversion to standard two skin XLIF incisions. Mean surgery time was 55 min per level (range 45-75 min). No intraoperative injuries to peritoneal or retroperitoneal intrabdominal structures were experienced. At 12 months clinical follow-up there were no related complications and there was good cosmetic result.

Conclusion: Single skin/fascial incision is feasible and safe in the XLIF procedure. We believe that a single skin incision generates minimal somatic pain and achieves excellent cosmetic results.

344. Usefulness of Calcium Phosphate Bone Paste to Prevent the Collapse of the Vertebral Body in PLIF with Titanium Cages for Osteoporotic Patients
Kosuke Kuribayashi
Introduction: Cylindrical titanium cages have been extensively used as a device in posterior lumbar interbody fusion (PLIF). This cage can confer enough stability to the symptomatic motion segment and restore disc height to achieve a significant increase in the neuroforamen volume. It is reported, however, that titanium cages often bring about collapse of the vertebral body following their subsidence and bone union failure. I present my experience with a patient who could avoid developing to the collapse of the vertebral body even after subsidence thanks to calcium phosphate bone paste (bone paste).

Methods: A total of 742 patients underwent PLIF with titanium cages between September 1997 and August 2009. Of those, bone paste was used in 274 cases.

Results: Three patients needed additional surgery because of the collapse of the vertebral body in the “no bone paste” group. Although a 70-year-old female patient in the “using bone paste” group had not only the subsidence of a cage but also a pedicle screw penetrating to the endplate of the vertebral body, she could gain bone union without an additional surgery. However, it was difficult to assess the bone formation because roentgenograms had been showing bone paste as white through the observation period.

Conclusion: Bone paste is liquid and can infill the dead space of the disc space. In addition, it will have hardened within ten minutes and bring out the ability of holding the load with cages immediately. This reason is why bone paste can prevent the collapse of the vertebral body in PLIF with cages. However, using bone paste should be limited for osteoporotic patients, because it doesn’t have an osteoinduction capacity, so it remains a foreign substance. Furthermore, autologous bone chips should be placed in front of cages in the disc space to observe bone union.

345. Feasibility and Efficacy of Cervical Stabilization with Transpedicular Screw Fixation
Franco Ennas, Mario Ganau, Alberto Maleci
Introduction: Subaxial cervical instability for decades has been mostly managed by anterior surgical approaches. Recent availability of specific instrumentations has opened new frontiers also for posterior approaches, which from a biomechanical perspective are more appropriate. Transpedicular screw fixation (TPSF) seems to be more effective than other posterior techniques, as established by experimental studies that have confirmed their higher pull-out resistance. The major drawback against TPSF has always been the risk of neurovascular complications. This study focuses on the surgical experience obtained with TPSF for cervical instability, with particular attention to technical notes and clinical results.

Methods: Between 2001–2009, TPSF has been performed in 42 patients with cervical instability related to: degenerative mielopathy (more than 3-levels) in 31 cases, post-traumatic instability in 7 cases, and bone metastasis in 4 cases. Every patient underwent axial CT scan preoperatively, in order to evaluate orientation and width of pedicles, and postoperatively to confirm the correct screw placement. During surgery sagittal orientation of screws was assessed by radiofluorescence control, while a specific protractor guided their lateral orientation, without any aid from neuronavigation.

Results: A total of 196 screws (3.5mm) have been placed; their inclination, according to SAS (space available for transpedicular screws), ranged between 30°–48° at C3–C6, and between 21°–33° at C7. Mean surgical time was 2 hours; no vascular complications were encountered. Early mobilization was possible in most of the cases, according to preoperative neurological state. Postoperative CT scans detected asymptomatic incorrect positioning of 17
screws, occupying part of the foramen transversarium (n 14) or even the spinal canal (n 3), without any need for replacement. Optimal cervical stability was always confirmed at late radiographic follow-up (range: 6–78 months).

Conclusion: While literature confirms that even neuronavigation does not avoid the risk of iatrogenic neurovascular damage, we have noticed that a tailored presurgical planning is sufficient to reduce it.

346. Four-year Experience with Stand-alone Ostapek Cages in Cervical Spondylotic Myelopathy
Franco Ennas, Mario Ganau, Alberto Maleci

Introduction: Anterior approaches for cervical spondylotic myelopathy (CSM) allow for direct visualization and removal of ventral compression on the spinal cord. Nevertheless pros and cons of fusion vs. non fusion techniques and instrumentation are still debated. To date many synthetic materials have been proposed to manufacture cervical cages; unfortunately the most widespread titanium and PEEK, while less rigid than steel, are isotropic and much stiffer than bone. In contrast Ostapek cages (made of 66.7% long fiber carbon composite and 33.3% PEKKK resins) have demonstrated to provide an anisotropic elasticity closer to the biomechanical properties of the vertebral body, and therefore to promise physiological load of the bone tissue over time.

Methods: Between 2005–2009, anterior cervical corpectomy and fusion using ostapek cages have been performed in 46 patients, affected by CSM due to anterior spinal cord compression. Cages were filled with autologous bone obtained from vertebral somatectomy. Quality of fusion was assessed at 3 and 6 months postoperatively by X-rays, CT and MRI scans, and finally late clinical follow-up was obtained in every patient.

Results: Anterior plate fixation has been necessary only in a case of rheumatoid arthritis. Mean duration of surgery was 2 hours, with no need for hemotransfusion; and 0% of morbidity. Patients were rapidly mobilized after operation, and discharged from the ward within 3–4 days. MRI scans confirmed a good cervical decompression in all cases, and X-rays and CT study showed an advanced degree of fusion as soon as 3–months postoperatively in 95% of cases. At late follow-up (mean: 30 months) our patients still reported an high degree of satisfaction.

Conclusion: This surgical series confirms the theoretical advantages of ostapek cages, which have provided the primary and dynamic stability of the anterior column in a stand-alone manner, and the rapid rate and high quality of bone fusion.

347. Prospective Case Series of Anterior Cervical Discectomy and Fusion Using Stand-alone Carbon Fiber Cages: Radiographic Evidence of Fusion and Maintenance of Lordosis
Maya Babu, Fred Chiu-lai Lam, Michael W. Groff

Introduction: Dynamic plates have generated enthusiasm as adjuts to anterior cervical discetomy and fusion (ACDF) surgery, although plating may not be necessary. Smith and Robinson’s original description of anterior cervical arthrodesis did not include plate fixation. Avoiding plate insertion can eliminate graft shielding, simplify re-operation at adjacent levels if necessary, and limit the needed exposure for index surgery. We herein report our case series of 50 ACDF’s using stand-alone carbon-fiber cages.

Methods: We prospectively collected data on 50 cases of 1-, 2-, and 3-level ACDFs in which a carbon fiber cage was used as a stand-alone device without plating. The graft chamber was filled with a combination of Healso and local bone. Healso, a cellulose sponge of hydroxyapatite, was admixed with bone marrow aspirate taken from the anterior iliac crest. Flexion/extension X-rays were obtained to assess fusion and maintenance of lordosis at one-year follow-up. Fusion was defined by formation of bridging bone, minimal angulation (< 6 degrees) and translation (< 3 mm) on flexion(extension. Change in lordosis angle immediately post-operation to follow-up was measured using the Cobb angle method.

Results: Successful fusion was seen in 100% (34 of 34 levels) of one-level fusions, 100% (26 of 26 levels) of two-level fusions, and 83% (5 of 6 levels) of three-level fusions. Maintenance of lordosis achieved postoperatively was preserved in all cases (overall mean angle change: 2.7 degrees). Of the 50 cases reviewed there were no cage extrusions or migrations, no permanent difficulties with voice or swallowing, and no wound complications.

Conclusion: To the best of our knowledge, this is the first case series showing fusion and maintenance of lordosis using stand-alone carbon-fiber cages. While this series requires additional follow-up, our preliminary findings suggest that stand-alone carbon fiber cages are a viable and safe alternative to plating with allograft.

348. Late Sequelae of Spinal Column and Cord Injury: Syringomyelia and Tethered Cord
James A. Stadler, Ill, Aruna Ganju

Introduction: Late sequelae of spinal column and cord injury can include syringomyelia, tethered cord, and spinal deformity. Each of these entities may result in loss of motor, sensory, bowel/bladder, or autonomic function in patients who are already impaired by spinal column and/or cord injury. There is debate in the medical literature regarding the optimal diagnostic and therapeutic options for this population.

Methods: A retrospective review of demographic, clinical, and radiographic data was performed for 12 patients with post-traumatic syringomyelia and tethered cord. Preoperatively, all patients underwent some combination of the following tests: plain films, conventional MRI, cine MRI, and CT myelogram. Diagnostic tests attempted to identify a subarachnoid stenosis and obstruction to CSF flow. Surgical treatment consisted of laminectomy, lysis of adhesions, cystic fenestration, untethering of the spinal cord, and duraplasty. Comparison of pre- (Figure 1) and postoperative (Figure 2) syrinx length and diameter was performed on six patients. Preoperative quality of life data is available for four patients.

Results: Of the six patients for whom pre- and postoperative MRI data is available, in regards to syrinx length, 50% of patients showed a postoperative decrease in syrinx length whereas the remaining 50% exhibited no change. 50% of patients showed a postoperative decrease in syrinx diameter while 33% of patients revealed an increase in postoperative diameter. One patient demonstrated no change in syrinx diameter postoperatively.

Conclusion: Late sequelae of spinal column and cord injury such as syringomyelia and tethered cord can lead to loss of neurologic function in this patient population. Diagnostic measures are directed towards identifying a focal site of CSF flow obstruction. Current–day treatment options address and restore normal CSF dynamics. Parameters by which to gauge the feasibility and efficacy of surgical intervention require better definition via prospective studies analyzing pre- and postoperative neurologic condition, functional impairment, and quality of life.

349. Neuronavigation in Surgery of the Craniovertebral Junction
Perry Dhalwale, Garnette R. Sutherland, R. John Hurlbert
**Introduction:** The transoral transpharyngeal surgical approach is a recognized technique for management of ventral lesions at the clivus and upper cervical spine. We examine our experience with this procedure and the use of neuronavigation and intraoperative magnetic resonance imaging (IMRI).

**Methods:** A retrospective review of all patients undergoing transoral transpharyngeal surgery in the iMRI unit from 1997 to present was performed. Preoperative demographic data, clinical history, physical examination and imaging studies were reviewed. Detailed data was collected on surgical approach, pathology, and immediate postoperative management. Information on intraoperative and postoperative adverse events was also collected.

**Results:** Nineteen patients underwent resection of ventral lesions at the craniovertebral junction through a transoral approach in the iMRI suite. Mean age at time of surgery was 50 years of age. A variety of pathologies were identified including neoplasms (n=7), congenital anomalies (n=7), and degenerative disease (n=5). Intraoperative imaging and neuronavigation allowed for tailoring of the surgical approach in each of our patients: 4 patients required a palatal split, 5 patients required a mandibulotomy and 9 patients underwent transoral surgery without a palatal split or mandibulotomy. Interdissection images allowed for immediate confirmation of gross total resection in all cases. Postoperatively, patients were managed in the ICU for an average of 7 days. Thirteen of 14 patients had neurological improvement at a mean of 2.2 years of followup. One patient died from tumor progression.

**Conclusion:** Intraoperative MRI and neuronavigation are useful adjuncts to allow for selective surgical exposure and quality assurance in the transoral approach to the craniovertebral junction.

350. **Use of Acupuncture for Refractory Autonomic Dysfunction**
Ronald Reimer, Jessica Crowe

**Introduction:** Acupuncture has been used for over 5,000 years and is becoming more widely accepted in Western medicine. Tiny needles are placed, coupled with electrical stimulation, to promote healing via improved flow of Qi (energy). A common cause of delayed postoperative recovery is autonomic dysfunction, such as nausea, vomiting (PONV) and ileus. Patients undergoing abdominal and/or transplant surgery are prone, increasing hospital LOS and costs. Annually, 2.7 million procedures in the US lead to ileus 1 day in duration costing $1 billion. The 1997 NIH Consensus Statement endorsed acupuncture for PONV.

**Methods:** Our series includes 50 patients with autonomic dysfunction, treated since 2002, including 30 females and 20 males, ranging from 17 to 85 years of age. Some were hospitalized for up to 10 weeks and requiring hyperalimentation. The series included postop organ transplants (20%), general surgery patients, patients receiving chemotherapy, and outpatients with chronic impairment. Using universal precautions, acupuncture with low frequency electrical stimulation was performed.

**Results:** A retrospective telephone survey was performed. Most patients fell asleep during treatment and the maximum benefits were experienced between one and 72 hours post treatment. All but 5 hospitalized patients tolerated NG tube removal and increased oral intake, many being discharged within 36 hours. Twenty-six of 29 patients (90%) with nausea and vomiting reported diminished or eliminated symptoms. Eleven of 12 patients (92%) with nausea alone reported resolution. Seven of 9 patients (78%) with ileus alone reported alleviation of symptoms. Two patients were able to cancel scheduled surgery after acupuncture. One noted that it saved his insurance company $50,000.

**Conclusion:** In cases of refractory autonomic dysfunction, acupuncture has been extremely effective (87%) in improving quality of life and/or shortening LOS without complications and should be considered as an adjuvant therapy.

351. **Success of Interbody Vertebral Fusion with Silicated Calcium Phosphate**
Walter W. Eckman; Michelle McMillen; Lynda Gail Hester

**Introduction:** Evolution of less invasive lower morbidity surgical procedures drives the search for alternatives to augment interbody spine fusion. rhBMP2 produces excellent fusion rates but has significant morbidity (swallowing and breathing problems in anterior cervical procedures; nerve root injury, osteolysis and bone overgrowth in posterior lumbar procedures). This is an ongoing prospective study of fusion rates using interbody Silicated Calcium Phosphate (SCP) to promote fusion. Study design is evaluation of radiographic images of patients (X-rays and reformatted CT scans) when healing of fusion is expected (about 12 to 18 months). Uncertain fusions are followed until either fusion or non-union is demonstrated.

**Methods:** All cervical procedures were anterior using polymeric interbody devices and anterior plate fixation (ACDF). Lumbar procedures were minimally invasive transfacial interbody fusions (MITLIF) using polymeric or titanium interbody devices and unilateral pedicle fixation.

Eighty-three patients had ACDF from February 2006 to April 2008. Forty-one completed studies 7 to 30 month’s post-op. 69 levels were evaluated: 18 one-level, 16 two-level, 5 three-level and 1 four-level. One hundred thirty-four patients had single level MITLIF from April 2007 to September 2009. 65% (87 of 134) went home on the same day of surgery. 45 patients completed follow-up studies 11 to 17 months post-op.

**Results:** Cervical fusions appear healed at all 69 levels (100%). Two patients (3 levels) with probable but uncertain fusion were lost to follow-up. Lumbar fusions appear healed in 43 of 45 patients (96%). Fusion was uncertain in two patients (4%). Neither series demonstrated morbidity which could be attributed to SCP. To date there are no confirmed non-unions with interbody SCP.

**Conclusion:** SCP appears to be a safe and effective bone graft substitute in both anterior cervical and posterior lumbar interbody fusions.

352. **Preliminary Results Using AxiaLIF and Percutaneous Pedicle Screw Fixation in the Treatment of Lumbar Isthmic Spondylolisthesis**
David J. Hart, William B. Rodgers, Rishi Goel

**Introduction:** Traditionally, surgical correction of isthmic spondylolisthesis has been associated with good surgical outcomes, but has been highly labor-intensive and often complicated by extensive soft tissue injury, abundant blood loss and long hospital stays. The authors present initial experience with use of the AxiaLIF technique combined with percutaneous pedicle screw fixation for treatment of isthmic spondylolisthesis.

**Methods:** Cases with minimum 12-month follow-up were selected from the two senior authors’ pool of AxiaLIF surgeries and retrospectively analyzed for demographic data, clinical outcomes, operative data, and fusion status. Patients were excluded if they had any other surgical procedure performed.

**Results:** 18 patients were analyzed. The mean age was 51.1 (25-76). There were 9...
minimally disruptive posterior fixation. In the XLIF group, there were no transfusions or infections, with a mean hemoglobin change of 1.44; while hemoglobin change in PLIF patients averaged 3.10. Hospital stay averaged 1.2 days for XLIFs and 3.16 days for PLIFs. 89% of XLIF patients had a Lenke score of 1 at 12 months vs. 79% of PLIF patients at 12 month. While reoperation rate among XLIF patients was 3.7% (4/108), there was a 10% reoperation rate in the PLIF cohort.

Conclusion: There is little in the literature describing the use of minimally invasive techniques for 2-level pathologies. In our experience, patients with multi-level pathologies can expect the same benefits and successful outcomes from this less invasive procedure as those with single-level indications. Moreover, the clinical and radiographic outcomes in two-level XLIF compare favorably to those using more traditional open techniques in this single-site series.

354. MIS 2-level Fusion vs. Open 2-level Fusion: The Significance of a Surgeon’s Efficiency

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: The AHA released data in April 2009 stating that 59% of hospitals have reported either a moderate or significant decrease in elective procedures. Efficiency is more crucial than ever in healthcare. This study examines the effect of transition to minimally invasive technique from traditional open methods on a spine surgeon’s efficiency.

Methods: Key performance indicators were defined as factors of a single surgeon’s efficiency. KPIs included LOS and complications, cases per day, patient encounters, and personal hours saved. Clinical data from a single-site series of 115 2-level MIS lumbar fusions (2-level XLIFS and XLIF-AxialLIFs at L4-S1) were collected from 2007–2009 and compared with a database of 109 open 2-level PLIF patients from the same practice, captured from 2005–2007. Case quantity and patient encounter data from a surgeon’s practice were collected from 2005–present and reviewed to calculate efficiency.

Results: In the MIS group, average LOS was 27.6 hours, and the complication rate was 4.8% with no infections; in the open group, LOS 75.8 hours, and complication rate 13.6% with 3 infections. OR time for 2-level XLIFs was 103.3 minutes, and OR time for XLIF-AxialLIF combinations was 137.6 minutes, (includes placing posterior instrumentation). OR time for the open group was 107 minutes. Reoperation rate in the MIS group was 2.5%; in the open group, 12.7%. Cases per day in 2008 were 5.2, compared to 3.9 in 2005. From 2006 to 2008, patient encounters increased 51.2%. Personal hours saved per day, compared to years prior to 2007, was 2.32 hrs – 10%–20% of a work day.

Conclusion: The advent of MIS techniques in a single surgeon’s practice has greatly improved efficiency. This efficiency has lead to increased profitability of the surgeon’s practice and may advantageously affect the profitability of hospitals and related institutions, potentially counteracting the decrease in elective surgery.

355. Lumbar Fusion in Octogenarians: The Promise of Minimally Invasive Surgery

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: Although spinal pathologies are common in the elderly, additional health conditions often preclude operative treatment because anesthesia, blood loss, and recovery are too demanding. Minimally invasive approaches, however, reduce procedure-related morbidity and recovery time. Early results of two lumbar interbody fusion (XLIF) procedures – one open (PLIF) and one minimally invasive (XLIF) – were compared in octogenarians to demonstrate the safety of each in this extreme elderly population.

Methods: In our single-site prospective series of 690 XLIF patients, 39 were identified as greater than or equal to age 80 with a minimum of 3-months follow-up. A complete, retrospective review of surgical patients treated in the same practice with traditional open posterior (PLIF) approach found 20 greater than or equal to age 80. Comparisons were made between groups to identify differences in morbidity and mortality rates of the two procedures.

Results: No clinically significant differences in demographics, diagnoses, or comorbidities were found between groups. Complication rate, blood loss/transfusion rate, and hospital stay were significantly lower in the MIS group (p<0.0001). MIS patients left the hospital an average of 4 days earlier than the open PLIF patients, most discharged home (92.2% XLIF vs. 0% PLIF) rather than to skilled nursing facilities. Six deaths occurred in the PLIF follow-up, 3 within 3 months post-op; there was 1 death at 6 months post-op XLIF.

Conclusion: Surgical treatment need not be withheld based on age; elderly patients can successfully be treated using MIS
356. Outcomes of MIS Spinal Fusion: 12 and 24 Months
W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson
Introduction: XLIF outcomes at 1 year are presented and are compared with initial 2-year data.
Methods: Of our single-site series of 690 XLIF patients, 266 have presented for 12-month follow-ups, and 34 for 24-month follow-ups. Clinical and radiographic outcomes were evaluated. A patient questionnaire was used to collect satisfaction data at 12 months.
Results: Of the patients with 12-month follow-ups, range aged from 27–87 years (average 62.6 years). Comorbidities included smoking (31%), chronic steroid use (12%), diabetes (21%), CAD (50%), and COPD (5%). 134 patients (48%) were obese (BMI>30), 41 morbidly obese (BMI>38). Average VAS improved from 8.8 at pre-op to 2.6 at 12 months. Disk height improved from 5.9mm to 10.4mm at post-op, settling about 1mm to 9.3mm by 12 months. Lithis was reduced from 4.0mm to 0.6mm, maintained at 12 months. Definative signs of fusion (Lenke 1-2) were present in 91% at 3 months, 98% at 6 months, and 99% at 12 months. 66 patients had CT scans at 1-year postop. Fusion by CT criteria of 50% area fused was achieved in all but 3 -levels (96.6%). Early 24-month outcomes indicate maintenance of 12-month outcomes. VAS at 24 months was 2.4, average disk height was 9.7mm, and slip was 0.8mm. At 12 months, 88% were very satisfied or satisfied with their surgery. 90% would definitely or likely do the surgery again. 83% were considered excellent or good outcomes by the surgeon.
Conclusion: Our data shows satisfactory intermediate term clinical outcomes in our series of XLIF at 12 months. VAS scores improved, disk height was restored and maintained, and slip was adequately reduced. Patient and surgeon satisfaction scores at 12 months are encouraging. Early data shows maintenance of these outcomes at 24 months. More follow-ups will be beneficial to determine long-term outcomes.

357. CT Fusion Assessment in XLIF Patients at 1 Year
W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson
Introduction: XLIF has been shown to result in good short-term outcomes with minimal morbidity. Long-term outcomes have been assumed to mimic those of other interbody fusion procedures. However, no reports to date have focused specifically on fusion rates associated with XLIF.
Methods: From our prospective, nonrandomized single-site consecutive series of 690 XLIF patients, patients reaching 1-year follow-up were asked to undergo a voluntary lumbar spine CT scan. CT scans from 66 patients with 1-year follow-up have been obtained to date, which were reviewed to evaluate fusion, and compared with clinical results and patient satisfaction.
Results: Patient age ranged from 34–87 years (average 61.8 yrs). 88 levels were treated: 50 1-levels, 10 2-levels, and 6 3-levels; 16 at L2–3, 32 at L3–4, and 37 at L4–5. Grafting materials included a composite of DBM, local bone graft, and bone marrow aspirate. Twelve surgeries included supplemental unilateral pedicle screw fixation performed in the same surgical position. Average disk height improved from 6.1mm to 9.4mm at two-year follow-up. Signs of fusion by Lenke scores of 1 or 2 were 97% at 6 months, 99% at 12 months, and 100% at 24 months. Fusion by CT criteria of 50% area fused was achieved in all but 3 levels (96.8%). Average VAS pain scores decreased from 8.6 at pre-op to 1.7 at 12 months, with a slight increase to 1.9 at 24 months. At 1 year, 89% of patients were satisfied or very satisfied with their outcomes. The surgeon reported clinical assessment was good or excellent in 84%.
Conclusion: XLIF has proven to be a safe and effective procedure. This is the first report specifically highlighting fusion rates of XLIF by CT assessment. High rates of fusion can be reasonably expected using this minimally invasive interbody fusion procedure.

358. Minimally Invasive Treatment of Recurrent Disk Herniation via XLIF
W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson
Introduction: Because the psoas muscle, within which is the lumbar plexus, is traversed during the XLIF approach, appropriate care is needed to avoid nerve injury during surgery and prevent approach-related neural deficit. Dynamically evoked EMG is used routinely to detect neural proximity and location during the XLIF approach, but no studies on its utility have been reported.
Methods: In a prospective, non-randomized, multicenter, IRB–approved clinical study of 102 patients undergoing XLIF at L3–4 and/or L4–5, EMG threshold
values from the dilators used in the procedure were recorded at the surface of the psoas muscle, mid–psoas, and on the spine. At each location, the dilators were rotated 360°, taking recordings immediately posterior, superior, anterior, and inferior. The rotational position (angle in degrees) of each dilator at which the lowest threshold was found was noted. Pre- and postoperative neurological exams were also recorded to identify new motor deficits.

**Results:** A total of 133 levels were treated at L3–4 (n = 24), L4–5 (n = 47), and both L3–4 and L4–5 (n = 31). Alert-level EMG feedback was given in 55.7% of all cases; 43.6% at L3–4 and 62.9% at L4–5. The relative frequencies of the location of the lowest threshold found for all three dilators combined at each level are summarized. Though nerves were more commonly identified in the posterior margin (63%), there was significant variability in the location of nerves identified. The posterior half of the disc space was targeted in 90% of cases, with no significant neural deficits. Three (2.94%) new postoperative neural motor deficits were identified, all transient.

**Conclusion:** The ability to identify and report a discrete, real-time EMG threshold during the transpsoas approach helps to avoid nerve injury and contributes to the safety and effectiveness of the XLIF procedure. Additionally, nerve location is variable, thus reinforcing the need for real-time directional and proximity information.

**360. Minimally Invasive Lumbar Fusion (XLIF) Using a TCP–HA Bone Graft Substitute (FormaGraft): Fusion Rates Out to 1 Year**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

**Introduction:** Good short-term outcomes after XLIF have been shown. Fusion outcomes have been assumed to meet or exceed those of other interbody fusion procedures due to access for greater disk preparation, large structural implant, and retention of stabilizing ligaments. However, no reports to date have focused specifically on fusion rates associated with XLIF, or on the graft materials used in XLIF. Given the limitations of autograft, many US surgeons use bone morphogenic protein in lumbar fusions. However, issues related to early resorption and hospital cost have fueled continued evaluation of other bone graft substitutes.

**Methods:** The use of a beta-tricalcium phosphate/hydroxyapatite (FormaGraft) with bone marrow aspirate (BMA) was prospectively studied in 57 consecutive 1- and 2-level XLIF procedures. Radiographic outcomes were evaluated to demonstrate fusion and were compared with clinical results.

**Results:** Patient age ranged from 25–79 years (average: 55.7 yrs). Primary diagnoses included stenosis (31), DDD (12), spondylolisthesis (8), HNP (6). Comorbid conditions included previous spine surgery (47.4%); smokers (38.6%); diabetes (24.6%); chronic steroid use (10.5%); obesity/morbid obesity (54.4%). 64 levels were treated: 50 = 1-level, 7 = 2-level; 10 = 3-level, 4 = 4-level, 2 = 5-level, 1 = 6-level. graft included equal amounts by volume FormaGraft and BMA, aspirated from the adjacent vertebral body under lateral exposure. All included supplemental fixation. Hgb change and hospital stay averaged 1.23g and 1.0 days. Complications included one iatrogenic HNP requiring secondary decompression. One patient died at 2 weeks post-op of an unknown cause. Average disk height improved from 6.4mm to 10.9mm, and was maintained at 9.9mm at 12 months. Fusion by Lenke score = 1 was 93.4% at 12 months. Average VAS pain scores decreased from 9.0 at pre-op to 2.6 at 12 months. 91% expressed satisfaction with their procedures at 12 months, and 95% said they would do it again.

**Conclusion:** XLIF has proven to be a safe and effective procedure, and now 12-month results using ßTCP–HA bone graft substitute confirm fusion, maintenance of improvements, and overall patient satisfaction.

**361. XLIF at L4–5 and the Protective Effect of Prophylactic Dexamethasone**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

**Introduction:** It has been reported that XLIF procedures performed at the L4–5 level have a higher incidence of postoperative motor deficits compared to other lumbar segments, and must occasionally be aborted to due anatomic constraints.

**Methods:** In our single-site consecutive series of 690 XLIF patients, 410 (60%) included the L4–5 level. Clinical and radiographic data were prospectively collected and reviewed to assess XLIF procedure at the L4–5 level.

**Results:** Age averaged 60.8 years (24–88 years). 76.9% had one or more comorbidities. 31.0% had prior lumbar surgery. All procedures were successfully completed. Hospital stay averaged 1.3 days. Average VAS pain scores improved from 8.7 at pre-op to 2.5 at 12 months and 2.2 at 24-months follow-up. Lenke fusion scores of 1–2 were present in 96.2% at 6 months, and 99.1% at 12 months. Neural complications included 4 (0.6% of all cases, 1.0% of L4–5 cases) transient lower leg weaknesses (3 quads, 1 anterior tibialis; all resolved within 3 months). After the fourth postoperative motor deficit, we began to administer dexamethasone (10mgIV prior to skin incision) prophylactically in all XLIF patients in whom the L4–5 level was to be approached. Since the use of dexamethasone, no additional neural deficit developed, a statistically significant difference (p = 0.0245).

**Conclusion:** The incidence of postoperative motor deficits following XLIF at L4–5 is low. The prophylactic administration of dexamethasone results in a statistically significant reduction in motor deficits.

**362. Safety and the Learning Curve of Trans-sacral Fusion (AxiaLIF) at L5–S1: Complications in the First 165 Surgeries of a Single Surgeon Series**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

**Introduction:** Trans–sacral fusion of L5–S1 has been well described. Improvements in the technique and instrumentation have been implemented to reduce the risk of complications, particularly during the “learning curve.” To our knowledge, the early complications during the adoption phase for AxiaLIF have not been reported in detail.

**Methods:** Clinical and radiographic outcomes of all AxiaLIF patients were evaluated. Surgical and postoperative complications were also documented. Preliminary 12-month postoperative data is reported (n = 42).

**Results:** 165 patients (64M, 81F; age 54.9 yrs, range 22–88 yrs; BMI 31.8) were treated by a single surgeon using the AxiaLIF technique to achieve fusion. 127 procedures were single-level; 29 procedures involved concomitant fusion at L4–5 (via XLIF). All but one involved supplemental posterior instrumentation. OR time averaged 91.4 min. LOS averaged 27.2 hrs (1.13 days).

Hemoglobin change was 1.79 g. There were 19 complications: Hardware (1), screw revision at POD 2), graft herniation (3, all required laminotomy), pneumonia (1), wound dehiscence at incision (4, 3 treated with local care, 1 treated with wound VAC), cardiac (1, CHF), urinary retention (1), gastritis (1), ileus (1), infection (1, I&D), transfusion (3), nonunion (2, revised at 10 and 12 mos). There have been 3 reoperations for ASD. There were no visceral, vascular, or neurologic complications. Disk height improved from 4.2mm preop to 7.8mm
postop; minimal subsidence was noted at 6 months with some settling at 12 months (disk height 5.5mm). Lysis was reduced from 4.4mm preop to 1.2mm postop with slight settling to 2.0mm at 12 months. VAS decreased from 8.8 preop to 3.5 at 3 mos and further to 3.2 at 12 mos. Conclusion: The adoption phase for AxiaLIF shows very few complications compared to traditional open techniques.

**363. Minimally Invasive Fusion at the Lumbosacral Junction in the Elderly (Age >70 Years)**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: The elderly patient provides a challenging fusion healing environment due to existing comorbidity. This study evaluates the AxialLIF fusion at L5–S1 in the elderly patient population greater than 70 years of age.

Methods: 28 patients with a mean age of 75.9 years (range 70–88 years) received L5–S1 fusions with AxialLIF. Eight of the patients had Grade I and two patients with Grade II spondylolisthesis. Supplemental posterior fixation was used in all but one of the patients. The VAS scores, disc heights, and improvement in slip in the four patients are presented for this patient population at 3–6-months postoperatively.

Results: The mean VAS score in these patients preoperatively was 8.7 and reached 3.2 at 6 months postoperatively, demonstrating a 5.5 point drop in the VAS score. Initially, the height increased by 3.6mm postoperatively, with 1.2mm of settling at the 6-month time frame. For the eight patients with a Grade I or II spondylolisthesis, there was approximately a 52% reduction in slip (3.1mm) measured at 6-months postoperatively. The mean OR time was 77.8 minutes, with a mean length of stay of 1.4 days. The hemoglobin change was 1.9 g. All patients but 2 were discharged home. One patient was revised elsewhere for ASD. There were five complications: 1 postoperative transfusion and 1 wound problem requiring wound VAC (same patient), 1 urinary retention, and 1 CHF requiring care in a rehabilitation facility.

Conclusion: A successful VAS outcome was achieved in these challenging patients. This approach provided adequate reduction of a Grade I or II spondylolisthesis due to the added contribution in biomechanical stability of the intact surrounding ligamentous tissue and posterior supplantation. This approach provides a favorable alternative for spinal correction requiring fusion for the elderly patient.

**364. Transsacratal Interbody Fusion (AxialLIF) in Obese Patients**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: This report discusses results of MIS fusion at the L5 junction in the obese patient.

Methods: In our single–site prospective series of transsacratal lumbar fusions (AxialLIF) we treated 96 (61F, 35M) patients who were obese by BMI >30. Data were reviewed to assess comorbidities, surgical details, hospital stay, complications, clinical and radiographic outcomes. Preliminary 12–month data is reported (n=24).

Results: In our experience, no surgery could be not successfully completed. The heaviest patient weighed over 150 kgs; the largest BMI was 50.6. 27% were morbidly obese (BMI ≥38). Ages ranged from 26–83 years (ave 53 yrs). Comorbidities included smoking (31%), prior spine surgery (33%), diabetes (30%), CAD (36%). LOS averaged 1.2 days; hemoglobin change 1.8 g. Disk height increased 3.1mm, with 1.5mm settling by 12 months. Slip was an average 4.9mm; with a average decrease in reduction of 2.1mm at 6 and 12 months. Preop VAS was 8.8 and decreased to 3.6 at 3 months, 3.0 at 6 months, with a slight increase to 3.8 at 12 months. There were no infections. Complications included 1 malpositioned pedicle screw that was revised POD15, 2 minor coccygeal wound dehiscences treated with local dressings, 2 graft herniations requiring laminotomy, 1 wound problem requiring VAC, 1 gastritis, 1 CHF, 1 urinary retention, 2 transfusions, and 1 nonunion revised at 12 months. There were no neural or visceral injuries, or hardware failures. Two patients had mild gapping of the coccygeal incision that was treated with local dressings and resolved, two patients had graft herniations requiring laminotomy, one patient had an infection, one patient required transfusion, and one patient developed a nonunion that was revised at 12 months.

Conclusion: A transsacral MIS approach using the AxialLIF fixation system at L5–S1 for a Grade I or Grade II spondylolisthesis offers a safe, reproducible alternative to traditional open procedures. This approach provides adequate reduction of a Grade I or II spondylolisthesis. The intermediate results demonstrate encouraging clinical outcomes with an acceptable complication rate. However, the areas of graft herniation, disc height settling, lysis settling, and fusion rates bear watching.

**365. Single Level Lumbar Fusion for a Grade I and II Spondylolisthesis Correction Using the AxialLIF Rod System**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: Spondylolisthesis correction has been conventionally addressed by lumbar fusion of the slipped segment. MIS transsacular fusion (AxialLIF) offers the opportunity to address spondylolisthesis correction and spare the facet joint and surrounding ligamentous tissues to the spinal column, thus providing superior stability to the slipped segment. In addition, the directional vector of placement of the intervertebral device facilitates reduction of the listhetic segment. Herein, we report our early results using this approach. To our knowledge, this represents the first report of the use of this technique in spondylolisthesis.

Methods: 88 patients (38 M, 50 F, age 52.1 yrs, BMI 30.8) were treated with AxialLIF fusion at L5–S1 for either a Grade I (n=73) or Grade II (n=15) spondylolisthesis. The VAS scores, disc heights, and improvement in slip and complications are presented.

Results: VAS improved by 71% over the first year; disk height increased 2.7 mm from preop to postop (although there was some settling (2.2 mm) by 12 months); lysis was reduced by 3.2mm at postop, but settled by 1.2mm at 12 months. There were no neural or visceral injuries, or hardware failures. Two patients had mild gapping of the coccygeal incision that was treated with local dressings and resolved, two patients had graft herniations requiring laminotomy, one patient had an infection, one patient required transfusion, and one patient developed a nonunion that was revised at 12 months.

Conclusion: A transsacral MIS approach using the AxialLIF fixation system at L5–S1 for a Grade I or Grade II spondylolisthesis offers a safe, reproducible alternative to traditional open procedures. This approach provides adequate reduction of a Grade I or II spondylolisthesis. The intermediate results demonstrate encouraging clinical outcomes with an acceptable complication rate. However, the areas of graft herniation, disc height settling, lysis settling, and fusion rates bear watching.
Provincial spine care pathway. The pathway was based on a systematic review of the assessment and treatment of spinal disorders. The final pathway was subjected to an external review.

**Results:** The Saskatchewan Spine Pathway (SSP) has three major components: (1) Education of primary care physicians to identify and treat major patterns of back pain and leg pain. (2) SSP clinics, staffed by specialized primary care providers, assess and triage patients to receive further non-surgical therapy, specialized imaging and/or referral to a spine surgeon. (3) Performance will be assessed by monitoring wait times, cost-effectiveness and patient-reported outcomes.

**Conclusion:** The availability of spinal monitoring in Canada remains variable, although most surgeons believe it is an important adjunct to improve patient safety.

### 369. Safety and Feasibility of En Bloc Resection for Primary Spine Tumors: A Systematic Review by the Spine Oncology Study Group

Tomasato Yamazaki, Gregory Stuart McLoughlin, Shreyaskuma Patel, Laurence D. Rhines, Daryl R. Fourney

**Introduction:** There is currently good evidence to support the premise that the best chance for surgical cure in primary tumors of the spine is by en bloc resection with disease-free margins; however, the early morbidity of these procedures begs the question of whether they are justified. The Spine Oncology Study Group (SOSG) developed a research question that is the purpose of this study: Based on the rate of achievement of disease-free margins, morbidity and mortality (i.e., early efficacy of surgery), should Enneking principles of staging and en bloc resection of primary tumors be applied to the spine?

**Methods:** A formal systematic review with search of MEDLINE, EMBASE, and the Cochrane Database of Systematic Reviews databases was undertaken. Included reports described patients with low grade malignant spine tumors, the method of staging and surgical resection, and the complications. Two blinded, independent reviewers used a standardized study selection worksheet. The results of the literature review were reviewed by a multidisciplinary group of experts (SOSG) to arrive at a final grade of recommendation using the GRADE approach.

**Results:** 89 articles were identified, with 11 selected after excluding small case series and studies that included other pathologies (e.g., metastatic disease). Surgical and oncologic staging accurately predicted the attainment of wide or marginal margins in 88% of cases treated by en bloc resection. Surgical complication rates ranged from 13% to 56%, and mortality ranged from 0% to 7.7%.

**Conclusion:** En bloc resection of primary...
spine tumors with disease-free margins is achievable if proper oncologic and surgical staging determines that it is feasible. The adverse event profile of these surgeries is high (even at experienced centers). Therefore, these surgeries should be performed by experienced, multidisciplinary teams (Strong recommendation, low-quality evidence).

370. Video-assisted Thoracoscopic Surgery (VATS) Assisted by O-arm-based Navigation for Thoracic Disc Herniation

Jin-Sung Kim, Sang Soo Eun, Sang-Ho Lee, Max Franco De Carvalho, Jong-Mok Shin, June-Ho Lee

Introduction: Anterior approaches to the thoracic spine have become established as the standard for appropriate treatment of thoracic disc herniation (TDH). The trend toward the use of minimally invasive procedures with endoscopic visualization of the thoracic cavity in thoracic spine surgery has evolved. We believe that it is difficult to develop a new set of visual—motor skills unique to endoscopic procedures and understand the 3-dimensional (3-D) anatomy while performing a 2-dimensional (2-D) imaging procedure.

Methods: The authors report the results of six patients submitted to TDH discectomy using VATS assisted by an O-arm based on StealthStation navigation and describe the surgical technique. The main symptoms included back pain and gait disturbance.

Results: The duration of the symptoms was 2.8 years on average. The mean follow-up was six months. During the surgical procedures, there was an average of 470 ml of blood loss (bleeding range 250 ml to 840 ml), and the operation time was 321 minutes on average (operation time range, 200 minutes to 405 minutes). There were no complications during the surgical procedure or the immediate postoperative time. After the surgery, all patients’ symptoms and walking improved.

Conclusion: Our initial combined use of O-arm-based navigation and VATS proved to assist the surgeon in simultaneously performing and ensuring a focal decompression of the spinal cord with better depth orientation. Video-assisted thoracoscopic surgery assisted by O-arm-based navigation is a viable, safe, effective, and minimally invasive option for the treatment of thoracic disc herniation.

371. Cement Augmented Anterior Reconstruction with Short Posterior Instrumentation: Less Invasive Surgical Option for Kummell’s Disease with Cord Compression

Sun-Ho Lee, Eun Sang Kim, Whan Eoh

Introduction: We report the surgical procedure and clinical outcome of a Cement augmented anterior reconstruction with Pedicle screw fixation for osteoporotic vertebral collapse with intravertebral cleft (Kummell’s disease).

Methods: In this prospective controlled cohort study, ten elderly or medically-compromised patients with cord compression were enrolled consecutively. The vertebrae involved were located from T3 to L2 (T11 L2: 9 patients, 90%). Instrumentation and posterolateral bone graft were performed within one level above and below the collapsed vertebra except one patient required long fixation. Posterior decompression was performed when needed. The polymethylmethacrylate (PMMA) cement was then injected into the intravertebral cleft. A visual analog scale and Frankel grade were used to evaluate the clinical outcome. The vertebral height, segmental Cobb’s angle and wedge angle were measured. The mean follow-up duration was 12.1 months.

Results: The mean number of fused segments was 3.2. The mean visual analog scale (VAS) before vertebroplasty was 7.5, but it decreased to 3.2 postoperatively, and was 3.7 at the latest follow-up. Motor deficits were present in eight patients (80%). The neurological function improved by at least one Frankel grade in seven (83%) of the eight patients with motor deficits. The mean decrease in kyphosis angle was 12.6° and the mean wedge angle reduction was 12.1°. There was a significant difference between the initial and postoperative radiographs (p<0.05). However, the angle improvement showed slight regression during the follow-up. Bony fusion was achieved in all cases. There were no catastrophic complications during surgery and follow-up. One patient developed wound dehiscence. No patient showed collapse, loosing or leakage into the canal of the PMMA. There was no revision or instrument failure.

Conclusion: Based on the preliminary results of this study, the authors advocate the use of short instrumentation in combination with cement augmentation and posterolateral fusion for Kummell’s disease in elderly or medically-compromised patients.

372. Three-dimensional (3-D) Image-guided Placement of S2 Alar Screws to Adjunct or Salvage Lumbosacral Fixation

Eric W. Nottmeier, Sarah Balseiro, Douglas S. Fenton, Stephen M. Pirris

Introduction: Achieving fusion across the lumbosacral junction can be challenging due to the unfavorable biomechanics associated with ending a fusion at this level (1–3, 8). Iliac screws have been shown to be an effective adjunct to S1 pedicle screws by increasing biomechanical stability (6,7). Disadvantages of iliac screw placement include difficulty in connecting the iliac screws to the lumbosacral construct and painful loosening or prominence (2,4,5,7,8). The authors describe their technique of three-dimensional (3-D) image-guided placement of S2 alar screws to adjunct or salvage lumbosacral fixation.

Methods: Fourteen patients undergoing lumbosacral fusion had 23 S2 alar screws placed using this technique. Indications for placement of S2 alar screws are listed in Table 1. Image guidance in this study was accomplished with the Medtronic Stealth Station Treon used in conjunction with the O-arm. All screws were placed using 3-D image guidance (Fig. 1). The entry point of the screw was typically chosen lateral and superior to the S2 dorsal foramen with the trajectory directed anterior, inferior and lateral (Fig. 2). Attempt was made to place the screw with the tip purchasing the cortical bone that can be found at the anterior, inferior and lateral boundary of the sacral ala (Fig. 3). An independent radiologist graded the placement of the screws on either the intraoperative O-arm scan obtained after instrumentation placement or on thin-cut, postoperative CT scans obtained at follow-up.

Results: No complications occurred in this study as a result of S2 alar screw placement or image guidance. Four screws did penetrate the anterior cortex of the sacrum with no clinical consequence. At the time of abstract submission, 9 patients were able to have follow-up CT scans, all of which were graded as solid fusion at the lumbosacral junction by the grading radiologist.

Conclusion: The placement of S2 alar screws can be accomplished safely with 3-D image guidance. Advantages of this technique include simple placement with easy connectivity to the adjacent construct without having to cross the sacroiliac joint.
373. Reoperation Rates after Microdiscectomy with and without Anular Repair
Lisa L. Guyot, Steven Griffith

**Introduction:** Reoperation after lumbar microdiscectomy occurs at a reported rate of 5–20%. Anular defects are thought to be the primary cause of reherniations and, until recently, repair of the anulus was time-consuming and technically difficult. This retrospective study reviews a single surgeon’s experience using a commercially-available soft tissue closure system to repair the anulus after lumbar discectomy.

**Methods:** A consecutive series of primary lumbar microdiscectomy cases (n=106) over a 12-month period (January to December 2008) was studied. In forty-five patients (n=45), anular repair (AR) using tissue approximation (Xclose™ Tissue Repair System) was performed at the conclusion of the procedure. In the remaining sixty-one cases (n=61), defects in the anulus were left unrepaired. Clinic follow-up averaged 1.3 ± 1 months (range: one week to six months) depending on symptom resolution. Chart review was conducted when all patients were a minimum of six months from their primary surgery. Chart review determined whether repeat surgery was required and whether it was performed at the same level and same side. Secondary analysis compared microdiscectomies performed in the first six months of 2008 (i.e., with consideration of AR) to those in the first six months of 2007 (i.e., no consideration of AR).

**Results:** In cases without anular repair, 6.6% (n=4) required a second discectomy at the same level and side; considering one of these patients required a third surgery (arthrodasis), the reoperation rate was 8.2%. When anular repair was performed, one (2.2%) reoperation was performed, although on the contralateral side at the same level. Six-month year-over-year analysis showed 11.1% (n=8) of discectomies in 2008 needed a second surgery compared to 6.0% (n=4) of discectomies in the first half of 2008, irrespective of whether anular repair was performed.

**Conclusion:** This study demonstrated the effectiveness of repairing the anulus fibrous by reducing the need for repeat surgery after lumbar microdiscectomy by 45 to 65%. Although not all patients are candidates for this procedure based on intraoperative surgeon judgment, consideration of this technique can be beneficial in potentially reducing the risk of reherniation requiring reoperation after lumbar microdiscectomy.

374. Neuro–foraminal Stenosis Causes Radiculopathy in Patients with Severe Adult Degenerative Scoliosis Requiring Operative Intervention
Kai-Ming G. Fu, Justin S. Smith, Prashant Rhagavan, Christopher I. Shaffrey

**Introduction:** Prior literature on radiographic evaluation of adult scoliosis has not identified foraminal stenosis as a significant source of symptoms. These reports evaluated younger adult patients with untreated idiopathic scoliosis. We report on the radiographic findings of a consecutive series of older patients with degenerative scoliosis with symptoms requiring operative intervention.

**Methods:** 37 adults with degenerative scoliosis, without prior corrective surgery, were included. Preoperative evaluation included MRI or CT myelogram, scoliosis radiographs, and completion of the Oswestry Disability Index and Visual Analog Pain Score. From T6–S1, the foraminae were graded by an independent neuroradiologist for stenosis as normal, mild, moderate, or severe. Charts were reviewed for assessment of radiculopathies.

**Results:** Mean patient age was 68 years. Patients had a mean length pain VAS score of 6.4 and mean ODI of 53. At least one level of severe foraminal stenosis was identified in 97%. 82% had maximum foraminal stenosis in the curve concavity. All but 3% of patients reported radicular pain, including 78% with discrete and 19% with indeterminable radiculopathies. Of those with discrete radiculopathies, 76% had pain corresponding to areas of the most severe foraminal stenosis, and 20% had pain corresponding to areas of moderate stenosis.

**Conclusion:** Significant foraminal stenosis was overwhelmingly present in degenerative scoliosis patients seeking surgical treatment. In the vast majority, the distribution of leg pain corresponded to areas of moderate or severe foraminal stenosis. Failure to recognize and address symptomatic foraminal stenosis when surgically treating adult degenerative scoliosis may negatively impact clinical outcomes.

375. Posterior Cervical Fixation following Anterior Resection of C2 Rheumatoid Pannus: A Clinical Outcomes Analysis
Ricky Madhok, Paul A. Gardner, Matthew J. Tormenti, Richard M. Spiro, Adam S. Kanter

**Introduction:** Rheumatoid arthritis is a chronic systemic disease. Atlanto-axial subluxation is a manifestation that occurs in 4–35% [1,2]. Conservative therapy has generally yielded poor results; without surgical intervention most patients will continue to progress to a non-ambulatory bed ridden state [3]. However serious concerns also exist about the risk of surgical intervention in these patients.

**Methods:** Patients with moderate to severe myelopathy with significant rheumatoid retro odontoid pannus disease were selected to undergo an endoscopic trans-nasal anterior decompression followed by posterior cervical fusion. Operative and perioperative data was retrospectively reviewed in regards to morbidity, mortality, operative complications, length of stay and disposition. Long term outcomes included Nurick and NDI outcome measures as well as the need for additional interventions.

**Results:** Nineteen patients were treated for rheumatoid pannus disease of the odontoid. The mean patient age was 74.6 years. No patient suffereded worsening of their preoperative neurologic status with all patients having either improvement or stabilization of their neurologic status postoperatively. NURICK and NDI data was available for 10 patients who had a mean followup of 26.5 months (range 8–60). The mean NURICK score postoperatively was 1.2 and no patient received a score of 5. The mean NDI score was 9.9 (range 0–32). Seven of ten patients had a NDI score of less than 15. Of the remaining nine, five had died at the time of follow-up and four were lost to follow-up. At follow-up, no patient has required revision surgery.

**Conclusion:** An anterior decompression followed by a posterior cervical fusion can be performed with good outcomes and low morbidity. In objective follow-up evaluation, the majority of patients returned to an excellent quality of life with no or minimal disability. Additional follow-up and experience will be required to continue to evaluate this technique.

376. Using Daptomycin for the Treatment of Surgical Site Infections after Spinal Procedures: Preliminary Experience
Nikolaos Syrmos, Mario Ganau, Antonella De Carlo, Giulia Bellisano, Kostantinos Grigoriou, Dimitrios Arvanitakis

**Introduction:** The increasing frequency of Methicillin-resistant Staphylococcus Aureus as a cause of surgical site infections, and the decreased susceptibility to Vancomycin, highlight the need for alternative therapies. Daptomycin is a novel lipopeptide antibiotic, naturally produced by the saprotroph Streptomyces Roseosporus, specifically useful in
multiresistant infections. The aim of this study is to evaluate its safety and efficacy in superficial infections following spinal surgical procedures.

**Methods:** Between 2006 and 2008 a clinical trial with Daptomycin has been conducted, accounting for 34 cases of postsurgical infections. Daptomycin was administered with an e.v. dosage of 4 mg/kg or higher for at least 7 days.

**Results:** Preoperative clinical data showed that in 14 cases infection had occurred despite antibiotic prophylaxis. The most common site of infections were the epidermis or the fascia, while the most common pathogens was S. Aureus. The median dosage of Daptomycin was 5 mg/kg; and the treatment was generally discontinued after 15 days. Daptomycin was well tolerated in all patients with gram-positive infections, whereas salvage therapy with second-line antibiotics was necessary in a patient affected by a Gram-negative bacteremia. No side effects were noticed during the trial.

**Conclusion:** To date a large number of novel antibacterial agents have been developed for the treatment of complicated skin and soft tissue infections, among them Daptomycin seems to be a very promising one. During this preliminary experience it has proved to be particularly effective and well tolerated in patients with gram-positive infections.

According to the literature, we confirm that the chances of success are determined by the following parameters: 1) the severity of the illness, 2) the patient’s co-morbidities, 3) the timely use of appropriate antimicrobial therapy at the onset of clinical signs. It is still debated if there should be a priori a combined or single-agent approach to cover a broad range of likely causative organisms.

**377. Benefits of O-Arm in C1-C2 Surgical Treatment of Instability: Retrospective Study of 22 Cases**

**Duccio Boscherini, Vincenzo De Rosa**

**Introduction:** The interest in the use of C1 lateral mass and C2 screws in the treatment of atlantoaxial instability has increased. Fluoroscopy is commonly used to guide surgeon in posterior cervical axial region. This imaging modality, however, is limited in that it provides only a two-dimensional representation of the C1 - C2 complex, thus rendering accurate and safe screw placement problematic. To correct this shortcoming, we have employed O-Arm, a three-dimensional (3-D) rotational radiographic imaging device linked to work in conjunction with an image-guided surgery (IGS) system.

**Methods:** The study group comprised 12 women and 10 men, with a mean age of 63 years (range 52–87 years). All patients demonstrated clinical and radiographic evidence of C1-C2 instability. The cause of the instability was trauma in 18 patients, rheumatoid arthritis in 2 patients, failed prior anterior surgery in 2 patients. All patients underwent stabilization using IGS system assisted by 3-D intraoperative imaging device. We retrospectively studied 22 adults who underwent posterior stabilization according to Harm and Melcher technique (C1 lateral mass C2 pars intermedia screwing).

**Results:** There were no new or worsening neurologic symptoms reported at a mean 9.6 months follow-up. A mean of 2.8 3-D scans was performed during the procedures. Such an imaging device enabled to verify the correct alignment of bony structures and screws’ ideal depth. Postoperative complications included one surgical site infection. Of 88 screws placed, all were well positioned, 6 had to be re-positioned during surgery according to 3-D imaging information gained. Optimal alignment was achieved in all patients. In 4 cases, C2 screws were implanted in the pedicle because pars intermedia height was limited, navigation and O-Arm coupling proved to be advantageous in such situation.

**Conclusion:** Intraoperative imaging gives the mean to verify during the procedure fracture reduction and alignment, screw optimal position (depth and trajectory) and refreshes imaging-based navigation system. Optimal results in safest conditions can be achieved in C1-C2 screw placement with this technique. This surgical application illustrates the potential and benefits of such technology.

**378. Utilization of Nanoparticles to Assess Biodegradable Polymer Channels for Spinal Cord Injury Repair**

Eve C. Tsai, Harrison Westwick, Xuefen Yang, Arturo Cardenas-Blanco, Matthew Coyle, Benu Sethi, Xudong Cao

**Introduction:** We have previously demonstrated that bioengineered synthetic hydrogel channels can facilitate axon regeneration and functional recovery after spinal cord injury. Unfortunately, these synthetic channels underwent calcification and with prolonged implantation, functional recovery was compromised. To circumvent this adverse reaction, we have developed biodegradable synthetic channels composed of a polymer of poly–lactate–co-glycolate (PLGA) and utilized superparamagnetic iron oxide (SPIO) nanoparticles to label the channel to allow noninvasive assessment of the channel over time.

**Methods:** We assessed biocompatibility in a Sprague Dawley rat spinal cord transaction model and utilized magnetic resonance imaging (MRI) to visualize the channel noninvasively and serially over time. Using a dip coating technique, PLGA channels were constructed by dip coating of PLGA onto a glass rod. The channels were then foamed with supercritical carbon dioxide. The SPIO nanoparticles were incorporated directly into the channel during the dip coating. Adult, female rats then underwent complete spinal cord transection at the eighth thoracic level. The transected stumps were then inserted into either end of the SPIO channel. Controls underwent transaction and channel implantation that did not contain SPIO. The animals underwent a survival period of twelve weeks, and were assessed for mortality, morbidity and functional recovery using the Basso Beattie and Bresnahan (BBB) locomotor scale and weekly MRI imaging.

**Results:** SPIO nanoparticles were found to provide contrast for the biodegradable PLGA channels and to allow visualization of the channel by MRI. There was no increase in morbidity or mortality and there was no statistically significant reduction in BBB locomotor scores with the incorporation of the nanoparticles.

**Conclusion:** Nanoparticle incorporation into biodegradable channels for SCI can allow noninvasive assessment of the location of biomaterial and its effects on the local host tissue through the use of MRI. The use of nanoparticles can help expedite the evaluation of biodegradable biomaterials for spinal cord injury repair.

**379. Preliminary Experience with a Gelatine Fluid Hemostatic Matrix in Non-instrumented Lumbar Spinal Surgery**

Enrico De Micheli, Mario Gana, Massimo Gerosa

**Introduction:** Hemostasis in mini-invasive approaches for vertebral surgery may be difficult for many reasons: bleeding generally occurs from multiple spots such as arterial or venous vessels, from bony structures or epidural plexi; therefore it is often difficult to individualize, reach and successfully control. This case-control study reports our preliminary experience with a fluid bioreabsorbable suine gelatine hemostatic matrix in non-instrumented lumbar spinal surgery.

**Methods:** In 15 patients (mean age 72-year) affected by multi-level lumbar spinal stenosis, 6–10cc of hemostatic matrix...
have been used following surgical decompression by single or multi-level laminectomy or laminotomy. An homogeneous group of 30 patients undergoing similar surgical procedures served as control. Primary end-points were: the length (in minutes) and the quality of hemostasis, the volume of blood loss (calculated as cc into the drainage, and pre- and postoperative ratio of erythrocytes, hematocrit, and platelets counts); whereas secondary end points were: patient satisfaction after surgery (according to VAS, JOA, and Obwegeser scores calculated at a 1-month, 3-month and 1-year follow-up intervals) and absence of radiological matrix-related abnormalities at a 1-year MRI control.

**Results:** Hemostasis was much more rapidly achieved in the fluid hemostatic arm (mean 3 minutes) than in the control group, especially with regard to minimally invasive procedures. However the matrix wasn’t effective in a case of arterial bleeding. Volume of blood loss was slightly less in the case–group, while no significant differences have been noticed concerning the clinical outcome in the two groups. No adverse effects have been observed, and no evidence of radiological changes have been demonstrated even at a long-term follow-up.

**Conclusion:** The use of a fluid hemostatic matrix seems particularly useful when standard surgical/hemostatic techniques are ineffective. Indeed the homogeneous distribution and rapidity of action make this matrix of valuable help especially during minimally invasive procedures such as unilateral laminotomies for unilateral decompression of spinal stenosis.

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**380. Surgical Manifestations of Thoracic Arachnoid Pathology: Case Series and Review of the Literature**

David F. Bauer, Patrick R. Pritchard, Thomas A. Moore, II, Mark N. Hadley

**Introduction:** Thoracic arachnoid pathology manifests as thoracic myelopathy with or without syrinx formation, and may present a significant management dilemma. Treatment and outcome may depend on the length of the pathology. This presentation explores experience with twenty-four patients with both long and short segment thoracic arachnoid pathology. A previous series of thoracic spinal cord herniation has been described (1). This series includes twenty-one additional patients with complex thoracic arachnoid pathology causing symptoms and signs of thoracic spinal cord dysfunction refractory to medical management.

**Methods:** The UAB neurosurgical database was searched to identify patients treated for thoracic arachnoid pathology. A chart review and contemporary follow-up of these patients was carried out, along with a systematic literature review of thoracic arachnoid pathology using the MEDLINE and PubMed databases.

**Results:** There are multiple manifestations of thoracic arachnoid pathology causing thoracic myelopathy, including dural duplication, dural bands, spinal cord herniation, arachnoid adhesions, spinal cord tethering, and arachnoiditis. Etiology of this pathology included trauma, infection, intraspinal hemorrhage, epidural anesthesia, intrathecal contrast injections, and congenital malformations. Surgical management, when indicated, is case specific. In the management of twenty-four patients with a median follow-up of six years, focal, short segment areas (limited to one or two vertebral segments) of tethering, adhesions or cord compression respond well to microsurgical detethering, cyst excision, or fenestration. Long segment multi-level scarring and tethering responds less well to these treatments, and is more likely to result in recurrence, requiring cerebral spinal fluid diversion.

**Conclusion:** Thoracic arachnoid pathology causing thoracic cord dysfunction is varied, has multiple etiologies, and can be difficult to treat long-term. Serial follow-up is essential to document persistent clinical and radiographic success. Initial microsurgical detethering of the spinal cord is reasonable, understanding that there is a high likelihood of subsequent need for a subarachnoid–pleural or syringo–pleural shunt, particularly in patients with long-segment pathology.

**381. Surgical Strategy for Spinal Meningioma**

Tomohiro Murakami, Izumi Koyanagi, Takahisa Kaneko, Alsuhi Okura, Kazuhsa Yoshifugi, Kiyohiro Houkin

**Introduction:** Spinal meningioma is the second most frequent intradural spinal tumors. Typically, spinal meningiomas have broad adhesion to the dura mater. The management of the dural attachment will be important to prevent recurrence of the tumor. In this study we retrospectively analyzed the tumor location and the operative procedures in spinal meningiomas in our institute. The purpose of this study is to determine the surgical management strategies for spinal meningiomas.

**Methods:** This study included 17 meningiomas in 15 consecutive patients (2 males and 13 females) with spinal meningiomas that underwent operation between April 1, 2002, and March 31, 2009. The mean age was 54.3 years (range: 22–83 years). The levels of tumor were cervical in 8 cases, thoracic in 8 cases and thoraco–lumbar in 1 case. Two cases were associated with neurofibromatosis type 2 (NF2).

**Results:** All cases underwent removal of tumor via hemilaminectomy or laminectomy by posterior approach in prone position. Three tumors were located at the intra- and extradural spaces of the upper cervical spine. In two of them, we resected the tumor and also the dorso–lateral hypertrophic dura mater to which the tumor firmly attached, and performed duraplasty using the femoral fascia. In other meningiomas, the tumors were located intradurally, and the attached dura was bipolar–coagulated. Tumors were totally removed in 12 cases. Subtotal resection was performed in 2 cases of NF2 and one case of the intra- and extradural tumor extension. During the follow-up period, there was no recurrence or regrowth of the tumors.

**Conclusion:** Bipolar–coagulation of the attached dura mater is sufficient to prevent recurrence of the intradural spinal meningioma. For meningiomas showing intra- and extradural extension, surgical removal of the hypertrophied dura and duroplasty may be important.

**382. Detailed Radiographic Evaluation of Segmental Settling Characteristics after Treatment with Cervical Anterior Dynamic Plates**

Tobias Pitzen

**Introduction:** Dynamic cervical plates for anterior spine stabilization have been successfully introduced. There is evidence, that rate of implant complications is lower and speed of fusion is higher, however, loss of correction is more pronounced compared to rigid plates. For further improvement of dynamic plating, a detailed radiographic evaluation of settling properties may be helpful. The objective of the current study is to analyze the settling characteristics in patients treated with anterior dynamic cervical plates.

**Methods:** The data analyzed were collected in a multi-center randomized trial. All cases belong to the subgroup of monosegmental dynamic plating. Parts of the study have already been published not including the current results. Radiographic measures were evaluated by an independent radiologist. We investigated the loss of cranial overlap (LCO) during a 6-month follow-up period, defined as the
change of the distance between the cranial end of the plate and the upper endplate of the fixed segment and the following correlations 6-12 months postop: loss of cranial overlap vs. loss of lordosis (LOL), loss of cranial overlap vs. loss of segmental height (LOH). Furthermore, we evaluated the influence of plate slot length on loss of average height and change of screw position (SP) over time. Finally, we checked, if Body Mass Index (BMI) correlates to screw sliding (= change of SP).

**Results:** Mean LCO decreased significantly over time (discharge -0.4mm (p=0.005), 3mo -1.1 mm (p=0.001), 6mo -1.2mm (p=0.019); n=21) and LCO correlated significantly to LOL (r=0.602, p=0.001) as well as to LOH (r=0.388, p=0.028). Plate slot length didn’t influence LOH (p=0.05, T-Test), while SP changed significantly between discharge and 3 months (p<0.01, Linear contrasts, Repeated-Measures ANOVA), but not between 3 and 6 months (p>0.5). BMI correlated significantly to screw sliding after 3 months (r=-0.1, p=0.01) and 6 months (r=-0.56, p<0.01).

**Conclusion:** The detailed analysis of settling characteristics reported illuminates the concept of anterior dynamic plating in the cervical spine. These data can be used to further improve dynamic plate designs and to better adapt their function to human body biology.

384. The Outcome after Interspinous Device: Coflex in Usage for 2-years Follow-up
Dar-Yu David Yang

**Introduction:** The Coflex has been an alternative device to treat symptomatic degenerative lumbar spinal stenosis. However, the effectiveness of the Coflex in symptomatic degenerative lumbar spinal stenosis and aging is not known. To date, limited data are available on complications observed in association with Coflex procedures, and even less information exists on their underlying causes. The aim of this two-year follow-up was to analyze a series of complications occurring at a single institution and their potential causes of implant failure.

**Methods:** 68 patients were treated with Coflex on lumbar spine stenosis and/or with HIVD, 54 patients of single levels and 13 patients of double levels, one of three levels. The mean follow-up duration was 12 months.

**Results:** Six complications were recorded: 1 device dislocations and 2 spinous process fractures, 2 of recurrent HIVD and one of infection. Postoperatively, except above six patients, 2 patients experienced no relief of symptoms. Recurrence of pain still present, and worsening of neurological symptoms was observed in one patient.

**Conclusion:** The Coflex interspinous device showed high failure rate, defined as surgical re-intervention, after short term follow-up in patients with spinal stenosis caused by degenerative spondylosis and HIVD. We do recommend the Coflex for the treatment of simple spinal stenosis with hypertrophy of ligamentum flavum.
Introduction: Spinal intramedullary lipomas are usually associated with spinal dysraphism, of which posterior spinal element defects allow the intramedullary lipoma communicating with subcutaneous lipoma. Nondysraphic intramedullary lipoma was rare, and the presentation, treatment strategies, and clinical courses of this disease were not clear, since it is estimated no more than 100 patients worldwide.

Methods: Our institution has treated two patients with intramedullary lipoma in upper thoracic level in the interval of 20 years, and both have been regularly followed-up with MRI. We retrospectively reviewed serial images of these two patients.

Results: Both patients underwent decompressive laminectomy and partial tumor excision for debulking. Neurological deficits recovered partially after the operation, and the surgical intervention seemed to prevent further neurological deterioration.

Conclusion: Total excision of intramedullary lipoma without damaging to spinal cord seemed unfeasible. Due to its slow-growing nature and our long-term follow-up result, partial tumor excision with decompression surgery is clinically acceptable.

387. Topping-off Using a Dynamic Rod (N-Hance™) in Lumbar Spinal Fusion

Josef Simon, Nicolas Marcotte, Eric John Woodward

Introduction: As posterior lumbar fusion has become more common in treating degenerative lumbar conditions, adjacent segment degeneration (ASD) has been increasingly recognized. Adjacent segment disease is implicated as a significant factor in failed back surgery syndrome (FBSS) with rates as high as 35% - 45% (1,2). Surgical strategies to limit ASD include total disc arthroplasty and pedicle based dynamic instrumentation. These techniques, however, are relatively novel and their ability to alter progression of ASD is not well established. This study reviews patients undergoing lumbar fusion augmented by “topping-off” the adjacent level using the dynamic N-Hance™ rod.

Methods: Prospectively collected clinical data from 100 consecutive lumbar fusion patients were reviewed retrospectively from a single institution comparing the N-Hance™ rod to a control group of rigid rod fixation. The study group underwent single level TLIF augmented by dynamic fixation of the adjacent, cranial level without additional posterolateral fusion. Clinical measures included ODI, VAS, and SF-36 measures, patient satisfaction, radiographic evidence offusion, narcotic use, and complication and revision rates. Follow-up was greater than one year.

Results: Fusion and complication rates were comparable between the two groups. ODI, VAS and SF-36 measures additionally suggested improved clinical outcomes, with overall higher patient reported satisfaction. Fewer revisions for ASD were required on patients with N-Hance™ rods at one year.

Conclusion: Our findings suggest that lumbar fusions supplemented with a topping-off technique using N-Hance™ rods have equivalent fusion and complication rates with higher patient satisfaction, improved clinical outcomes, and a reduction in adjacent segment degeneration when compared to fusions using standard rigid titanium rods.

388. Radiographic Outcomes in Two-level ACDFs: Comparison of PEEK and Allograft Interbody Devices at 1-Year Follow-up

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: In an effort to decrease complications and costs associated with harvesting of iliac crest bone graft (ICBG), demineralized bone matrix (DBM) combined with local bone was employed as a fusion adjunct inside the interbody devices of ACDFs.

Methods: 195 patients underwent instrumented 2-level ACDFs. Patients were assigned to one of two treatments arms that included a composite of DBM plus autogenous endplate reamings, incorporated into allograft bone dowels or PEEK spacers and stabilized with dynamic anterior plating. Fusion was defined as, uninterrupted bridging of well mineralized bone across the interbody space and no significant motion on flexion/extension radiographs. Both operative levels were assessed for fusion using a modified Lenke score. Any pseudarthrosis at either level was considered a failure.

Results: Of 136 patients who presented for 12-month follow-up, 51 were treated with allograft interbody dowels (18M, 33F; age 62.1 yrs; 16 smokers) and 85 were treated with PEEK spacers (32M, 53F; age 56.3 yrs; 22 smokers). Average 12-month Lenke score across all subsets was 1.10 (allograft 1.19; PEEK 1.02). There were no infections, neurologic complications or plate breakages. Only one patient (allograft) developed a clear pseudarthrosis.

Conclusion: The combination of a demineralized bone matrix-local bone composite contained within allograft dowels or PEEK spacers resulted in similar fusion rates (> 97%) at 12-months postoperatively. Based on Lenke scores, allograft dowels appear to fuse more slowly than PEEK spacers but this may be perceptional.

389. Long-term Prospective Multi-Center Clinical Cohort Evaluation of the L5–S1 AxiaLIF® Procedure

Peter C. Gerszten, William D. Tobler, Henry E. Arjan, Christopher P. Ames, W. Daniel Bradley

Introduction: There has been a recent evolution in minimally invasive approaches to lumbar interbody fusions. The purpose of this study was to evaluate the clinical outcomes, fusion rates, and complications of patients undergoing the percutaneous, presacral L5–S1 Axial Lumbar Interbody Fusion (AxiaLIF®) procedure.

Methods: A cohort of 139 patients from 4 centers (53 men, mean age 45 years) who underwent the AxiaLIF procedure were prospectively evaluated. Inclusion criteria included failure of non-surgical therapy for at least 6 months. Preoperative and two-year visual analogue scale for pain (VAS) and Oswestry Disability Index (ODI) were collected and analyzed. Fusion status was determined by dynamic lateral radiographs or multiplanar CT imaging. Complications were tracked from time of surgery through two years of follow-up.

Results: The primary indication for surgery was “pain of discogenic origin” in 97 patients, “spondylolisthesis” in 15 patients, “post-discectomy syndrome” in 15 patients, and “other” in 10 patients. Before surgery for the entire cohort, the mean VAS was 72 mm (range 63–100 mm) and mean ODI was 44% respectively (range 41–46%). The patient cohort at two years demonstrated a reduction in pain VAS by 69% and a reduction in ODI by 48%. Fusion rates by individual surgeon ranged from 78% to 93%. Mean blood loss was less than 50 ml. The most frequent complication was misplaced percutaneous pedicle screws. There were no vascular, neural, urologic, or bowel injuries recorded in this cohort.

Conclusion: This series represents one of the largest long-term follow-up
evaluations to date on the AxiaLIF® procedure. The clinical and radiographic outcomes of patients undergoing LS–S1 interbody fusions using the AxiaLIF® procedure are comparable if not better to those recorded in the literature of more traditional open interbody fusion techniques.

390. The Utility of VEPTR in the Older Child (>10 Years) with Complex Spine and Chest Deformity
John B. Emans, John Smith, Kit M. Song, Amer F. Samdani, Tricia St. Hilaire, Robert M. Campbell, Jr., Randal Betz
Introduction: VEPTR is designed to treat chest and spine deformity in young children. However, older children with complex spinal deformity may also benefit from placement of a VEPTR when vertebral column resection is deemed neurologically too risky. The purpose of this paper is to report the results of children over 10 years of age with complex spinal deformities who were treated with VEPTR.

Methods: From a database of 214 patients treated in an FDA IDE study of VEPTR, 10 patients were identified who underwent surgery after age 10 and had a minimum of two year follow-up. Patients were followed for an average of 39.6 months. Diagnoses included congenital scoliosis with or without fused ribs (n=6), hypoplastic thorax (n=3), and myelomeningocele (n=1). Patient charts were reviewed for clinical and radiographic data.

Results: Four of ten patients had previously undergone a limited spine fusion. The mean age at initial VEPTR surgery was 12.4 years. Immediate Cobb angle correction averaged 26.2%. At two year follow-up, Cobb angle correction averaged 18.6%. Excluding those that were previously fused, correction at 2 years averaged 32%. The average absolute T1 tilt angle demonstrated modest improvement from avg. 17 to avg. 14 degrees. Coronal balance showed an average improvement of 3.8cm. Thoracic height, hemithoracic height, and width all improved (Table 1). One patient (10%) experienced two device related complications, one rib fracture, and one hook migration. No neurologic complications were seen in any patients. Patients underwent an average of 5 lengthenings. Replacement of the device due to growth was required in two patients. Four patients have since undergone definitive spinal fusion.

Conclusion: This study demonstrated the safety and utility of VEPTR in carefully selected older patients (>10 years) with complex spine and chest wall deformities. VEPTR results in modest curve improvement (32% in previously unfused patients), continued growth of thoracic spine height (1.5cm), stabilization of hemithoracic height and width, and improved head shift. Based on our review, VEPTR may be a viable option for these children when VCR is deemed too risky.

392. Cervical Spine Surgery for Degenerative Changes: Are We Meeting Patient Expectations?
Marjorie C. Wang, Ann B. Nattinger
Introduction: Little is known about patient expectations and satisfaction with cervical spine surgery for degenerative changes. Prior studies have suggested that changes in quality-of-life as measured by SF-36 may plateau at 6 months after spine surgery. Our objective was to study patient expectations and satisfaction with this surgery. We hypothesized that most patients would be satisfied with treatment by 6 months after surgery and that myelopathy patients would have lower expectations before surgery than non-myelopathy patients.

Methods: We performed a prospective study of patients undergoing elective cervical spine surgery for degenerative changes at a single academic center, excluding patients with prior cervical spine surgery. Surveys were administered before surgery and 6 months after surgery. Patients received usual clinical care.

Results: 41 patients (aged 26–83 years, 42% male) have completed surveys, of whom 23 have myelopathy. Before surgery, 85% or more patients had extremely high expectations for pain relief, improvement or prevention of numbness, tingling, or weakness, and improvement in physical function. Just over half of patients (58%) felt their quality-of-life would be extremely improved after surgery. At 6 months after surgery, only 34% of patients were extremely satisfied with surgery. 20% to 32% of patients were extremely satisfied with their improvement in pain relief, numbness, tingling, or weakness, physical function, and quality-of-life. Although expectations were similar among non-myelopathy and myelopathy patients, there was a trend for less satisfaction with surgery (p=0.2) and improvement in physical function (p=0.1) among myelopathy patients.

Conclusion: Patient preoperative expectations of cervical spine surgery for degenerative changes are very high, and at 6 months after surgery, the majority of patients are not satisfied with surgery. Future studies should include other centers, measure patient satisfaction over a longer time period, and address patient expectations to improve preoperative counseling and patient satisfaction.
393. Two-level Instrumented ACDF Using Demineralized Bone Matrix and Local Bone: 136 Cases at 1-Year Follow-up

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: In an effort to decrease complications and costs associated with harvesting of iliac crest bone graft, demineralized bone matrix (DBM) combined with local bone was employed as a fusion adjunct in 2-level ACDF procedures.

Methods: 195 patients underwent instrumented 2-level anterior cervical disectomy and fusion procedures. Patients were assigned to one of two treatments arms that included a composite of DBM plus autogenous endplate reamings, incorporated into allograft bone dowels or PEEK spacers. Fusion was defined as definitive, uninterrupted bridging of mineralized bone across the interbody space and no significant motion on flexion–extension radiographs. Both operative levels were assessed for fusion using a modified Lenke score. Any pseudarthrosis at either level was considered a failure.

Results: 136 patients, 55 male and 81 female, with average age of 53.9 years (range 31–81 years) presented for 12-month follow-up. Average 12-month Lenke score was 1.08. There were no infections, neurologic complications or plate breakages. One 59-year-old diabetic male smoker had a pseudarthrosis at the time of 6-month follow-up.

Conclusion: The combination of a DBM–local bone composite contained within allograft dowels or PEEK spacers and dynamic cervical plating resulted in fusion in 135/136 patients at 12 months postoperatively. This combination achieved fusion results comparable to earlier literature reports for autograft or instrumented allograft dowels without the incumbent expense and documented complications of BMP.

394. Spinal Hydatid Disease with Paraplegia

Sushila Jaiswal, Awadhesh K. Jaiswal, Arun K. Srivastava, Rabi Sahu, Sanjay Behari

Introduction: Hydatid disease also called cystic echinococcosis (CE) in man is caused by tapeworm cestode, Echinococcus Granulosus. The disease affects liver and lung in 80–90% of cases. Bone involvement is less common accounts for 0.4 – 5% of reported cases. Primary spinal hydatid cysts are extremely rare and accounts for about 1% of all cases of hydatid disease. The authors report a histopathologically confirmed primary spinal hydatid disease in a 21-year-old lady presenting with paraplegia.

Methods: The data and information presented were derived from a review of patient medical records and radiographic and histological studies, as well as a review of the relevant medical literature.

Results: A 21-year-old female presented to neurosurgery clinic with the complaints of back ache for 1 month and rapidly progressive weakness of both lower limbs for 2 weeks and was paraplegic with sphincteric involvement for 5 days prior to admission. Neurological examination revealed spastic paraplegia with hypoesthesia below D12 dermatome. MRI of dorsal spine revealed multiple extradural heterogeneous cystic lesions with severe spinal cord compression at the D10 level. His ultrasonographic examination of the abdominal and pelvic organs did not demonstrate any disease. Laminectomy was performed at D9–D11 levels. Intraoperatively, numerous extradural cystic lesions were encountered compressing the spinal cord. They had translucent walls and clear fluid content typical of hydatid cysts and had destroyed the posterior elements of the D–10 vertebra. All the cysts were removed from adjacent extradural spaces. Histopathological examination showed the cyst wall having outer acellular laminated layer and inner germinal layer characteristic of a hydatid cyst. Following surgery, the bilateral lower limb weakness improved significantly and she was discharged with instructions to continue a regimen of anthelmintic treatment consisting of albendazole. At follow up of 12 month, she was symptom free.

Conclusion: Spinal hydatid disease is an uncommon disease and produces features of cord compression. MRI features are characteristic and surgical excision is the mainstay of treatment and it should follow anthelmintic drugs to avoid recurrence.

395. Comparing the Rate of Two Fusion of Intervertebral Constructs in Two–level PLIFs Using a Commercially Available DBM

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: In an effort to decrease complications and costs associated with harvesting of iliac bone graft (ICBG), demineralized bone matrix (DBM) combined with bone marrow aspirate (BMA) and locally harvested bone (LB) was employed as a fusion composite in 2-level instrumented posterior lumbar interbody fusions (PLIF).

Methods: 109 patients underwent 2-level instrumented PLIFs. Patients were assigned to one of two treatment arms that included a composite of DBM + BMA + LB that was placed in the aperture of polyethylene ether ketone (PEEK) spacers (n=56) or the medullary canal of machined fibular allograft wedges (n=45) prior to being implanted in the interbody space. Anteroposterior and lateral flexion/extension radiographs were evaluated utilizing a modified Lenke scoring. Fusion was defined as uninterrupted bridging bone across the interbody space without motion on the flexion/extension radiographs.

Results: 106 of 109 patients, with average age of 56.9 years (range from 32 to 85 years) at 12 months. 98.1% of PEEK patients and 86.9% of allograft patients were considered fused. Noted complications include: infection (n=3), wound disruption (n=2), pneumonia (n=1), pulmonary embolus (n=1), and dural tear (n=1); 6 reoperations were performed for adjacent segment degeneration.

Conclusion: The results indicate excellent 12–month fusion rates in both cohorts. We believe that it is easier to assess PEEK graft incorporation, which might account for the different fusion rates between the two groups.

396. DBM Use in 2-level PLIFS: Fusion Comparison of Smokers and Non-smokers

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

Introduction: This study compares the rate of fusion between smokers and non-smokers, using a commercially available demineralized bone matrix (DBM) coupled with bone marrow aspirate and local bone in 2-level posterolateral interbody fusion (PLIF) procedures.

Methods: 109 instrumented, 2-level PLIF procedures were performed by a single surgeon using a graft composite were prepared from ground lamellar bone, supplemented with DBM and posterior iliac crest bone marrow aspirate (BMA). The composite was placed in the aperture of PEEK or machined allograft spacers (to achieve interbody fusion) and along the intertransverse membrane (to achieve posterolateral fusion). Anteroposterior and lateral flexion and extension radiographs, obtained at three-, six-, and twelve–months, were evaluated utilizing Lenke’s criteria for intertransverse fusion and modified Lenke criteria of interbody fusion. Global fusion was defined as either:
Lenke or modified Lenke score of 1; or Lenke score 2×modified Lenke score 2. **Results:** 46 smokers and 60 non-smokers, ranging in age from 33–85 years (average age = 57.42 years) presented for 12-month follow-up. Intertransverse/interbody scores for smokers = 1.84/1.77 and for non-smokers = 1.63/1.25. Similar complication rates were observed in both groups; 8 reoperations were performed for adjacent segment disease. **Conclusion:** Smoking is often identified as a contributing factor to increased pseudarthrosis (non-union) rates in spinal fusion surgeries. The fusion rate for smokers and non-smokers was 94.7% and 92.4%, respectively and failed to show a significant difference between the two groups. Slightly better (intertransverse) Lenke scores were noted in the nonsmokers.

**397. A DBM, BMA, Local Bone Graft Composite in Multi-level PLIF: Fusion Rates**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

**Introduction:** This study determines the viability of a graft composite composed of demineralized bone matrix (DBM) coupled with bone marrow aspirate (BMA) and local bone (LB) in 2-level posterolateral interbody fusion (PLIF) procedures. **Methods:** 109 instrumented, 2-level PLIF procedures were performed by a single surgeon using a graft composite prepared from ground lamellar bone, supplemented with DBM and posterior iliac crest bone marrow aspirate (BMA). The composite was placed in the aperture of PEEK or machined allograft spacers (to achieve interbody fusion) and along the intertransverse membrane (to achieve posterolateral fusion). Anteroposterior and lateral flexion and extension radiographs, obtained at three–six–, and twelve–months, were evaluated utilizing Lenke’s criteria for intertransverse fusion and modified Lenke criteria of interbody fusion. Global fusion was defined as either: Lenke or modified Lenke score of 1; or Lenke score 2×modified Lenke score 2. **Results:** 106 patients were evaluated at 12 months. Intertransverse (Lenke) scores = 1.89 and interbody (modified Lenke) scores = 1.19. Complications included: infections (n=3), wound disruption (n=2), pneumonia (n=1), pulmonary embolus (n=1), dural tear (n=1); 6 re–operations were performed for adjacent segment disease. 97 patients were judged to be fused; there were 2 nonunions. **Conclusion:** The DBM–local bone–BMA achieved fusion in 97/106 2-level PLIFs at 12 months postoperatively. This combination achieved fusion results comparable to earlier literature reports for autograft without the incumbent expense and documented complications of BMP.

**398. Fusion Results Using DBM and BMA in Extreme Lateral Interbody Fusion (XLIF)**

W.B. Rodgers, Edward J. Gerber, Jamie R. Patterson

**Introduction:** The XLIF approach is a less disruptive alternative in lumbar fusion procedures. Fusion rates using various grafting alternatives have not been reported. **Methods:** 89 patients underwent XLIF using a graft composite composed of demineralized bone matrix (DBM), iliac crest bone marrow aspirate (BMA), allograft chips, and local bone harvested from the central vertebral body. Fusion was defined as definitive, uninterrupted bridging of mineralized bone across the interbody space and no significant motion on flexion/extension radiographs. **Results:** 59 pts (26M: 33F; Avg 61.8 yrs; Avg BMI 30.7; 69 LV/LV; 16 L2/LV; 13 LV/L; LOS 1.5 days; 0 infections) were available for follow-up 12 months after surgery. VAS pain scores improved from 8.5 to 1.19. Disk height improved from 5.9 preop to 10.4mm postoperatively and was 9.0 mm at 12 months. Llisthesia (35 pts) improved from 4.2mm preop to 0.8mm at 12 months. Modified Lenke scores were 2.2 (3 mos), 1.2 (6 mos), 1.1 (12 mos). No patient had a pseudarthrosis by motion criteria and none has been re–explored. **Conclusion:** The combination of a DBM–BMA–allograft–local bone composite contained within PEEK spacers 59/59 patients at 12 months postoperatively. Little has been reported about fusion rates in MIS procedures but this combination achieved fusion results comparable to earlier literature reports for Autograft or BMP in posterior or anterior lumbar fusions without the incumbent expense and documented complications.
aim of this study was to analyze the safety and efficacy of the Coflex™ compared with simple decompressive surgery in central lumbar stenosis.

Methods: Between September 2006 and June 2008, 114 patients were treated, 50 in the control group and 64 in the Coflex™. The mean follow-up duration was 18.6 vs. 19.8 months. They were clinically evaluated at the preoperative, 1 month, 3 month, 6 month, 1-year and 2-year stage with plain X-rays and clinical questionnaires (Visual Analogue Scale score for low back pain and leg pain, Oswestry Disability Index).

Results: By 24 months, most of the patients reported clinically significant improvement in their symptoms in both group. Five complications were recorded in Coflex™ group: 2 surgical site infections, 1 device dislocation and 2 spinal process (SP) fractures. 6 patients underwent reoperations (PLIF) due to unresolved symptoms or recurrences.

Conclusion: The results of this prospective study indicate that the Coflex™ offers considerable clinical improvement and decrease a rate of reoperation due to unresolved stenosis symptoms compared with the simple decompressive procedure. Also the Coflex™ was as safe as simple decompression.

401. Combination with Anterior Cervical Fusion and Arthroplasty in the Management of Multi-level Cervical Disease: Combined Surgery and Technical Tip
Kyoung Suok Cho, Sang-Bok Lee, Pil-Woo Huh, Do-Sung Yoo, Seok-Gu Kang, Chun-Kun Park
Introduction: Multi-level cervical anterior interbody fusion is widely accepted as leading to a reduction in normal cervical spine motion and increasing the stress at adjacent levels. Concerns regarding stress at levels adjacent to fusion and possible adjacent-level degeneration as well as a desire to maintain a more normal biomechanical environment have led to investigation of cervical disc replacement as an alternative to fusion procedures. The authors retrospectively evaluated the safety and efficacy of a combination of cervical fusion and arthroplasty in the treatment of patients with multi-level cervical disease and introduce technical tip to keep the lordotic curve during the operation.

Methods: The authors retrospectively reviewed outcomes in 38 patients with multi-level cervical disease in whom combined surgery (Bryan® disc or Prodisc® and Zephir® plate) was performed from 2005 to 2009. At same period, we performed 56 cases of Bryan® disc and 95 cases of Prodisc-C® cervical arthroplasty for cervical disease. One-level fusion and adjacent one-level arthroplasty were conducted in 32 patients, and two-level fusion and one-level arthroplasty were performed in 6 patients. During the surgery, rolled tourniquet was placed behind all the patients’ shoulders. For the arthroplasty, deflated the tourniquet to keep the patients’ neck neutral position and inflated the tourniquet to make the patients’ neck extension to keep the lordosis for the fusion operation.

Results: At the end of the follow-up period (mean 18 months), preoperative symptoms improved in all the patients who underwent combined surgery. All the patients had no significant changes in lordosis at the treated levels or in the overall curvature on radiographically. There is no hardware related complication except 4 cases of fibular bone settling.

Conclusion: The authors found the combined surgery to be safe and efficient for anterior decompression in patients with multi-level cervical disease and this technique is easy to perform and keep the lordotic curve during the operation. This technique is a practical option in combined operations for multi-level cervical disease.

402. Tandem Cervical or Thoracic Stenosis Associated with Lumbar Stenosis: A Clinical Review
Rakesh Kumar
Introduction: Lumbar stenosis may be associated with cervical and/or thoracic stenosis and remains undiagnosed, especially when the presenting problem is low back pain.

Methods: Records of 58 patients presenting over 10 years with low back pain but who had cervical or thoracic stenosis were analyzed. Their median age was 58 years. They were myelopathic. Further workup led to cervical stenosis or thoracic stenosis as the primary pathology. Intraoperative electromyography (EMG) is coming into favor as a tool to detect and avoid neurologic complications of pedicle screw placement. Previous studies have employed computed tomography (CT) postoperatively to detect screw position in patients where EMG was employed. However, no study to date has compared CT scans in patients with and without EMG assistance in the placement of pedicle screws. Our center has recently started using surgeon-directed EMG regularly for pedicle screw placement. We routinely perform CT scans postoperatively, providing an opportunity to compare pedicle screw placement in consecutive cases before and after the implementation of EMG in our institution.

Methods: Surgeons’ records were scrutinized for cases of lumbar pedicle instrumentation between January 2006 and present. Images were assessed independently by a senior radiology resident and senior neurosurgery resident. Pedicle breaches were graded as in or out. Screws were further graded by degree of breach: A (in), B (>1.1mm), C (2.1mm–4.0mm), D (>4mm). Surgical time was taken from the anesthesiologist’s chart. EMG was performed preoperatively.

Results: In this initial analysis, we evaluated 182 pedicle screws (85 in the EMG group and 97 in the non-EMG group). There was no statistically significant effect of EMG on pedicle screw position. The EMG group had a trend toward better neurological outcomes (p=0.054). There was a trend toward longer surgical time in the EMG group (difference of 10 minutes, p=0.108).

Conclusion: The present study suggests
that surgeon-directed intraoperative EMG does not affect pedicle screw position. Monitoring of neural integrity may reduce poor outcomes at the expense of longer surgical times. Further study is required.

**404. Analysis of Missed or Delayed Diagnosis of Cervical Spine Fractures Associated with Head Injury**
Masahiko Akiyama, Shigehiro Nakahara, Hiroyasu Nagashima, Satoshi Tani, Toshiaki Abe

*Introduction:* Cervical spine (c-spine) fractures are not uncommon, occurring in 2 to 6% of blunt trauma patients. Unlike North America, neurosurgeons are mainly involved in screening trauma patients associated with head injury in Japan. However, most of neurosurgeons in Japan are not well trained to screen trauma patients, tend to underestimate the frequency and significance of c-spine fractures. Missed or delayed diagnosis of c-spine injuries has been reported as a frequency of 5 to 20% in North America, but it could be much higher in Japan.

*Methods:* Fourteen patients, whose c-spine fractures were once missed or delayed diagnosis, were retrospectively analyzed.

*Results:* During November 2007 and September 2009, we had 39 c-spine injury patients in 22 months. There were 14 (36%) missed or delayed diagnosis of c-spine injury patients, who were 12 men and 2 women, from 45 to 85 years old (average 61.4). Trauma mechanism was due to 3 motor vehicle accidents and 11 falls, only 3 patients (21%) were defined as “high energy trauma”. 7 patients (50%) were under influence of alcohol. Injury levels were as following: C2: 3 patients, C3–C6: 9 patients, cervico-thoracic junction 2 patients. All patients complained neck pain, however, only 2 patients were shown neuroradiologically positive findings. Six patients were required surgical fixation, 1 patient needed halo vest fixation, 3 patients were treated with hard collar, 2 patients with soft collar, and 2 patients without collar. Causes of missed or delayed diagnosis of c-spine injury were inadequate sets of imaging in 9 cases, inadequate image reading in 5 cases.

*Conclusion:* Radiographic assessment is essential to screen trauma patients, who do not meet following all criteria: 1 awake, alert, and not intoxicated, 2 without neck pain or tenderness, 3 do not have significant associated injuries that detract from their general evaluation.

**405. Adjacent Segment Disease after Anterior Cervical Interbody Fusion Requiring Second Operation**
Kyoung Suok Cho, Sang-Bok Lee, Pil-Woo Huh, Do-Sung Yoo, Seok-Gu Kang, Chun-Kun Park

*Introduction:* Anterior cervical discectomy and corpectomy for the treatment of cervical spondylosis and cervical disc herniation enjoy favorable rates of fusion and successful clinical outcomes. However, postoperative degenerative changes at adjacent discs may lead to the development of new radiculopathy or myelopathy. In the previous reports, the incidence of symptomatic adjacent segment disease has ranged from 7% to 25%. The present study was undertaken to investigate the incidence of symptomatic adjacent segment disease after anterior cervical interbody fusion (ACIF) and to describe our surgical method for those patients.

*Methods:* Between 1999 and 2005, a total of 165 patients underwent anterior cervical interbody fusion for intervertebral disc herniation and cervical spondylosis. A total of 115 of these patients could be followed up clinically and radiologically for more than 2 years (follow-up rate, 82%). Of these, 77 were men and 38 were women and the average age at operation was 51 years (range, 26 to 75 years). The average length of follow-up was 5.8 years (range, 2 to 9 years). The diagnosis of symptomatic adjacent segment disease was based on the presence of new radiculopathy or myelopathy symptoms referable to an adjacent level, and the presence of a compressive lesion at an adjacent level by magnetic resonance imaging.

*Results:* Symptomatic adjacent segment disease developed in 10 of 115 patients (8.7%) followed. We performed fusion extension three, fusion plus total disc replacement (TDR) one and only TDR six patients. All patients were improved after surgery without any complication except one transient hoarseness.

*Conclusion:* The cervical arthroplasty is a reasonable treatment option for patients who have had previous surgery in which interbody fusion has been performed and who have developed degeneration of adjacent levels.

**406. Long-term Back Pain after Single Level Discectomy for Radiculopathy: Incidence and Healthcare Cost Analysis**
Scott Parker, Matthew J. McGirt, Risheng Xu, Timothy F. Witham, Ziya L. Gokaslan, Ali Bydon

*Introduction:* The most common spinal procedure performed in the United States is lumbar discectomy for disc herniation. Long-term disc degeneration and disc height loss occur in many patients after lumbar discectomy. The incidence of mechanical back pain following discectomy varies widely in the literature and its associated healthcare costs are currently unknown. We set out to identify the incidence and healthcare cost of mechanical back pain attributed to segmental degeneration or instability at the level of prior discectomy at our institution.

*Methods:* We retrospectively reviewed 111 patients undergoing primary single-level lumbar hemilaminotomy and discectomy for radiculopathy at a single institution, Table 1. The incidence of mechanical back pain attributed to segmental degeneration or instability at the level of prior discectomy was assessed. All diagnostic modalities, conservative therapies, and operative treatments utilized for the management of post-discectomy back pain were recorded. Institutional billing and accounting records were reviewed to determine the billing costs of all diagnostic and therapeutic measures.

*Results:* At a mean follow-up of 37.3 months after primary discectomy, 75 (68%) patients experienced minimal to no back pain, 26 (23%) experienced moderate back pain requiring conservative treatment only, and 10 (9%) experienced severe back pain that required a subsequent fusion surgery at the site of the primary discectomy, Table 2. The mean cost per patient of conservative treatment alone was $4,696. The mean cost per patient of operative treatment was $42,554, Table 3. The estimated cost of treatment of mechanical back pain associated with postoperative same-level degeneration or instability was $493,383 per 100 cases of first-time, single-level lumbar discectomy $493,34 per primary discectomy.

*Conclusion:* Postoperative mechanical back pain associated with same-level degeneration is not uncommon in patients undergoing single level lumbar discectomy and is associated with substantial healthcare costs.

**407. Comparison of Contoured Loop with Sublaminar Wire and Occipito-C1-C2 Pedicle Screws in Craniovertebral Vertebral Junction Lesion**
Kyoung Suok Cho, Sang-Bok Lee, Pil-Woo Huh, Do-Sung Yoo, Seok-Gu Kang, Chun-Kun Park

*Introduction:* Craniovertebral junction

Introduction: Complications reported with the off-label use of recombinant human bone morphogenetic protein-2 (rhBMP-2) in anterior cervical fusion procedures include dysphagia, swelling and hematoma. (1-3, 6, 7) Reports in the literature describing the use of INFUSE in posterior cervical fusion procedures are sparse and consist of case reports. (4,5) The authors present the fusion and complication rate in 63 patients undergoing instrumented posterior cervical fusion using INFUSE.

Methods: The medical records of 63 consecutive patients undergoing instrumented posterior cervical fusion using INFUSE were retrospectively reviewed. The method of INFUSE delivery to the cervical levels was similar in most patients. After the interarticular portion of the facet joint was decorticated, a small piece of an absorbable collagen sponge (ACS) soaked with INFUSE was placed in this area. The estimated dose of INFUSE delivered to each facet joint was 0.2mg. Morcellized allograft or local autograft was then mixed with demineralized bone matrix in a 3cc/1cc ratio and placed over the ACS. A total of 256 cervical levels (C1-T1) were treated. An independent radiologist graded fusion on postoperative, thin-cut computed tomographic (CT) scans obtained at 3–12 month follow-up (Fig 1).

Results: Clinical improvement was noted in 18 cases (81.8%) in Group I and 13 cases (81.3%) in Group II. Twenty nine patients (90.6%) had a stable postoperative occipitocervical construct was noted in 16/18 (72.2%) in Group I and 16/16 (100%) in Group II. No patient developed evidence of new, recurrent, or progressive basilar invagination or complication except one vertebral artery injury in Group II.

Conclusion: The clinical outcome in both groups was favorable, but solid bone fusion was noted in occipito-C1-C2 pedicle screw group. Serious vertebral artery injury complication can occur in occipito-C1-C2 pedicle screw group. An important technique for treating select upper cervical traumatic injuries and it is also useful in the surgical management of spondylosis. The literature concerning anterior instrumentation of the axis for degenerative disease is sparse (largest series = 4 patients). This report details the technique and outcomes of C2 anterior plate fixation for a series of patients the majority of which presented with symptomatic degenerative spondylosis.

Methods: 46 consecutive patients underwent single or multi-level fusions over a seven-year period; 30 had advanced degenerative disease manifested by myelopathy and/or deformity. Exposure was achieved with rostral extension of the standard anterior cervical exposure via careful soft tissue dissection, mobilization of the superior thyroid artery and the use of a table-mounted retractor. Removal of the submandibular gland, section of the digastric muscle or additional skin incisions were not needed.

Results: Screws were placed an average of 4.6 mm (+/- 2.3 mm) from the inferior C2 endplate with a mean sagittal trajectory of 15.7° (+/ - 7.6 degrees). Short- and long-term procedure-related mortality was 4.4% and perioperative morbidity of 15.7° (+/- 7.6 degrees). Short- and long-term procedure-related mortality was 4.4% and perioperative morbidity.
was 8.9%. Patients remained intubated an average of 2.5 days following surgery. Dysphagia was initially reported by 15.2% patients but resolved by the 8th postoperative week in all patients. Arthrodesis was achieved in all patients available for long-term follow-up. Multi-level fusions were not associated with longer hospitalization or morbidity. **Conclusion:** Anterior plate fixation of the axis for degenerative disease can be accomplished with acceptable morbidity employing an extension of the standard anterolateral route.

**411. Spine Surgery in Patients Over 100**
Peter L. Mayer

**Introduction:** Rarely patients over 100 years of age can benefit from spine surgery. We report three cases.

**Methods:** Case Report.

**Results:** Case 1 was a patient aged 102 years who was living independently. She presented with cervical myelopathy due to a large extradural tumor. Surgery was performed and the patient did well for two more years. Of note the tumor was a chordoma, presumably indicating a congenital etiology. Cases 2 and 3 were patients aged 100 and 101 years who presented with painful osteoporotic compression fractures. Both underwent kyphoplasties and did well. Patient 3 presented at 104 years of age with another painful compression fracture and underwent a second successful kyphoplasty.

**Conclusion:** It is occasionally appropriate to perform surgery on patients over 100 years of age. Surgery is possible as at any other age, and results are good. This is the first presentation of neurosurgery on centenarians.

**412. Kyphoplasty-Augmented, Short-Segment Pedicle Screw Fixation for the Management of Thoracolumbar Burst Fractures**
Donald John Blaskiewicz, Mohamed Mudathir Abdulhamid, Igor Richard Yusupov, Walter P. Jacobsen, Ross R. Moquin

**Introduction:** Short-segment pedicle screw fixation is a popular means for stabilizing burst fractures of the thoracolumbar spine; however, this construct has been shown to have high rates of failure secondary to anterior- and middle-column insufficiencies. Vertebral body augmentation with transpedicular vertebroplasty or kyphoplasty has been shown to provide mechanical support of the anterior and middle columns.

**413. Massive Spinal Charcot Disease Presenting as Increasing Abdominal Girth and Discomfort: Case Report**
Frank S. Bishop, Meic H. Schmidt

**Introduction:** Charcot disease of the spine, or spinal neuropathic arthropathy, is a destructive degenerative process involving the vertebral bodies and surrounding discs. It results from repetitive microtrauma in patients who have decreased joint protective mechanisms from loss of deep pain and proprioceptive sensation, typically because of spinal cord injury or sensory neuropathies. We report a case of massive spinal Charcot disease presenting with increasing abdominal girth and discomfort.

**Methods:** This 33-year-old man suffered a complete spinal cord injury in a 25-foot fall. He had a severe T10 fracture dislocation (Fig. 1A) and underwent T8–T12 posterior spinal fusion followed by thoracotomy for T10 corpectomy and anterior column reconstruction with interbody cage placement (Fig. 1B). He presented five years postoperatively with increasing abdominal girth and discomfort. Lumbar spine computed tomography (CT) demonstrated severe spinal breakdown with an associated fluid collection from T12 to L3 (Fig. 2) consistent with Charcot disease of the spine.

**Results:** The patient underwent a three-staged procedure for spinal stabilization and reconstruction. The first surgery entailed open debridement and exploration, with aspiration of the cyst contents and removal of free-floating bone fragments. The second procedure involved a T4–ileum posterolateral spinal fusion (Fig. 3A). The third operation entailed a retroperitoneal approach for L1–L3 corpectomy and anterior reconstruction with an expandable titanium interbody cage and anterolateral instrumentation with plating (Fig. 3B). The patient did well after his staged procedures, with resolution of his abdominal complaints. At his 6-month follow-up appointment, the patient continued to do well without progressive deformity or pseudoarthrosis.

**Conclusion:** Spinal Charcot disease typically presents with progressive kyphotic deformity and audible noises with postural changes. This patient presented with unique complaints of abdominal discomfort and increasing girth from massive bony destruction and cyst formation causing intra-abdominal compression. The patient’s symptoms resolved with spinal decompression, realignment, and restabilization.

**414. Discogenic Cauda Equina Syndrome**
Igor Jan Sulla

**Introduction:** Discogenic cauda equina syndrome (Ces-d) is an infrequent but potentially catastrophic complication of lumbar disc disease. With an aim to analyze possible negative factors influencing outcome in patients with Ces-d a clinical study was undertaken.

**Methods:** In a group of 158 patients (57 females, 101 males) operated on for Ces-d during the period of time from January 1, 1982 to December 31, 2007, who responded personally or by filling a questionnaire minimally one year
Introduction: Lumbar spinal stenosis is a very common pathology of elderly population. Neurogenic intermittent claudication represents the major complaint of these patients. Aperius™ interspinous implant represents a good treatment option because allow improvements in ambulatory ability using a minimally invasive technique.

Methods: We performed Aperius™ implantation in 400 patients from April 2007 to August 2009. The average age of our patient population was 68 years old. Symptoms severity, physical functioning, quality of life and pain were assessed using the Zurich Claudication Questionnaire (ZCQ) and the Visual Analogic Scale (VAS). We performed the surgical approach under local or spinal anesthesia whenever was applicable. A one level implant was performed in 73% of patients; a two levels implant in 26% and a three–level implant in 1%. The most commonly treated level was L4–L5 (49%), followed by L3–L4 (37%), L2–L3 (9%) and L5–S1 (5%).

Results: Mean pain VAS score improved significantly from 8.4 at baseline to a value of 4.13 at 2–months follow–up. The ZCQ score for patient satisfaction showed that 81% of the patients being satisfied after the procedure. Most significant improvements were seen in ambulatory ability and self–care. In all cases was possible early mobilization of patients (2 hours after surgery). Symptoms relief was detectable early.

Conclusion: Clinical early results are good and promising. Relief of neurogenic intermittent claudication is satisfactory in a relevant percentage of patient. Surgical technique is easy and without significant intra and postoperative risks. We advocate Aperius™ interspinous implant as a good option in the treatment of lumbar spinal stenosis especially in a elderly patient population.

4.16. Treatment of C1–2 Subluxation Posterior Transarticular Screw Fixation: Preoperative Planning with Virtual Puncture

Ying–Chih Chen, Fon–Yih Tsuang, Yong–Kwang Tu, Darming Denning Lai

Introduction: To report the preoperative planning strategy and the clinical results for the treatment of atlantoaxial dislocation with posterior transarticular screw fixation

Methods: From June 2002 to March 2009, 38 patients with atlantoaxial dislocation were operated in our department. Beside preoperative magnetic resonance images, preoperative and postoperative CT scans with 3–D reconstruction were performed and evaluated with a virtual surgery software to evaluate the screw trajectory, screw length and positions. Six patients received anterior decompression followed by posterior transarticular screw fixation, and 27 received posterior transarticular screw fixation alone. For those unsuitable for transarticular screw fixation, wiring or screw/rod fixations were performed.

Results: In our transarticular screw fixation cases, clinical symptoms improved in 32 of our 33 patients, and were stable in 1 patient. There was no vertebral artery injury in our series, and all patients showed fusion on the follow–up images.

Conclusion: For posterior atlantoaxial stabilization, volumetric CT can be used in precision demanding surgery like transarticular screw fixation. In the pre–surgical planning, screw entry points, medio–lateral angles as well as upward trajectories vary greatly; therefore, a standard surgical technique is not suitable for most patients.

4.17. Clinical (Expanded Off Label) Indications and Results of Cervical Arthroplasty Using PRODISC–C

Narayan Sundaresan, Robert Holtzman, Lauren F. Schwartz, Joey Torres–Gluck

Introduction: Currently, FDA approval for cervical arthroplasty is limited to single level radiculopathy between C3–C7 for two devices currently on the market: Prodisc–C and Prestige. Clinical experience both in Europe and in the US suggest a wider evolving range of clinical indications for PRODISC–C– these include multi–level disease, adjacent segment disease, myelopathy, as well as hybrid constructs. We present our clinical experience with the expanded clinical indications and results of PRODISC–C.

Methods: We reviewed the indications, clinical parameters, technical factors, and outcome of 42 consecutive patients undergoing cervical disc replacement with PRODISC–C over an 18 month period. Technical factors related to surgery, clinical and neurological factors pre– and postoperatively, complications, and radiographic studies were evaluated from an ongoing data base. Besides the FDA approved criteria, clinical indications included: multi–level disease, adjacent segment disease, myelopathy, and hybrid constructs.

Results: There were 24 females and 18 males with ages ranging from 18–62 years. Indications for surgery included single level disease (10 pts), multi–level disease (18 pts), adjacent segment disease (8 pts), myelopathy (2 pts), and hybrid constructs (4 pts). Neurological outcome and pain relief were excellent in all single level and multi–level patients, as well as those with myelopathy; however, the outcome was less satisfactory in patients with adjacent segment disease. Perioperative complications included one endplate fracture from the keel in a multi–level placement, and an additional revision in a hybrid construct for incomplete resolution of myelopathy.

Conclusion: Our clinical results suggest an expanded role for cervical disc replacement, since the majority of clinical indications (75%) in our series were for off label uses. In expanding the clinical indications, a longer learning curve related to technical factors, as well as less than optimal result in some cases may be expected. The medico–legal aspects of off label uses of Prodisc–C will be discussed, as well as technical factors we have learnt to optimize results.
**418. Angulation Changes in Anterior Cervical Fusion with Allograft vs. Carbon Fiber Cage**
Fangxiang Chen, Kelly B. Mahaney, Muhittin Belirgen, Jennifer Noeller, Patrick W. Hitchon

**Introduction:** In recent years, PEEK (polyetheretherketone) cages for anterior cervical discectomy and fusion (ACDF) have become an alternative option to the traditional methods of allograft and autograft. The authors sought to determine rates of subsidence in ACDF utilizing PEEK cages or allograft. The purpose of this study is to establish whether a difference in rates of subsidence can be detected radiographically.

**Methods:** A retrospective review was undertaken of recent cases of ACDF with PEEK cages or allograft. Twenty-two cases of ACDF with PEEK were compared with 15 cases using allograft. X-rays and physical and mental component summary scores (SF-36 summary health score) at 6 months follow-up (range from 4 to 7 months) were compared with X-rays obtained at the time of surgery to determine change in lordotic angulation.

**Results:** The patients with PEEK demonstrated an average kyphotic angle of 2.5º (per level fused) at time of surgery and 2.08º at six months. The patients in the allograft group had an average angle of 0º at time of surgery and kyphotic angle of 4.0º at six months. There was a significant increase in kyphotic angle in the allograft group over time (p = 0.014, two-factor repeated measures ANOVA). While there was also a significant difference in kyphotic angle change over six months between the two groups (p = 0.03), SF-36 health score revealed no difference in physical function, health limitation, emotional limitation, energy, social function or general health. There was no significant change in angulation in the PEEK group over the 6 months.

**Conclusion:** There was a difference in average kyphotic angulation change over 6 months between the allograft and PEEK groups, and within the allograft group. No appreciable difference in settling was observed in the six-month follow-up period within the PEEK group. PEEK cages offer an attractive alternative to allografts in ACDF.

**419. FlexiCore® Disc Replacement vs. Fusion: Pain Relief and Narcotics Use from Four IDE Study Sites at 2-year Follow-up**
Charles S. Theofilos, Rick Sasso, Eric J. Woodard, James Zucherman

**Introduction:** Potential criticisms of surgical treatment for lumbar DDD are that postoperative narcotic usage may mask less than positive clinical results. Surgical options include fusion and more novel approaches such as total disc replacement. This abstract reports clinical outcomes and narcotic medication usage from 4 of 23 sites participating in the FlexiCore IDE clinical trial.

**Methods:** The study was a prospective, randomized (2:1), controlled trial. There were 74 FlexiCore® patients and 39 circumferential fusion patients implanted at a single level from L1-S1. VAS, ODI, and narcotic usage were assessed at all follow-up visits. A McNemar’s Test was used to test the homogeneity of marginal proportions.

**Results:** Clinical results were similar in both groups. Mean VAS scores improved from 85 preoperatively to 40 at the 2 year follow-up in the FlexiCore® group. The fusion group improved from 83 to 39 at 2 years. At 2 years, ODI improved from 59 to 29 in the FlexiCore® group and 59 to 32 in the fusion group. Within each treatment group, the mean VAS and ODI results were significantly improved up to 2 years. There was a significant difference (p = 0.0075) in the 2 year shift proportions of FlexiCore® subjects that discontinued the use of narcotics. Specifically, there were 12 subjects that shifted from narcotics use at baseline to no narcotics use at 2 years. The results for the fusion group were not significant.

**Conclusion:** Both treatments led to a reduction in pain scores at all time points. A greater percentage of FlexiCore® patients were able to discontinue narcotic pain medication. Preliminary results from these sites suggest the FlexiCore® may provide greater pain relief unmasked by medications than the standard treatment of fusion. Full study data is needed to confirm these findings.
February 2000 to September 2002 in General Hospital Pula. Instability and spondylolisthesis were exclusion criteria. Outcome was measured as difference in the Oswestry Disability Index (ODI) at 1-year and 5-year follow-up examinations. Duration of surgery, blood loss, incision length and hospital stay were measured.

**Results:** 44 out of 56 patients were enrolled. Twenty-six patients were randomized in FSL (13) and YL (13) groups while 18 were allocated in observational FSL (13) and YL (5) cohorts. Significant improvement on 1-year and 5-year follow-up was noticed in LF and YL groups (30.25; 26.65 and 28.78; 16.05, respectively). LF ODI was significantly better compared to YL at 5-year follow-up (27.82 vs. 40.74). No significant difference was found between the randomized and observational cohorts. FSL was more invasive and two dural lacerations appeared in YL group.

**Conclusion:** LF is a more invasive surgical technique than YL but with better long-term outcome.

### 422. Intrathecal Morphine in the Management of Postoperative Pain in Adult Lumbar Spinal Surgery: A Systematic Review of Randomized Controlled Trials

**Perry Dhaliwal, Philippe Mercier, Stephen du Plessis, Steven Casha**

**Introduction:** Intrathecal morphine has been used in the management of postoperative pain in numerous surgical disciplines. Its efficacy in pain management following lumbar spinal surgery remains unclear. A systematic review was conducted to examine the role of intrathecal morphine for postoperative pain management following lumbar spinal surgery.

**Methods:** We conducted electronic literature searches in MEDLINE, EMBASE, Cochrane Registry of Controlled Trials and Cochrane Database of Systematic Reviews. Studies were included if they involved adult patients (>18 years-of-age) undergoing lumbar spinal fusion, were randomized controlled trials, and involved the use of intrathecal morphine for postoperative pain management. Two independent reviewers used a coding form to gather information about preoperative patient characteristics, study methodology, surgical procedures, dose and delivery of intrathecal morphine, postoperative pain scores as well as opioid related side-effects. Differences were resolved by consensus.

**Results:** Eight of 487 abstracts met our initial inclusion criteria, however, methodological issues in the majority of studies limited our assessment. For example, patient populations were not well defined, there were variable types of surgical procedures performed, variable doses of intrathecal morphine were used and variable pain and side effect assessments were conducted. Despite those limitations, lower pain scores and decreased narcotic use are consistently observed in the early postoperative period following the administration of intrathecal morphine. In addition, the use of intrathecal morphine for postoperative pain management appears to be well tolerated with minimal side effects.

**Conclusion:** Intrathecal morphine may be a useful method of managing postoperative pain but heterogeneity in the available literature limits translation into clinical practice. Further studies are required to delineate the efficacy of intrathecal morphine in the management of postoperative pain following lumbar spinal surgery.

### 423. A Novel Technique for Direct Reduction of Vertebral Compression Fractures (VCF): A Safety Study, Techniques, and Preliminary Clinical Data

**J. Patrick Johnson, Shoshanna S. Yavnman, Parham Zarrini, Samer Ghostine, Harvinder S. Sandhu, Srinath Samudrala**

**Introduction:** Vertebral compression fractures (VCFs) are common causes of pain and morbidity that increase with advancing age, osteoporosis, and intravertebral tumors. Current treatments, such as vertebroplasty and kyphoplasty, can stabilize the vertebral body, but are limited in their ability to restore vertebral body height (VBH) and correct angular deformities and by potential complications related to cement extravasation, such as compression of neural elements. We present the StaXx delivery system, a novel percutaneous treatment technology for VCFs, that uses the targeted insertion of PEEK wafers into the vertebral body under fluoroscopic guidance and offers the potential for VBH restoration and angular correction.

**Methods:** A two-part study was conducted: 1) an initial safety evaluation in fresh cadaveric specimens (four small to large body specimens) of the surgical technique to access T11 to L4 vertebrae and 2) a preliminary clinical report (3 males and 2 females, mean age of 73, range 55–85 yrs, levels T11–L4) on clinical and radiographic outcomes. VBHs (anterior, middle, and posterior) were measured for each affected vertebrae and used to calculate the anterior height/posterior height ratios. Angles were measured (Cobb method) for segmental vertebral deformities, intervertebral space, and regional sagittal alignment (L1–L5 or T12–S1).

**Results:** The cadaveric study achieved the successful targeting and positioning of the StaXx technology, detailing incision sites, bony entry points, instrument trajectory, and the StaXx reduction procedure. All patients showed satisfactory outcomes in pain reduction and motor strength. Comparison of pre and post–procedure measurements showed evidence of VBH restoration (mean anterior, middle, and posterior height corrections of 4.3, 5.1, and 3.0, respectively) and angle correction (3.2 ± 0.8 SE).

**Conclusion:** Our preliminary analysis, using cadaveric and clinical data, demonstrates that the StaXx system provides a novel and unique technology that may have significant benefits over current techniques in VBH and angle correction. Future progress is directed towards large population studies that will provide statistical support to our current findings.

### 424. Clinical and Functional Evolution of Patients with Deep Wound Infection after Spinal Lumbar Fusion

**Asdrubal Falavigna, Orlando Righezzo, Alisson Teles**

**Introduction:** To describe the authors’ experience in managing deep wound infection after performing a procedure on the lumbar spine and the clinical and functional long-term course of these patients.

**Methods:** Prospective cohort study with the patients who presented deep infection of the surgical wound. All the patients with a clinical suspicion of this complication were submitted to wound opening, collection of material for a microbiological examination, exhaustive washing, debridement, implementation of a continuous washing system, primary suturing of the wound and treatment with antibiotics I.V. and then orally. The instrumentation was not removed from any patient. The patients were evaluated radiologically, clinically and functionally during the follow up. Paired analyses were performed using the Wilcoxon test to evaluate changes in the instrument scores.

**Results:** The incidence of infection was 3.1% (15/485). The most prevalent etiological agent was Staphylococcus aureus. No pseudoarthrosis was observed in any case. In a mean follow up of 47.6 months, changes were seen in the numerical scale pain scores (p=0.001).
Oswestry Disability Index (p=0.017) and physical component of SF-36 (p=0.036). In the final evaluation, 64.2% of the patients (9/14) presented minimal disability, and 35.8% (5/14), moderate disability.

**Conclusion:** Aggressive treatment of postoperative infections after spinal lumbar fusion avoids removal of the instrumentation and allows maintaining vertebral stability. Despite the complication, the patients presented improvement with regard to pain, functional capacity and preoperative quality of life.

425. **Key Limitation of Functional Assessment by Treadmill Testing in Patients with Lumbar Spinal Stenosis**

John D. Markman, Maria E. Frazer, Ross S. Hanson, Nicole M. Murray

**Introduction:** Fifteen minute treadmill exercise testing has been validated as a research tool to assess function in surgical patients with neurogenic intermittent claudication (LSS). Patients may exceed the 15-minute testing interval prior to treatment, thereby reducing the sensitivity of the assay for clinically meaningful changes in functional status. This research examines key limitations of adapting treadmill testing from the surgical literature gained from pain intensity and functional assessments of a common non-surgical treatment.

**Methods:** A series of 28 patients (11 male, 17 female, age range: 51–86 years) were enrolled in a pilot outcome study evaluating the functional benefit of epidural steroid injection (ESI) for NIC assessed by treadmill testing. In this crossover design, total walking time (Ttotal) was evaluated by t-test following a 15-minute treadmill test. Data was further analyzed to exclude patients exceeding 15 minutes prior to ESI.

**Results:** Following ESI, the average Ttotal for all patients (n=28) increased by 13%, and failed to show significance (1.09 minutes, p=0.48). Subpopulation data was analyzed after exclusion of patients who reached the testing interval of 15 minutes prior to ESI. Following ESI in this more impaired population (n=16), the average Ttotal increased by 84% (2.86 minutes, p=0.03), representing significant functional improvement.

**Conclusion:** A 15 minute treadmill testing interval may be too brief to gauge the functional impairment of a segment of patients with pain upon ambulation due to lumbar spinal stenosis. Exclusion of this subpopulation from this data set examining response to epidural steroid injection revealed the functional benefit of this therapy for patients with more severe symptoms. This observation suggests that shorter evaluation periods, such as that used for the six minute walk test, may not be sufficiently sensitive to identify responders of non-surgical treatments in which effect sizes are reduced compared with surgical decompression.

426. **Surgical Outcome of Spinal Neurofibroma Associated with Paraplegia: An Analysis of Ten Cases**

Awadwesh K. Jaiswal, Sushila Jaiswal, Arun K. Srivastava, Rabi Sahu, Sanjay Behari

**Introduction:** Neurofibroma is a common benign spinal tumor. The common clinical features are pain and varying degree of motor and sensory deficits. Microsurgical excision offers good surgical outcome.

**Methods:** The study was performed by retrospective review of the medical records of the patients of spinal neurofibroma associated with paraplegia operated in our department.

**Results:** 10 patients (6 males and 4 females, age ranged from 14–48 years) with spinal neurofibroma associated with paraplegia were surgically treated at our institution over last 6 years. The mean duration from onset of symptoms to surgery was 8.25 months. Pain was the initial symptom in all the cases. One case was associated with Neurofibromatosis type II and had asymptomatic small neurofibromas at other levels also. All cases were having paraplegia at the time of admission and all patients underwent MRI for diagnosis. The neurofibroma was intradural extramedullary (8 cases), extradural (1 case) and both extradural and intradural (1 case). The tumor was located in thoracic region in all the cases. All patients were operated via standard posterior approach. The tumor was situated posterolateral in 8 cases and anterolateral in 2 cases. Macroscopically total removal was achieved in 9 patients and subtotal in 1 patient. One patient developed hematoma at operative site following surgery which required evacuation. Histopathology was suggestive of neurofibromatosis in all the cases. Follow up was available in 8 cases and ranged from 5–42 months (mean 22.6 month). All 8 cases had varying degree of improvement following surgery.

**Conclusion:** Microsurgical excision of spinal neurofibroma is associated with good surgical outcome.

427. **Spinal Neurenteric Cyst: An Analysis of Four Cases**

Sushila Jaiswal, Awadwesh K. Jaiswal, Arun K. Srivastava, Rabi Sahu, Sanjay Behari

**Introduction:** Neurenteric cyst (NC) is rare congenital anomalies that results from disturbance in the development of primitive neururenteric canal, notochord, neural tube and the adjacent endoderm and the mesoderm. These cysts have been reported under various names such as enterogenous cyst, gastrocytoma, teratomatous cyst, archenteric cyst, enteric cyst, and neururenteric cyst. The most common location is lower cervical and upper thoracic regions. Surgical excision is the mainstay of treatment.

**Methods:** The study was performed by the retrospectively reviewing the medical records of patients of spinal NC.

**Results:** Four cases of spinal NC (all males) were managed over last 2 years. Age ranged from 16 to 49 years (mean age-33.4 years). In two cases, the NC was located in cervical region (C1–C5 and C5) and in two cases in lumbar region (L1). Patients with cervical NC presented with neck pain and quadriparesis while those with lumbar NC presented with sphincter disturbances. No associated congenital anomaly was encountered in any of our cases. MRI was done in all cases and NC typically appeared as nonhomogenous isointense to slightly hyperintense on T1 weighted images and hyperintense on T2 weighted images with no enhancement with contrast administration. Total surgical excision of the cyst was achieved in two cases (both lumbar NC) and partial excision in two cases (both cervical NC). Histopathology showed the cyst wall lined by pseudostratified columnar as well as cuboidal epithelium suggestive of neururenteric cyst in all the cases. All patients improved in their symptoms following surgical excision and there was no recurrence of symptoms in any of our 4 cases till last follow up (follow up ranged from 4–15 months; mean–9.5 months).

**Conclusion:** Spinal NC is a congenital disorder and presents with varying degree of neurological deficits. Outcome following excision of spinal NC is good.

428. **Treating Cervical Pseudoarthrosis with Cervical Artificial Disc Replacement**

Kenneth Pettine

**Introduction:** Fusion rates with ACFD vary depending on the number of levels fused. Published series have reported pseudo rates of 5–10% with one-level and 10–20% with two- and three-level ACFD. The standard surgical correction for
pseudoarthrosis following ACDF is posterior fusion with instrumentation. 

Methods: This is the first report on the results of treating pseudoarthrosis after ACDF by converting to CADR. Eight patients underwent removal of a plate and fibrous pseudoarthrosis with redo spinal cord and nerve root decompression followed by implantation of a Prestige™ DR.

Results: There were no surgical complications. Range of motion at CADR was $8^\circ$, $11^\circ$, $7^\circ$, $10^\circ$, $11^\circ$, $8^\circ$, $10^\circ$ and $5^\circ$.

Conclusion: These preliminary results indicate converting an ACDF pseudoarthrosis to CADR may be an efficacious option. The advantages include restoring cervical ROM with less surgical morbidity compared to posterior cervical fusion.

429. Cervical Spine Chordomas: A Retrospective Review of 5 Patients Undergoing En Bloc Resection with Mean 4-year Follow-up

Patrick C. Hsieh, Alexander S. Taghva, Gary L. Gallia, Daniel M. Scibubba, Jean-Paul Wolinsky, Ziya L. Gokaslan

Introduction: En bloc surgical excision of chordoma with negative margins results in improved local disease control and survival compared to intraskeletal resections. Cervical spine chordomas are rare, and en bloc excision presents unique technical challenges.

Methods: The cases of five consecutive patients undergoing en bloc tumor excision for cervical spine chordomas from 2000–2007 were retrospectively reviewed in an institutional spine tumor database. Surgical margins, perioperative complications, tumor recurrence rate, and survival were analyzed from review of the patient’s charts.

Results: The mean patient age at the time of diagnosis was 61.2 years. Mean patient follow-up is 4.2 years. The most common presenting symptom was dysphagia, which was present in 4 of 5 patients. Biopsy for tissue diagnosis was performed in all patients prior to surgery. All five patients required multi-stage procedures to achieve en bloc tumor excision, and they required perioperative tracheostomy and gastrostomy tubes. 30-day perioperative complication was significant for one wound infection. Two of five patients had instrumentation failures requiring revision. No neurological or cerebrovascular complications were encountered. Surgical margins analysis by pathology revealed that marginal en bloc excisions were achieved in all five patients. Only one patient had tumor recurrence that required repeat surgical excision at the time of analysis, and the mean disease-free survival is 4.2 years.

Conclusion: Despite technical complexities, en bloc excisions of chordoma improve patient outcomes and survival. Our analysis of five patients indicates that patients have good disease-free survival with acceptable perioperative morbidity.

430. Gene Expression of End Plate and Nucleus Pulposus Cells In 3D Pellet Cultures for Disc Regeneration Applications

Shawn Allen Belverud, Passquale Razzano, Jenna Kiridly, Daniel Grande, Mitchell Levine, Nadeen Chahine

Introduction: Tissue engineering efforts have focused on the use of differentiated disc cells or stem cells for the regeneration of an IVD in vitro. Nucleus pulposus (NP) and end-plates (EP) are rich in proteoglycans (PG) and resemble articular cartilage (AC). The aim of this study is to compare the gene expression of NP and EP cells in pellet micromass cultures typically used to induce growth and differentiation of chondrocytes from articular cartilage (AC).

Methods: Bovine IVDs were dissected separating NP, AF and EP, and AC was dissected from femoral condyles. Pellets (250,000 cells) were cultured with chondrogenic media (CM) containing TGF-β3 up to 28 days. Control pellets were cultured in a basal media (BM) with 10% FBS. Quantitative RTPCR was performed for Collagen-1, Collagen-2 and Aggrecan, and are normalized to GAPDH. Some pellet whole mounts were stained Alcian Blue for cartilage (AC). The Positive Predictive Value of Provocative Discography in Artificial Disc Replacement


Introduction: Identifying the primary source of pain in patients with low back pain is challenging in many patients, despite advanced imaging techniques. Often, multiple levels will show some degree of degenerative disc disease (DDD) on imaging, and determining which level(s) should be treated is difficult. In these patients with questionable pathology, provocative discography is often performed. However, the use of discography to diagnose “discogenic pain” remains a highly controversial topic in spine surgery and radiology communities.

Methods: We retrospectively reviewed data from patients enrolled in the FDA ProDisc-L IDE study that were randomized to the artificial disc replacement (ADR) arm of the clinical trial and underwent positive low pressure provocative discography. ADR was performed at L3-L4, L4-L5, or L5-S1. Clinical outcomes (Visual Analogue Scale, VAS; Oswestry Disability Index, ODI) were assessed at 6 weeks and 3, 6, 12, and 24 months.

Results: Of the 161 patients that were treated with ADR, 33 had a single-level positive low pressure discogram during their diagnostic workup. At 12 months postoperative, 23 out of 31 patients (74%) met both the high clinical success and the minimal acceptable change criteria. At 24 months postoperative, 24 out of 33 (73%) met the high clinical success criteria and 28 out of 33 (85%) patients met the minimal acceptable change criteria.

Conclusion: The positive predictive value of discography was high when using clinical outcomes after ADR to assess the diagnosis of discogenic pain. Discography was generally reserved for patients with unclear pathology or symptomology in this study. However, even in these difficult to diagnose patients, the predictive value of positive discography was 73% to 85%. These results suggest that future prospective studies may benefit from using clinical outcomes after ADR when investigating the predictive value of discography.
432. Circumferential Decompression and Instrumented Fusion Using Expandable Cages via Posterolateral Approach for Corpectomy: A Prospective Case Series of 15 Consecutive Patients
Patrick C. Hsieh, Alexander S. Taghva, Ziya L. Gokaslan, John C. Liu

Introduction: Although posterolateral transpedicular and costotransversectomy approaches provide smaller surgical corridors over combined anterior/posterior approaches, circumferential decompression of the spinal canal with corpectomy can be achieved in a single stage. In addition, reconstitution of vertebral column stability can be achieved with expandable cages despite the smaller working corridor.

Methods: Fifteen consecutive patients with thoracic tumor, infection, or fracture that underwent a single-stage posterolateral corpectomy with circumferential decompression and stabilization were placed in our prospective surgical database and analyzed for this study.

Results: Surgical indications in this cohort included 10 tumors, 3 infections, and 2 fractures. All patients presented with spinal cord injury or myelopathy. The mean age of patients in this study was 52.3 years old, and mean follow-up was 13.2 months. 7 patients had high thoracic (T1-T4) corpectomy, 5 patients had mid thoracic (T5-T10) corpectomy, and 3 patients had thoracolumbar (T10-L2) corpectomy. Mean estimated blood loss associated with these procedures was 1250cc and the average length of hospitalization was 6.2 days following surgery. Neurological improvement by ≥1 grade motor scale was achieved in 80% of the patients. 30-day peri-operative complications included only 2 wound infections and 1 symptomatic pleural effusion. There were no neurological or vascular complications in this series.

Conclusion: Effective circumferential spinal decompression for spine tumors, infections, and fractures in the thoracic spine can be achieved via posterolateral transpedicular and costotransversectomy approaches. In cases with high thoracic spinal cord compression, they are particularly useful as transthoracic and lateral extravertectomy approaches are difficult at these levels. In addition, despite the smaller surgical corridor, vertebral column reconstruction can be achieved with expandable cages following corpectomy without increased risk for neurological complications.

433. Innovative Vertebral Augmentation Technique Relieves Pain while Maximizing Fracture Reduction Compared to Vertebroplasty and Balloon Kyphoplasty
Kent B. Remley, Nicole A. Bateman

Introduction: Vertebral augmentation aims to alleviate pain and attempt to restore vertebral height. The StaXX® FX Structural Kyphoplasty System represents a technological advancement in vertebral augmentation and provides 1 mm incremental vertical fracture reduction. The PEEK implant is supplemented with bone cement. The purpose of this study is to determine the percentage of fracture reduction achieved with the StaXX® FX system during vertebral augmentation and to verify that pain was alleviated.

Methods: Retrospective review of the initial 40 subjects undergoing vertebral augmentation with the StaXX® FX system is performed to evaluate vertebral body height and to assess pain. Using standing lateral radiographs, vertebral height is measured at anterior, central, and posterior points. Digitized films are measured by an independent source using validated software. Vertebral body height is reported as a percentage of the reference height. The change between preoperative and 2 week postoperative radiographs is then calculated. Patients verbally ranked their pain on a scale of 1 to 10.

Results: Independent film reviewers analyzed films sets for 24 levels in 21 patients. Preoperatively, all fractures demonstrated at least 15% initial height loss with a mean loss of 52%. Anteriorly, 83% (p<0.001) of the lost height was restored. Centrally, 86% (p<0.003) of the lost height was restored. Posteriorly, 79% (p<0.005) of the lost height was restored. No device related neurological or pulmonary complications occurred. Pain significantly decreased (p<0.0001) from a preoperative score of 9 to a postoperative score of 1.

Conclusion: Percutaneous vertebral augmentation, using the StaXX® FX System, demonstrates superior height restoration when compared with vertebroplasty (3-48%) or balloon kyphoplasty (3-49%) techniques. Pain reduction is equivalent to other vertebral augmentation methods. Vertical fracture reduction with implanted PEEK wafers minimizes intraoperative loss of correction and allows the device to be more effective at retaining procedure reduction.

434. Evaluation of Alkaline Phosphatase as a Cost–Effective Screening Tool for Spinal Infection in an Emergency Room Setting
Alexander S. Taghva, Christopher J. Stapleton, Jesse Winer, Daniel J. Hoh, Patrick C. Hsieh

Introduction: Diagnosis of spinal infections in the absence of magnetic resonance imaging (MRI) is challenging. With increasing health care budgetary strains, MRI may prove to be an expensive screening tool not accessible to all patients. Recently, we identified specific serum markers that are elevated in patients with MRIs positive for spinal infections. Here, we further evaluate these serum markers as potentially cost-effective tools for screening patients for spinal infection prior to MRI.

Methods: 42 consecutive patients seen for neurosurgical evaluation of possible spinal infection seen in an emergency room setting from 2006–2008 were retrospectively reviewed. Data collected included a comprehensive metabolic panel, CBC, CRP, ESR, and MRI findings. Patients were stratified according to: negative MRI, osteodiscitis and/or paraspinal abscess (O/PA), epidural abscesses (EA), and O/PA plus EA.

Results: Of 42 patients, 16 had negative MRIs, 12 had O/PA, 3 had EA, and 11 had both O/PA and EA. Alkaline phosphatase (AP), a marker of bone disease, was elevated (p<0.007) in patients with MRI evidence of spinal infection compared to those with negative MRIs. For AP levels >90, the sensitivity of discovering O/PA was 92% (negative predictive value (NPV) = 83%) though the specificity was 45% (positive predictive value (PPV) = 65%). The sensitivity of diagnosing EA alone was 100% (NPV = 100%) and the specificity was 45% (PPV = 33%). The sensitivity of finding both O/PA and EA was 64% (NPV = 56%) and the specificity was 45% (PPV = 54%). For AP levels ≥115, the sensitivity of discovering EA vs. O/PA alone was 100% (NPV = 100%) while the specificity was 50% (PPV = 33%).

Conclusion: Alkaline phosphatase is a sensitive but nonspecific marker of both osteodiscitis/paraspinal abscess and epidural abscesses and may serve as a helpful initial screening tool in the ED for patients presenting with possible spinal infection.

435. Facet Joint Biomechanics at the Treated and Adjacent Levels after Total Disc Replacement
Sergiu Botolin, Christian M. Puttltz, Todd Baldini, Anthony Petrella,
436. Pedicle Subtraction Osteotomy: A Safe Alternative Surgical Technique to Treat Patients With Myelopathy Secondary to an Old Post-traumatic Upper Thoracic Kyphotic Deformity


Introduction: The authors present the surgical technique and postoperative outcome of upper thoracic pedicle subtraction osteotomy (PSO) in a patient with severe myelopathy secondary to a post-traumatic focal upper thoracic spinal kyphotic deformity. PSO is a wedge resection of a vertebral body, which when closed places the spine in extension which may relieve the stretching forces on the spinal cord. While PSO has been described all along the spinal axis, its application to treat myelopathy resulting from a focal kyphosis in the upper thoracic spine has not been reported. Upper thoracic kyphosis is a regional sagittal plane deformity that presents a challenge to approach, correction, and stabilization.

Methods: A 57-year-old patient underwent a T4 PSO to stop the progression of his severe myelopathy resulting from ventral cord compression by a focal kyphotic deformity of the upper thoracic spine at the T3–4 vertebrae. Results: Follow-up was at 3 months. The PSO procedure achieved a focal kyphotic correction of approximately 30 degrees at the T3 and T4 level, which provided adequate ventral spinal cord decompression, and resolution of the stretching forces on the spinal cord. Conclusion: Upper thoracic kyphosis is a distinct form of sagittal plane deformity, which due to the anatomical and biomechanical characteristics of the region, can present with ventral spinal cord compression and stretching. It is a variable deformity with the most severe cases presenting as a gibbous that often requires using complex spinal reconstructive techniques. PSO allows for significant correction through one spinal segment and, when facilitated by a highly sensitive intraoperative monitoring system and fluoroscopy, may be used safely to correct severe focal kyphotic deforming of the upper thoracic spine resulting in spinal cord stretching and ventral compression.

437. Piriformis Syndrome following Lumbar Artificial Disc Replacement

Elizabeth Robinson, Peter G. Gonzalez, Susan Estes, Robert Cooley, Evalina L. Burger, Vikas V. Patel

Introduction: Artificial disc replacement (ADR) now offers an alternative solution for surgical treatment of severe lumber degenerative disc disease (DDD). To the authors’ knowledge, no case of piriformis syndrome following ADR has been reported. Physiologically, piriformis syndrome results from entrapment of the sciatic nerve at the greater sciatic notch with symptoms of pain and numbness radiating down the buttoc or the posterior leg to the foot. Because these symptoms of piriformis mimic those of radiculopathy it is vitally important to differentiate the source of nerve irritation to avoid unnecessary or inappropriate procedures.

Methods: In this case series, we report four patients who developed piriformis at our institution following ADR.

Results: Four patients, aged 38 to 46, developed some or all of the following symptoms in the affected leg after ADR: posterior leg and buttock pain, calf weakness, and toe and ball of foot numbness and tingling. The onset of symptoms ranged from six days to eight months postoperative, and became debilitating over time. Each patient was diagnosed with piriformis syndrome through physical examination. Three of the patients received a piriformis injection and reported 50%-100% pain relief lasting one to three weeks. All four patients subsequently underwent physical therapy that provided relief of their piriformis syndrome-related pain and enabled them to resume their normal activities.

Conclusion: Piriformis syndrome has not previously been described in the literature as a sequela of lumber ADR. Our case series indicates that this complication may be under-diagnosed. Careful consideration following ADR is required if the patient presents with buttock, leg or foot pain, and/or numbness. It is important for physicians to recognize the symptoms and indications of piriformis syndrome as compared to sciatica or compression and irritation of the nerve root. The proper diagnosis of piriformis syndrome can save patients from unnecessary fusion or exploratory discectomy.

438. Complications Associated with Axial Lumbar Interbody Fusion

Matthew A. McCullough, Emily M. Lindley, Courtney Brown, Evalina L. Burger, Susan Estes, Robert Cooley, Vikas V. Patel

Introduction: Axial Lumbar Interbody Fusion (AxiaLIF) is a novel minimally invasive approach for fusion of the L5 vertebra to the sacrum. This technique uses the presacral space for percutaneous access to the anterior sacrum. AxiaLIF has the potential to decrease patient recovery time, length of hospital stay, and overall occurrence of surgical complication. It can be used alone or in combination with minimally invasive or traditional open fusion procedures. The purpose of this study was to evaluate complications of the AxiaLIF procedure.

Methods: Patients who underwent AxiaLIF surgery between October 2005 and June 2009 at the authors’ two institutions were identified. We retrospectively reviewed the AxiaLIF procedures and identified complications associated with surgical anterior lumbar interbody fusion.
Introduction: Axial neck pain is a symptom commonly encountered by neurosurgeons. However, the management is highly controversial, in part due to the lack of accepted diagnostic tools for identifying generatora. SPECT bone scans can localize musculoskeletal pain generators, including active facet and intervertebral disc disease. However, there has been little data on the use of SPECT for the evaluation of neck pain.

Methods: This retrospective study identified all patients presenting with severe axial neck pain as a primary complaint. Patients underwent MRI, flexion/extension X-rays, and a Technetium bone scan. Abnormal scans were classified by two independent radiologists into: diffuse or local uptake and anterior or posterior uptake. Patients were sub-classified based upon neurologic diagnosis as well as imaging characteristics.

Results: 37 of 49 patients had increased and abnormal uptake. The distribution included: diffuse uptake (3), upper (5), and mid to lower cervical spine (29). Three patients had predominantly anterior cervical uptake, while 8 were predominantly posterior, and 26 demonstrated anterior and posterior uptake. Cervical discography was not utilized in these cases. Nine patients with a positive scan had no deformity, instability, or hypermobility on dynamic X-rays. These patients underwent multi-level anterior cervical discectomy and fusion. All 9 patients experienced appreciable reductions of greater than 70% in axial neck pain symptoms at one-year follow-up. The mean VAS improvement for axial pain was 4.7. Clear radiographic evidence of fusion was seen in all 9 cases.

Conclusion: The complication rate associated with AxiaLIF in the present study was relatively low (21.2%) and was lower than previously published complication rates for transforaminal lumbar interbody fusion (33.6%) and anterior lumbar interbody fusion (38.3%). The most common complications were superficial infection and pseudoarthrosis. We had one case of rectal perforation that required exploratory lapotomy and a loop colonoscopy for repair of the perforation. It is important for surgeons to be aware of the potential for these complications. Many of these complications can likely be avoided with proper patient selection and operative planning. Preoperative MRI, a detailed patient physical and history, adequate bowel preparation, improved access instrumentation, and the use of live fluoroscopy can all help to prevent complications with AxiaLIF surgery.

439. Nuclear Medicine Bone Scan as a Positive Predictor of Axial Neck Pain Remediable with Surgical Fusion

Michael Y. Wang, Paul Khoueir

Introduction: Axial neck pain is a symptom commonly encountered by neurosurgeons. However, the management is highly controversial, in part due to the lack of accepted diagnostic tools for identifying generatora. SPECT bone scans can localize musculoskeletal pain generators, including active facet and intervertebral disc disease. However, there has been little data on the use of SPECT for the evaluation of neck pain.

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440. Clinical Series of Occipital Condyle Screw Placement for Occipital Cervical Fixation

Rafael F. Cardona, Elias Dakwar, Juan S. Uribe

Introduction: Common occipital cervical fixation techniques include occipital plates as the sole method of obtaining cranial fixation. The limitations include: risk of intracranial injuries, minimal bone purchase of screw/plate, decreased area of exposed bone for fusion and difficulty with rod-screw configuration. By using the occipital condyles as the cranial fixation points, the occipital bony purchase is increased, it leaves greater area of bone for fusion, and simplifies the nature of the construct. We present 8 successful cases of cranio-cervical stabilization utilizing the occipital condyles as the sole cranial fixation points.

Methods: We evaluated eight consecutive patients with cranio-cervical instability, secondary to degenerative, neoplastic, or traumatic pathologies, requiring occipital cervical fusion. Preoperative imaging included CT angiogram in all patients. All patients underwent posterior occipital-cervical fixation with a polyaxial screw rod construct utilizing the occipital condyle, C1 lateral mass, and or C2 pars articularis for fixation. Intraoperative fluoroscopy and hypoglossal EMG stimulation was used in all cases. Neuronavigation was used in some of the cases.

Results: All patients underwent successful occipital-cervical stabilization using the occipital condyle as the cranial fixation point without conversion to a conventional occipital plate. No patient had any operative or postoperative complications or neurologic deficits. There was no vascular injury. The follow-up period ranges from 1 to 24 months.

Conclusion: Cranio-cervical stabilization utilizing occipital condyle screws as the sole cephalad fixation points is a viable alternative and can be used safely without neurovascular complication in the treatment of cranio-cervical instability.
postoperative occipital headaches from C1 screws impinging on the C2 nerve root. Instrumentation was removed in both patients after documenting radiographic fusion with complete resolution of symptoms. No vertebral artery or spinal cord injuries were reported.

**Conclusion:** We describe a safe and reliable alternative technique to fuse C1–2 instabilities by focusing on an intrarticular arthrodesis. This is advantageous from a biomechanical standpoint secondary to axial loading, and the large surface area available for arthrodesis. This technique does not involve resection of the C2 nerve root, and results in low risk for vertebral artery or spinal cord injury.

### 442. FLEXIS Interspinous Implant for the Treatment of Lumbar Spinal Stenosis: A 3-year Single Center Follow-up

Nikolaos Syromos, Mario Ganau, Pasquale Gallo, Kostantinos Grigoriou, Dimitrios Arvanitakis

**Introduction:** The FLEXIS Interspinous Device is a relatively new interspinous implant designed for patients affected by symptomatic spinal stenosis, complaining particularly about neurogenic claudication. Aim of our study was to investigate the clinical outcome of patients undergoing such a surgical procedure, before and at periodic intervals after FLEXIS implantation.

**Methods:** A consecutive series of 73 patients were enrolled in our center and surgically treated with FLEXIS implantation. Either 1 or 2 lumbar levels were addressed in each patient, including the L5–S1 space. They were clinically evaluated both preoperatively and at 1-month, 3-month, 6-month, 9-month, 1-and 2-year intervals with multiple clinical questionnaires (VAS, Zurich Claudication Questionnaire, Oswestry Disability Index, SF-36, JOA, AOSPINE).

**Results:** Out of 73 patients only 23 failed to complete all the questionnaires, at all the abovementioned time intervals, and hence were excluded from the present study. While soon after the surgical treatment almost every patients started to notice a complete relief of symptoms, by 12 months, a reduction to 80% of patients reporting clinically significant improvement was registered, nevertheless only 5% of our cohort didn’t express satisfaction with the procedure.

**Conclusion:** Our experience simply confirmed the data concerning interspinous devices already published in literature. The intra- and peri–operative low surgical risks, and the significant reduction in invasiveness represents the main advantages of this technique. In our experience the FLEXIS system has confirmed to be a reliable alternative to the most common devices, since it still preserve flexibility and mobility, and allow for a timely rehabilitation.

### 443. Rare Presentations of Spinal Dural Arteriovenous Fistula: Dual Extra and Intradural Venous Drainage

Ricky Medel, D. Kojo Hamilton, Aaron S. Dumont

**Introduction:** Spinal vascular malformations present a significant therapeutic challenge. To appropriately guide management of these lesions, a plethora of classification systems have been devised; however, they continue to lack inclusivity. Dural arteriovenous fistulae, the most common, are considered curable through surgical interruption of the draining intradural vein. Atypical anatomy, such as dual venous drainage, potentially complicates therapy.

**Methods:** We present three cases and performed a literature review as a means to expound on the current understanding of angioarchitecture and guide future investigations.

**Results:** Three patients presented acutely, two with progressive paraplegia and sphincter dysfunction and one with subarachnoid hemorrhage. All were found to have vascular malformations with combined epidural and intradural venous drainage. Two possessed an epidural fistula, whereas in the third it was located on the dural nerve root sleeve. Operative obliteration was required in two patients, with one having anatomy suitable for embolization. One patient in whom the intradural draining vein was ligated required reoperation after new intrathecal drainage formed causing recurrent symptoms. All experienced clinical improvement following treatment.

**Conclusion:** Approximately ten cases of arteriovenous fistulae with dual venous drainage have been reported. Commonly, the fistulas site is located epidurally; however, it can also exist within the dural root sleeve. Angioarchitecture must be appropriately characterized prior to intervention. Our experience, as well as the published literature, would suggest that isolated obliteration of the intradural draining vein without occlusion of the fistulas site and epidural drainage can lead to recurrence. One must be cognizant of these variations when evaluating this patient population.

### 444. A Rationale for Interspinous Dynamic Stabilization in the Elderly

Mario Ganau, Nikolaos Syromos, Laura Ganau, Francesco Ferri, Charalampos Iliaidis

**Introduction:** A rationale for the implantation of interspinous spacer in the elderly population is still lacking. The aim of our study is to elucidate the impact of this minimally invasive surgical procedure in a strictly selected population of patients older than 65-years.

**Methods:** A series of 33 consecutive elderly patients were enrolled and surgically treated with lumbar interspinous process spacers (13 X-Stop, 20 FLEXIS) for mono- or multi-level spinal stenosis. Their clinical assessment was achieved by multiple questionnaires (VAS, Zurich Claudication Questionnaire, Oswestry Disability Index, SF-36, JOA, AO SPINE) both preoperatively and at 1-month, 3-month, 6-month, 9-month and 1-year follow-up intervals.

**Results:** The surgical procedure was well tolerated in most of our patients, with 0% perioperative morbidity; the devices were always implanted under local anesthesia, allowing some of our patients to be treated despite their overall high anesthesiological risk. Clinical assessment revealed a favorable outcome during the first 3 to 6 months after surgery. However it is to be noticed that almost 30% of our cohort was lost at a certain point of the study, and 5 patients required a revision treatment for recurrence of disturbances within 1 year. Statistical analysis revealed that a slight deterioration in clinical outcome progressively occurred after the first 6 months, with no difference between the two subgroups (X-Stop vs. FLEXIS); even though 60% of patients still reported a good relief of pain, improvement of functional capabilities and in overall quality of life as far as 1 year after surgery.

**Conclusion:** Elderly patients did not show particular contraindications to interspinous spacers implantation, but their clinical outcome seems to be somewhat less brilliant than in younger patients. However the avoidance of more extensive open surgical procedures represents a great chance for this numerically important group of patients, despite their less favorable general health conditions.

### 445. Tripolar Spinal Cord Stimulation for Management of Low Back Pain

Theofilos Machinis, Marie Bradley, Richard A. Stanger, William C. Broaddus, Kathryn L. Holloway
**Introduction:** Programmable spinal cord stimulation devices have provided significant pain relief for patients with chronic pain. The literature has thus far focused mainly on its efficacy in improving lower extremity pain. Tripolar electrodes have the theoretical advantage of providing better coverage of central areas of the spinal cord, thus achieving better back pain control. In our current communication, we report our experience with 22 patients with predominantly low back pain treated with triaxial spinal cord stimulator placement, seen at our institution over a period of 3 years.

**Methods:** All charts, images and operative reports of patients were thoroughly reviewed. Mean age of patients was 54.3 years (range 30–77 years). Mean follow-up period was 184 days (mean 13–470 days). Outcome was assessed as no improvement, moderate improvement, significant improvement or worsening of symptoms.

**Results:** Four patients reported no back pain relief on follow-up visit. Nine of 21 patients reported moderate back pain relief whereas 8 patients experienced significant improvement in their back pain postoperatively. One patient developed lower extremity weakness after the procedure.

**Conclusion:** Tripolar spinal cord stimulators have an important role in providing back pain relief in patients with chronic low back pain who have failed operative or conservative management.

**447. Prospective Evaluation of the Charite™ Lumbar Artificial Disc Replacement With Minimum Three-Year Follow-up**

Kenneth Pettine

**Introduction:** Results of Charite A.D.R. from a completely independent F.D.A. IDE study were evaluated. The surgeon has no financial ties to Depuy and was not involved in the Charite study.

**Methods:** Sixty–six single level Charite surgeries at one I.D.E. site were reviewed. Inclusion/Exclusion and demographics will be discussed. Oswestry Disability Index (ODI), Visual Analogue Scale (VAS), patient satisfaction, and flexion/extension radiographs were evaluated pre-op and at 6 weeks, 3 months, 6 months, 12 months, 24 months and 36 months post-op. Clinical success was defined by at least 25% improvement in ODI at 24–months.

**Results:** Operating time average: 104 minutes at L4–L5 and 79 minutes at L5–S1. Average blood loss: 45 cc at both levels. Hospitalization average: 22 hours. Three patients required re-operation. ODI results: Pre-op = 63.8; twelve months = 27.25; twenty-four months = 20.5 (p<0.001). 36 months = 2.6 (p<0.001).

VAS results: pre-op = 85.1; twelve months = 31.4; twenty-four months = 33.8 (p<0.001). 36 months = 19.8 (p<0.001).

At twelve–month follow up 32% of patients had an ODI less than 10. At twenty–four months the percentage increased to 33% and 38% at thirty–six months. Also at twelve months 39% of patients had a VAS of less than two. At twenty–four months the percentage changed to 29%. These patients were considered basically “pain free” with “normal” function. Clinical success was met in 84% of the patients. Patient satisfaction at two–year follow–up was 88% and increased to 92% at three years.

**Conclusion:** Charite patients demonstrated clinical efficacy with significant decrease in ODI and VAS (p<0.001) from pre-op to three–year follow–up. FDA Clinical success was met in 84% of the patients. Satisfaction was 92% at three years. These results are better than reported in the Charite IDE study.

**448. Catamenial Sciatica: Mechanism and Proposed Management Algorithm**

John Robert Floyd, II, Ian E. McCutcheon

**Introduction:** Cyclic Sciatica (catamenial radiculopathy), waxing and waning with the menstrual cycle, is an uncommon condition typically caused by endometriosis affecting the lumbosacral plexus or proximal sciatic nerve. The affect of endometriosis can occur both intrapelvic and extrapelvic. Surgery for this condition must be appropriately directed to avoid negative exploration, maximize pain relief, and preserve neurological function.

**Methods:** A literature review was conducted on Pubmed with key words cyclic sciatica, catamenial radiculopathy, extrapelvic endometriosis, sciatic notch compression, and endometriosis. Our case and other case series were reviewed.

**Results:** The etiology of pain and weakness in sciatic endometriosis is multifactorial resulting from direct compression and chemical irritation. Pain can often be managed medically. Patients with symptomatic intrapelvic endometriosis experience compression from the uterosacral ligament, the obturator muscle, nerve sheath invasion, and from retroperitoneal evaginations of the pelvic peritoneum into the greater sciatic notch. For persistent pain or motor weakness, laparoscopic, retroperitoneal exploration is indicated by an experienced gynecologist. These patients typically improve with ablation, removal of endometrial deposits, and neurolaxis of the sciatic nerve. Patients with symptomatic extrapelvic endometriosis experience compression as the nerve passes through the greater sciatic foramen between the piriformis muscle and the gemelli and obturator internus, muscles. For persistent pain, or motor weakness, exploration of the sciatic notch is indicated. Pain is relieved with sciatic nerve decompression and neurolaxis.
Motor function improves with early diagnosis and decompression. If symptoms persist, laparoscopic, intrapelvic exploration is indicated.

**Conclusion:** In the absence of muscle weakness or denervation on EMG, empiric medical management is appropriate. If muscle weakness or denervation is present, surgical decompression is indicated. Knowledge of the anatomy and physiology aids in the determination of the correct surgical approach. Surgical decompression achieves relief of symptoms, and subsequent medical therapy allows sustained suppression of this disease.

**449.**
**Spine Surgery at an Ambulatory Surgery Center**
Kenneth Pettine

**Introduction:** Can spine surgery be safely performed at an ambulatory surgery center (ASC)? This question has important ramifications for providing quality health care at lower costs. Every spine surgery case performed at an ASC from spring 2005 through 2008 (1,030 cases) was prospectively evaluated.

**Methods:** All cases were evaluated with Oswestry Disability Index (ODI), neck disability index (NDI) and visual analog scale (VAS) at pre-op, three-month, six-month, one-year and often two-year follow-up. Surgery types included both instrumented (653) and non-instrumented (377) surgeries.

**Results:** In 193 anterior cervical fusion patients, there were no perioperative complications and no unplanned transfers. There was a statistically significant improvement in NDI and VAS values. In 83 lumbar ADR patients there was one intraoperative vein laceration. One arterial thrombosis and two patients were returned to the OR. There was a statistically significant improvement in ODI and VAS at two-year follow-up. One patient out of 377 lumbar microdiscectomy and decompression patients was returned to the OR. All anterior cervical fusions, ADR, and non-instrumented lumbar spine surgeries were released home within 24 hours of their surgery. Posterior lumbar fusion with pedicle screws, TLIF and, posterolateral fusions were evaluated in 298 patients. Three returned to the OR, five transferred to the hospital, two transferred to a rehab unit, and three had postoperative complications for a complication rate of 4.3%. These patients had an average stay of 48 hours and reported a significant improvement in post-op ODI and VAS. Outside insurance audits have indicated a 60% cost savings when performing these procedures at an ASC vs. a standard hospital setting. Patients reported a 97% satisfaction rate.

**Conclusion:** The results of the prospective analysis of 1,030 spine cases at an ASC indicate both instrumented and non-instrumented spine surgeries can be safely performed with efficacy at an ASC. There is a 60% cost savings compared to a hospital.

**450.**
**Bone Morphogenetic Protein Induced Cyst Formation after Lumbar Fusion Causing Neural Compression**
Lana D. Christiano, Daniel S. Yanni, Koji C. Ebersole, Rachid Assina, James K. Liu

**Introduction:** Bone morphogenetic protein (BMP) has been reported to cause early inflammatory changes, ectopic bone formation, adjacent level fusion, radiculitis, and osteolysis. We describe a patient who developed inflammatory fibroblastic cyst formation around the BMP sponge after a lumbar fusion resulting in compressive lumbar radiculopathy. We also present a patient who had recurrent foraminal stenosis due to heterotopic bone formation extending posterior from the graft.

**Methods:** The patient is a 70-year-old female presented with left L4 and L5 radiculopathy from a grade I spondylolisthesis with a left herniated disc at L4–S. She underwent a minimally invasive transfemoral lumbar interbody fusion with BMP and Mastergraft matrix packed into the interbody cage at L4–5. Her neurologic symptoms resolved immediately postoperatively. Six weeks later, she developed recurrence of her radiculopathy. Radiologic imaging demonstrated an intraspinal cyst with a fluid–fluid level causing compression of the left L4 and L5 nerve roots.

**Results:** Re-explooration of the fusion was performed and a cyst arising from the posterior aspect of the cage was found compressing the axilla of the left L4 nerve root and the shoulder of the L5 nerve root. The cyst was decompressed and the wall was partially excised. A gelatin BMP sponge was found within the cyst and removed. Postoperatively, her radiculopathy resolved and she went on to achieve interbody fusion.

**Conclusion:** BMP can be associated with inflammatory cyst formation resulting in neural compression. Spine surgeons should be aware of this complication in addition to the other reported BMP related complications.

**451.**
**Rates of Infection with Dynamic Stabilization Compared to Posterior Instrumented Fusion**
Daniel S. Yanni, Lana D. Christiano, Antonios Mammis, James Barrese, Ira M. Goldstein

**Introduction:** Dynamic stabilization offers an adjunct to fusion with motion preservation. The dynamic stabilization systems used in this study included Dynesys and Agile. Both dynamic stabilization constructs include a polycarbonate urethane spacer secured by titanium pedicle screws, which allows for limited flexion and extension. In comparison, standard instrumented fusion (IF) consists of titanium screws and rods/plates, which does not allow for motion at the level of the fusion. The reported infection rate following a standard IF ranges from 0.2%–7%.

**Methods:** This is a retrospective analysis of the senior author’s database reviewing the infection rate with hardware removal of dynamic stabilization compared to titanium instrumented fusion.

**Results:** 160 patients underwent posterior instrumented fusion of the thoracolumbar spine. Nine patients underwent posterior dynamic stabilization. Of the patients undergoing posterior instrumented fusion 3 developed a deep wound infection requiring removal of hardware (3/160, 1.9%). Of the patients undergoing dynamic stabilization, 3 required incision and drainage of a deep wound (3/9, 33%) and 2 required removal of hardware (2/9, 22%) secondary to persistent deep wound infection.

**Conclusion:** In our series, there was a significantly increased risk of deep wound infection with the use of dynamic stabilization system compared to standard IF. We postulate that the polycarbonate urethane spacer acts as a medium for bacteria, whereas, the titanium screws and rods are smooth, solid, and inert resulting in a lower risk of infection attaining clinical significance. Of the three patients receiving dynamic fixation, all demonstrated significant comorbidities (metastatic cancer, diabetes mellitus, and severe malnutrition). The risk of nonunion posed by these comorbidities led to the choice of dynamic implants but also likely increased the risk of significant deep wound infection. Future research should include a prospective trial comparing the infection rate of posterior instrumented fusions and posterior dynamic stabilizations.
Minimally Invasive Lateral Retropleural Thoracolumbar Approach: Cadaveric Feasibility and Report of 4 Clinical Cases

Elias Dakwar, Rafael F. Cardona, Juan S. Uribe

Introduction: Approaching the thoracolumbar spine poses an anatomic dilemma given the presence of the lower rib cage and the diaphragm. Each approach, whether anterior or posterior, has its own inherent advantages and disadvantages. With recent advances in minimal access technology, many spinal procedures are being performed with an emphasis on minimizing tissue damage and blood loss. We describe our early experience with a minimally invasive lateral retropleural approach using a tubular expandable retractor to the thoracolumbar spine.

Methods: We performed dissections in seven fresh cadaveric specimens to determine the feasibility of the approach. In all seven specimens, we performed the lateral retropleural approach to the thoracolumbar spine to access the lateral aspects of the vertebral bodies and disc spaces. With the cadavers in lateral decubitus position, and under fluoroscopic guidance, thoracic corpectomies were performed using an expandable tubular retractor system under loupe magnification. In addition, four clinical cases were treated using this minimally invasive approach. Operative results, complications, and early outcome measures were assessed. Intraprocedural fluoroscopy and postoperative computed tomography were used for the approach and to assess the extent of decompression respectively.

Results: In the cadaveric study, adequate exposure was obtained to successfully perform lateral corpectomies and to allow for interbody grafting between the adjacent vertebral bodies. The pleura, dural sac and intrathoracic contents were not violated. This approach was successfully performed in four clinical cases without conversion to conventional approaches. No operative or postoperative complications were encountered.

Conclusion: Our early experience suggests that this minimally invasive lateral retropleural approach allows adequate vertebeectomy and canal decompression without the tissue disruption associated to posterolateral approaches. This approach may improve the complication rates that accompany open or endoscopic approaches for thoracolumbar corpectomies.

Ocular Melanoma Metastasis to the Cervical Spine

Sophia Shakur, Ippei Takagi, Rimas V. Lukas, Steven Chmura, Ben Z. Rollberg

Introduction: Ocular melanoma is characterized by an unpredictable clinical course – fulminant metastatic disease may occur after a prolonged disease-free interval. Melanoma metastatic to the central nervous system (CNS) and spine is associated with wide dissemination and a poor prognosis. Rarely is there an opportunity for surgical intervention.

Methods: We report a case of a 66-year-old woman who was first treated for ocular melanoma in 1995.

Results: After metastatic progression, she entered a Phase I clinical trial, receiving a c-MET inhibitor. Six months later, she experienced paresthesias in the upper extremities; MRI of the cervical spine revealed an intradural extramedullary lesion compressing the cord from above the foramen magnum to C2. Symptoms progressed to profound hemiparesis within 4 weeks, with increase in size of the mass. Gross total resection of the tumor was achieved through a posterolateral approach. Intraoperatively, a large vascular mass was seen, attached to the C1 nerve roots. Histopathology was consistent with metastatic melanoma. Hemiparesis improved within 48 hours. No additional CNS metastases were seen; 10 days postoperatively 3-D radiotherapy was initiated to the site.

Conclusion: This case presented an unusual clinical situation and unique characteristics: ocular melanoma metastasis reached a large size within the cerebrospinal fluid space and was severely symptomatic without additional widespread CNS disease. We chose aggressive surgical treatment and gross total resection was possible. The mass appeared to arise from nerve rootlets or the arachnoid membrane, whereas spinal metastases typically arise within the vertebral body. Despite the usually grim prognosis of metastatic melanoma, treatment should be individualized and aggressive surgery may be beneficial.

Symptomatic Thoracic Kyphosis Associated with Macromastia: The High (Thoracic) Price of Beauty?

Daniel S. Yanni, Alexandros Dimitris Zouzias, Koji C. Ebersole, Ira M. Goldstein

Introduction: Radiological and plastic surgery literature have shown that macromastia can cause significant symptoms in patients from psychological to physical. It is unclear whether the etiology of back pain in patients with macromastia is a sagittal alignment problem or a weight/load problem. We present two patients with symptomatic thoracic kyphosis associated with macromastia.

Methods: We retrospectively reviewed two patients’ charts seen in consultation by the senior author and reviewed the available literature. Radiographic images were obtained to evaluate and follow the patients, in addition to periodic clinical follow up.

Results: Patient 1 is a 36-year-old female who underwent significant breast augmentation. Six months postoperatively, she developed symptoms of thoracic back pain, shoulder pain, pulmonary restriction, hand weakness, and hand paresthesias. Standing plain radiographs revealed a thoracic kyphosis of 68 degrees. MR imaging did not reveal any foraminal or canal stenosis. Patient 2 is a 63-year-old female with idiopathic macromastia who presents with thoracic back pain and thoracic kyphosis of 48 degrees. Conservative management with weight loss and bracing did not improve either patients’ thoracic kyphosis or her thoracic back pain. Patient 1 underwent reduction mammaplasty and application of a thoracic extension brace. Follow up plain radiographs revealed reduction of thoracic kyphosis from 68 to 36 degrees with clinical resolution of radicular symptoms, shoulder pain, thoracic back pain, and pulmonary restriction.

Conclusion: Macromastia, idiopathic or iatrogenic, can be associated with thoracic kyphosis. In patients who are symptomatic, we recommend an initial trial of conservative measures including application of an extension thoracic brace. In absence of compression fractures, disc disease, facet disease, or other significant findings in the spine, we recommend reduction mammaplasty prior to spine surgery. Further research is necessary to correlate the implications of macromastia associated thoracic kyphosis to global sagittal balance and compensatory lumbar lordosis and compensatory cervical lordosis.

Symptomatic Thoracic Kyphosis Associated with Macromastia: The High (Thoracic) Price of Beauty?
Introduction: Stereotactic radiosurgery (SR) is increasingly utilized in the treatment of metastatic spine disease. We have developed The Small Animal Radiation Research Platform (SARRP), a SR device designed for small animals. Conceptually, this device is a smaller version of SR devices currently employed in the treatment of human patients. Current evidence suggests that SR is at least equivalent to conventional fractionated radiotherapy with respect to arresting tumor growth and stabilizing neurologic function. However, dose requirements for effective stereotactic radiosurgery have not been determined. In this study, we sought to determine the efficacy of different doses of stereotactic radiosurgery on metastatic tumor growth and neurologic function.

Methods: Twenty-two female Fischer rats were implanted with CRL-1666 mammary adenocarcinoma into the L6 vertebral body. Each rat received stereotactically targeted radiation to the L6 vertebral body using the SARRP device on post-implantation day 7. Group 1 (n=6) received 10 Gy radiation, Group 2 (n=8) received 30 Gy and Group 3 (n=8) was a control group. Postoperatively, animals were functionally assessed daily via the Basso–Beattie–Bresnahan scale.

Results: Animals receiving 10 Gy SR showed a statistically significant later onset of functional hind limb paraplegia than the control group (14.3±2.4 days vs. 10.4±1.4 days, respectively; p=0.008). Onset of functional hind limb paraplegia was delayed further for animals receiving 30 Gy compared to the control group (16.6±1.6 days vs. 10.4±1.4 days, respectively; p<0.001). There was no significant difference in onset of functional hind limb paraplegia between rats receiving 10 Gy and 30 Gy SR.

Conclusion: In a rat model of metastatic epidural spinal cord compression, SR resulted in statistically significant delays in functional hind limb paraplegia. Although increased SR dose was not associated with delayed onset of functional hind limb paraplegia, the data does show a trend that suggests that increasing doses of SR will lead to longer delays in metastatic tumor growth and onset of neurologic dysfunction. Future studies will increase SR dose to the lesion site to determine the efficacy of increasing doses of SR on the treatment of metastatic tumors of the spine.

Conclusion: Patients with positive straight leg raising test preoperatively are more likely to be satisfied with microdiscectomy and have less disability in the early postoperative period.

Methods: Consecutive cohort of 67 patients with clinical and radiological diagnosis of lumbar disc herniation who underwent microdiscectomy. The inclusion criteria were the presence of a posterolateral herniated lumbar disc on magnetic resonance image scans and persistence of sciatica after clinical treatment for 4 to 8 weeks or progression of motor impairment in the inferior limb. The exclusion criteria were previous surgery, history of disabling low back pain, associated lumbar stenosis or spondylolisthesis, and being on workers compensation. All patients underwent clinical and functional evaluation at 30 days postoperatively. The Lasègue test was performed with the patient supine without dorsiflexion of the ankle, and the result was considered positive when the patient recognized typical nerve root pain at a degree up to 60. Functional evaluations were conducted with numerical rating of pain for leg and low back, Oswestry Disability Index (ODI), SF36, Beck Depression Inventory and Hospital Anxiety and Depression Scale.

Results: 49.3% of the sample presented with a positive Lasègue preoperatively. In the preoperative period, there was no difference in clinical and functional features between the groups. The follow-up, the patients who had a positive Lasègue preoperatively had less disability compared to patients without Lasègue’s sign (mean difference in ODI: 9.20; CI95%: 1.23 – 17.17; p = 0.024). Satisfaction with the treatment was higher in the positive Lasègue group (96.7% X 80.6%; X: 3.852; p = 0.050). The follow-up, no patients had a positive straight leg raising test.

Conclusion: Patients with positive straight leg raising test preoperatively are more likely to be satisfied with microdiscectomy and have less disability in the early postoperative period.

456. Lasègue’s Sign Is a Predictor of Short-Term Outcome in Lumbar Disc Herniation Surgery

Asdrubal Falavigna, Orlando Righesso, Alison Teles

Introduction: The objective of this study was to determine the predictive role of Lasègue’s sign in short-term outcome in lumbar disc herniation surgery.

Methods: Consecutive cohort of 67 patients with clinical and radiological diagnosis of lumbar disc herniation who underwent microdiscectomy. The inclusion criteria were the presence of a posterolateral herniated lumbar disc on magnetic resonance image scans and persistence of sciatica after clinical treatment for 4 to 8 weeks or progression of motor impairment in the inferior limb. The exclusion criteria were previous surgery, history of disabling low back pain, associated lumbar stenosis or spondylolisthesis, and being on workers compensation. All patients underwent clinical and functional evaluation at 30 days postoperatively. The Lasègue test was performed with the patient supine without dorsiflexion of the ankle, and the result was considered positive when the patient recognized typical nerve root pain at a degree up to 60. Functional evaluations were conducted with numerical rating of pain for leg and low back, Oswestry Disability Index (ODI), SF36, Beck Depression Inventory and Hospital Anxiety and Depression Scale.

Results: Motor dysfunction was observed in 62.09% of the patients (95/153). The patients with motor dysfunction had shorter duration of symptoms compared with the patients with normal neurological examination (30 X 60 days; p = 0.02). Disability was higher in the motor dysfunction group. The mean difference in ODI was 8.15 (CI95%: 1.42 14.88; p = 0.01). The levels of leg pain were higher in patients with motor impairment (8.62 X 7.66; p = 0.01) and low back pain was higher in the group without motor dysfunction (4.50 X 3.32; p = 0.02). There was no statistically significant difference in SF36, depression and anxiety between groups.

Conclusion: The patients with lumbar disc herniation and motor dysfunction present with more disability and leg pain.

457. Does Motor Impairment Reduce Function and Quality of Life in Patients with Lumbar Disc Herniation?

Asdrubal Falavigna, Orlando Righesso, Alison Teles

Introduction: Motor dysfunction is often observed in patients with lumbar disc herniation and sciatica. The objective of this study was to determine the relation of motor dysfunction to pain, disability and quality of life.

Methods: A cross-sectional study based on the preoperative evaluation of a surgical cohort of 153 patients with lumbar disc herniation. The inclusion criteria were the presence of a herniated lumbar disc observed on magnetic resonance imaging scans and persistence of sciatica after 4 weeks of conservative treatments. The patients with previous surgery were excluded. The following variables were collected: age, gender, length of symptoms, work compensation, neurologic examination (motor, sensitive, and reflexes), leg and low back pain (numerical rating scale of pain), quality of life (SF36), disability (Oswestry Disability Index), depression and anxiety (Beck Depression Inventory and Hospital Anxiety and Depression Scale). Bivariate analyses were conducted in order to compare the groups. This sample detects a minimal important difference (10 points in ODI) between groups with a significance level of 95% (alpha error = 5%) and statistical power of 85% (beta error = 15%).

Results: Motor dysfunction was observed in 62.09% of the patients (95/153). The patients with motor dysfunction had shorter duration of symptoms compared with the patients with normal neurological examination (30 X 60 days; p = 0.02). Disability was higher in the motor dysfunction group. The mean difference in ODI was 8.15 (CI95%: 1.42 14.88; p = 0.01). The levels of leg pain were higher in patients with motor impairment (8.62 X 7.66; p = 0.01) and low back pain was higher in the group without motor dysfunction (4.50 X 3.32; p = 0.02). There was no statistically significant difference in SF36, depression and anxiety between groups.

Conclusion: The patients with lumbar disc herniation and motor dysfunction present with more disability and leg pain.

458. Intermediate Term Experience with Tantalum Trabecular Metal Implants in the Cervical Spine

Daniel S. Yanni, Dana L. Christiano, Antonios Mammis, Pinkain Rameshchandra Jethwa, Ira M. Goldstein

Introduction: Trabecular metal (porous tantalum) is a porous, osteoconductive scaffold that has been used for bony reconstruction applications. Previous literature have demonstrated a high
Manubriotomy

Methods: Prospective cohort study of 16 patients who underwent an anterior approach to the cervicothoracic junction. The following features of the sagittal reconstruction of CT were taken into account to perform manubriotomy: (1) the surgeon’s parallel view of the superior vertebral body plateau that will be resected until the vertebral canal is reached and its correlation with the superior border of the manubrium and (2) the location of the great vessels, such as the aortic arc, right brachiocephalic trunk and brachiocephalic vein. If a corpectomy was intended, a line was drawn parallel to the superior plateau of the vertebral body to be resected from the vertebral canal to a position anterior to the manubrium. This line represents the surgeon’s operative view. If this line crossed above the superior border of the manubrium, a supramanubrial view, the manubriotomy was not necessary; otherwise the manubriotomy was performed.

Results: Preoperative radiological evaluation identified all cases in which manubriotomy was necessary (6/16). The mean surgical time, bleeding volume, pain intensity, medication intake and length of hospital stay were less in the cases in which manubriotomy was not necessary.

Conclusion: The need to perform or not the manubriotomy depends on the level of vertebral lesion and the vertebral body inclinations, the latter being the most important criterion. In our experience, injuries involving the C7 vertebral body and C7–T1 intervertebral disc herniation were treated with a standard cervical supramanubrial approach; when a T1 and/or T2 corpectomy was necessary, the line parallel through the superior plateau of the vertebral body to be resected suggests the need for the manubriotomy.

460.

Silicon Substituted Calcium Phosphate (SiCaP) as Bone Graft in Trans–sacral Fusion Procedures (AXIALIL™)

Juliano Fratezi, Harry Heinz Gebhard, Tatiana Olivia Saleh, Roger Hartl

Introduction: Trans–sacral fusion (AXIALIL™) permits a minimally invasive discectomy and attempts to achieve stabilization with low complication rates, minimal blood loss, muscle disruption, postoperative pain and shortened hospital stays. Actifuse™ is a calcium phosphate bone graft substitute with selective controlled silicate substitution in a patented 3–dimensional structure resembling natural bone. The goal of this study was to evaluate fusion rates in patients undergoing trans–sacral fusion surgery with SiCaP.

Methods: 27 patients, who underwent one or two level trans–sacral fusion with SiCaP (Actifuse™) were evaluated. All procedures were done with posterior fixation via pedicle screws and posterolateral fusion. Patients were followed with X–rays, CT–scans, Oswestry Disability Index (ODI), and Visual Analogue Scale (VAS) for back and leg pain.

Results: 13 males and 14 females (52.2 years, range 19–77) were included, 2 two–level procedures were performed. Mean follow/up (f/u) was 6.1±2.3 months 18/18 patients with f/u > than six months were radiographically fused. Four patients were smokers and there were no diabetic patients in this group. Subsidence of three and 3.87mm was seen in two patients, but this did not affect clinical outcome or fusion rates. VAS scores for back and leg pain, as well as ODI scores improved, 29% and 47.8%, respectively, after surgery.

Conclusion: Preliminary results are encouraging and show trans–sacral fusion with SiCaP bone graft to be a viable minimally invasive technique for L4/L5/S1 fusion. SiCaP has shown fusion success rates comparable to autograft. Avoiding donor site morbidity with SiCaP (Actifuse™) adds a benefit to minimally invasive spine surgery. The addition of silicate to a 3D structure appears to produce a biological response that appears to promote bone growth.
compared with 12 patients contemporaneously treated with C1 lateral mass screws for rigid cervical fixation (group L).

**Results:** In group 1, all 12 screws were radiographically contained fully within the pedicle, as opposed to only 16 of the 18 of the C1 lateral mass screws. The operative blood loss was significantly lower in the pedicle screw group (217 ± 52 ml vs. 523 ± 337 ml; p < 0.05). There were no vertebral artery, C2 nerve root injuries, or patients with occipital neuralgia in the pedicle screw group.

**Conclusion:** C1 pedicle screws can be safely placed with low morbidty when the vertebral artery is mobilized from its groove in the superior aspect of the atlas. This technique, when feasible, allows for direct visualization of the screw trajectory, likely decreases blood loss and the risk of C2 nerve root injury.

462. **Cervical Kyphosis: A Novel Classification System and Operative Treatment Algorithm**


**Introduction:** Cervical kyphotic deformity (CKD) is a variable disorder that presents with a wide array of clinical and radiographic manifestations and results from a broad various etiologies. Patients frequently experience axial and/or radicular pain with or without neurological deficits. Their surgical management is often challenging. Currently, no classification system has existed to establish the various types of cervical kyphotic deformities. We developed a novel algorithm for the classification and operative correction of the various CKDs based our experience in treating these types of deformities.

**Methods:** We present 15 cases (11 females, 4 males, mean age 57 years, range 16–79 years) exemplifying this classification and treatment algorithm. Flexion and extension cervical spine radiographs were obtained in all patients. Cases were classified as reducible (Type 1), partially reducible or fixed without fused facets (SPV-Type 2), partially reducible or fixed with fused facets (Type 3), or fixed with both anterior and posterior column fusion (Type 4). High-resolution computed tomography scans with reconstructed images were obtained on all non-reducible patients to determine the degree of fusion within the facet and uncovertebral joints. Single-stage anterior cervical discectomy with complete, bilateral release of the anterolateral annular ligaments, allograft fusion (ACDF) and plating was utilized to achieve complete correction in Type 1 and 2. Deformities of Type 3 and 4 were corrected with initial posterior facet osteotomies, followed by ACDF with or without plating and concluded with posterior lateral mass instrumentation. Electrophysiological monitoring and general anesthesia were used in all cases. Postoperative lateral X-rays were used to evaluate correction of kyphotic deformity.

**Results:** Satisfactory correction was achieved in all cases using surgical approaches guided by our classification algorithm with a mean correction of 36.8° ± 4.2 SE. There was no instance of perioperative mortality or progression of neurological deficits.

**Conclusion:** We discuss our treatment algorithm, strategies and surgical techniques as well as outcomes for patients with these deformities. This classification and algorithm identifies the type of cervical kyphosis and a treatment plan which provides good surgical outcomes.

463. **Cervical Spine Fusion Utilizing Silicon Substituted Calcium Phosphate (SiCaP)**

Juliano Fratezi, Harry Heinz Gebhard, Tatiana Olivia Saleh, Roger Hartl

**Introduction:** Fusion is the standard procedure for a variety of diseases in the cervical spine. Bone graft substitutes have been developed to obviate the need for autograft from the iliac crest and its resultant complications. Actifuse™ is a calcium phosphate bone graft substitute with selective controlled silicate substitution in a patented 3-dimensional structure resembling natural bone.

**Methods:** 15 patients who underwent cervical spine fusion were studied with x-rays and CT scans. Clinical evaluation included the Neck Disability Index (NDI) as well as VAS assessments done both pre- and postoperatively.

**Results:** Nine males and six females (avg. age 53.1 year, range 15–88) were included. Six patients underwent an anterior approach, seven a posterior approach, and three had combined anterior and posterior cervical fusion for a total of 42 levels. Follow-up time averaged 14.9 months, range 7–30. Radiographic fusion was seen in 15/15 (100%) patients, with no subsidence, hardware breakage, or loosening. Two patients were smokers and there were no diabetic patients. Average NDI scores decreased 14.0 points (pre-op 34.5, post-op 20.5, a 40% improvement); average neck VAS scores decreased 4.1 points (5.4 pre-op to 1.3 post-op; a 76.6% improvement; average arm VAS scores decreased 1.6 points (2.6 pre-op to 1.0 post-op, a 60.7% improvement). No complications such as osteolysis or soft tissue swelling occurred with the use of Actifuse™. Solid fusion occurred in all subjects, with no heterotopic bone formation or intracanal bony ingrowth.

**Conclusion:** Preliminary results from this series with the use of Actifuse™ bone graft substitute were encouraging. Actifuse™ appears to be a reliable alternative to autograft in cervical spine fusion, achieving solid fusion with no complications.

464. **3-D Stereotactic Navigation in Mini-open Transforaminal Lumbar Interbody Fusion (TLIF)**

Harry Heinz Gebhard, Karishma Parikh, Juliano Fratezi, Roger Hartl

**Introduction:** Percutaneous or mini–open spinal fusion procedures rely on imaging techniques for the placement of instrumentation which are associated with significant radiation exposure. Exact placement of instrumentation can be challenging, especially in the presence of a deformity. We used stereolactic computer assisted navigation to approach these concerns and report preliminary results.

**Methods:** 31 patients suffering from degenerative disc disease and/or spondylolisthesis, underwent mini-open TLIF with uni- or bilateral transpedicular screws. An Iso-C-arm and 3-D stereolactic navigation were used for screw placement. Retrospective data analysis was compiled from one and two level procedures. Screw accuracy (SA) was graded: 0 (accurate screw placement), 1 (>2mm displacement), and 2 (>2mm displacement). Visual analog scale (VAS) for back and leg pain, and the MacNab Outcome Score (MNS) were also assessed.

**Results:** Radiographic fusion was seen in 79.2% of the patients at a mean follow-up of 20.7 ± 4.9 months (n = 24, range 6–47). SA results were as follows: 0 (72%), 1 (16%), 2 (12%). Blood loss was 115.3 ± 63.0 ml. An intraoperative CSF leak occurred in 11.1% of cases. Length of stay was 3.9 ± 2.1 days. Mean VAS (back) at 18.4 ± 16.2 months (n = 36, range 1–48) had improved from 7.6 ± 2.8 to 3.0 ± 3.1 (VAS leg: 6.2 ± 3.4 and 2.2 ± 3.1, respectively). MNS was excellent in 29.4%, good in 55.9%, fair in 11.8% and poor in 2.9% of patients. All pseudarthroses (20.8%) were found in
the unilateral fixation group. Use of silicon substituted calcium phosphate (Actifuse™) as a bone graft tended to result in less pseudarthrosis than use of bone morphogenic protein (Infuse®). Conclusion: Mini-open TLIF resulted in a favorable outcome. 3-D navigation allowed for reliable screw insertion without surgical complications and minimal radiation exposure to operating room staff. Unilateral screw placement was associated with a high non-union rate and is not recommended.

465. Retrospective Analysis of Cervical Subaxial Trauma Patients Treated Surgically for Stabilization
Muhltiln Beirgen, Fangxiang Chen, Jennifer Noelker, Patrick W. Hitchon
Introduction: Traumatic subaxial cervical fractures can lead to significant medical consequences. Spinal cord compression and instability are 2 main issues to be considered in choosing the anterior or posterior surgical approach. Pathology dictates the approach in some situations such as: patients having spinal cord compression from either side needing decompression, coexisting traumatic disc rupture, locked facets or unreduced lesions with conservative ways. In others there is no clear consensus for choosing either approach, and this often depends on surgeon’s preference. In this study we analyzed our clinical experience retrospectively to identify our outcomes for surgeries with anterior vs posterior approaches.
Methods: From January 2000 to August 2009, 131 cases with cervical subaxial trauma underwent surgery. Thirty-three of these patients could have been treated through either an anterior or posterior approach and compose our study group. Patients in whom pathology dictated the approach, or did not have a 6 months follow-up were excluded.
Results: Posterior instrumentation and fusion was performed in 15 (45%) and anterior instrumentation in remaining 18 cases (55%). Diagnosis of these consist fracture dislocation in 26, compression fracture in 6, and distraction injury in 1. Initial conservative management was traction in 14, halo in 1 and collar in the remaining 18. Number of fused segment was 1 in all patients in the anterior group. In the posterior group fused segment was 1 in 3 patients, 2 in 2 patients, 3 in 5 patients, 4 in 4 patients and 5 in 1 patient. Surgical mortality is 0. Acute surgical complication was seen in 1 patient in the posterior group with hematoma in the surgical site. Failure of the construct occurred in 1 patient who underwent an anterior approach but needed additional posterior stabilization 1 week later. None of the patients suffered additional neurological deficits after the surgery. All patients achieved bony fusion and good alignment at follow-up.
Conclusion: Either anterior or posterior approach can be used for stabilization of subaxial cervical fractures. Posterior instrumentation entails a larger number of fused segments. This review is intended to suggest guidelines for stabilization either with anterior or posterior approaches.

466. Posterior Interbody Fusion with Distractable Cages: Pearls and Pitfalls
Susan Catherine Williams, Kenneth Foxx, Robert John Bollo, Jonathan Latzman, Uzma Samadani
Introduction: Distractable intervertebral body cages can be placed via a posterior approach were approved by the FDA in 2007. They allow for controlled in situ distraction of the disc space using PEEK wafers. The purpose of this study was to analyze our experience with these distractable cages in regards to patient selection, intraoperative time, complications and outcome.
Methods: The Manhattan Veteran’s Hospital database was queried for all cases of posterior intervertebral body fusion with distractable cages. Patients’ records were analyzed for length of operative time, intraoperative blood loss, incidence of complications including infection, unintended durotomy, injury to nerve roots, new neurological deficit, graft extrusion and graft subsidence. Single-level interbody fusions with distractable cages combined with single-level posterolateral fusion were compared with regard to blood loss and operative time to a database of all PLIF and TLIF cases performed at our center between 2002 – 2009.
Results: A total of 33 distractable cages were placed in 13 patients at 17 levels. One patient experienced an acute onset of cauda equina syndrome secondary to the migration of a cage wafer and had to be reexplored and a different patient experienced a wound infection. No other complications were incurred. Comparing our seven single-level distractable interbody fusions (dIF) to our database of 16 single-level TLIFs and 12 single-level non-distractable PLIFs, there was no statistically significant difference in intraoperative blood loss (dIF vs. PLIF, p=0.27; dIF vs. TLIF, p=0.27; PLIF vs. TLIF, p=0.98) or operative time (dIF vs. PLIF, p=0.13; dIF vs. TLIF, p=0.68; PLIF vs. TLIF, p=0.15).
Conclusion: Distractable cages can fit into compressed disc spaces with less retraction on the thecal sac and nerve roots. The major disadvantages are that they cannot be packed with bone graft and caution must be taken during insertion to avoid cage wafer extrusion.

467. In vivo Model for Implantation of Tissue Engineered Intervertebral Discs in the Rat Tail
Harry Heinz Gebhard, Robby Bowles, Lawrence J. Bonassar, Roger Hartl
Introduction: Degenerative Disc Disease is a leading cause of pain and disability. Partial or complete intervertebral disc (IVD) replacement with either mechanical or biological implants is a promising alternative to conventional fusion surgery. Initial composite disc implants showed promising properties in vitro. Little is known, however, regarding implant survival and integration in vivo. An animal model was developed to study these parameters in the rat tail.
Methods: Immunocompromized male rats (230–260g) were anesthetized and the caudal level (CA 3/4) was determined radiographically. A dorsal approach was established to expose the disc level and to perform a microsurgical discectomy. A bioengineered composite disc was implanted. The rodents were randomly distributed into three survival groups (one, two and three months) and followed clinically, with X-rays and MRI scans. Histology, biomechanical properties and biochemistry of the motion segments were determined after sacrifice.
Results: The model allows for reproducible discectomy and disc implantation in the rat tail spine. 20 Animals have been studied and we did not observe deformity, surgical or postoperative complications in the athymic rats. Histology showed complete removal of the intervertebral disc and a stable implant in place over the course of the experiments. Disc height was preserved in the implant group, compared to the group that had undergone discectomy only.
Conclusion: The newly created model allows for testing of various formulations of bioengineered composite IVDs in vivo. Cellular integration, disc placement, radiographic and MRI parameters can be studied, allowing for further developments in tissue engineered constructs as well as surgical techniques.
**468. One Graft or Two? A CT Morphometric Analysis of Anterior Cervical Fusion**

**Shiveindra Jeyamohan, John W. German**

**Introduction:** A basic principle of interbody fusion is that the surgery should maximize the surface area available for fusion. While some surgeons may advocate the use of multiple grafts per level, the results with a single graft are felt to be adequate in most patients. To date there is limited quantitative data regarding interbody fusion. Herein an attempt is made to quantify the surface area available for fusion.

**Methods:** Immediate postoperative CT scans from 24 patients who had undergone anterior cervical interbody fusion were reviewed. The following CT morphometric parameters were calculated: maximal effective surface area (MESA) available for fusion defined as the maximum length and width of the interspace, the graft surface area (GSA), and the per cent of the maximal effective surface area available for fusion covered by the graft (GSA/MESA). Results were compared for levels in which a single vs. two grafts were placed.

**Results:** Thirty-four spinal levels in 24 patients were analyzed of which 29 had a single allograft placed and 5 had two allografts placed side by side. The MESA was 299.1 ± 91.5 sq mm with a range of 122.1 to 534.4 sq mm. The difference in GSA between a single and two allografts was significant (single: 142.2 ± 55.9 sq mm; two: 233.9 ± 54.5 sq mm, p < 0.05). The difference in the GSA/MESA was not significant (single: 55.9 ± 13.4 per cent; two: 54.5 ± 16.3 per cent; p > 0.05).

**Conclusion:** In this preliminary CT morphometric analysis a surprisingly large range was identified in the MESA available for fusion. While the addition of a second allograft significantly increases the GSA it does not necessarily increase the per cent of the maximal effective surface area available for fusion covered by the graft.

**469. Rod Bending: Can Computer Assistance Help?**

**Shahid MehdNimjee, Carolyn Hardin, Robert E. Isaacs**

**Introduction:** Rod bending can be a time consuming and frustrating step in the finalization of a complex spinal construct. It requires repetitive bending and rebending which ultimately promotes metal fatigue and the creation of stress risers. When performed poorly, it preloads the construct and increases the chance of hardware failure.

**Methods:** Eight fellowship-trained orthopedic and neurosurgical spine surgeons were given the task of shaping a rod to a very difficult seven screw construct using standard equipment. Each surgeon had a minimum of 2 years post-fellowship experience and all have practices devoted to spinal surgery. Their times to complete the rod were compared to the time it took to form a rod sized and shaped using the Bendini system. This device consists of a means to steriley acquire the positions of the screws and a modified manual rod bender capable of following the derived bend instructions.

**Results:** Using a 5.5mm rod and a French bender, fellowship-trained surgeons took 16–27 minutes to get the rod fully seated into the screws. It took over 50 removals and rebending attempts in each case to achieve a properly formed rod. In contrast, in each of 3 attempts, the computer-designed rod took less than 2 minutes to form and fit the screws without any rebending. On average, the use of computer- assistance decreased the time it took to produce a rod by an order of magnitude (p < 0.001 compared to the surgeon’s times).

**Conclusion:** Computer-assistance can significantly reduce the complexity of rod bending. It can lower the number rebending steps required to form a properly seated rod. As repeatedly rebending a rod induces metal fatigue, when presented with a complex spinal construct, one could consider computer-assistance as a means to not only reduce operative time but also serve as a means to potentially lesson the risks associated with manual rod formation.

**470. Concomitant Traumatic Brachial Plexus and Spinal Cord Injury: An Underestimated Association**

**Marie-Noëlle Hébert-Blouin, Elena Pirola, Peter C. Rhee, Allen T. Bishop, Alexander Y. Shin, Jonathan Morris, Robert J. Spinner**

**Introduction:** Concomitant traumatic brachial plexus and spinal cord injury are rarely reported. The diagnosis of one or the other of these lesions may be difficult, especially if the deficit from one of the lesions is an important deficit. This study evaluates: 1) the frequency of spinal cord injury in patients with traumatic brachial plexus injury, and 2) the characteristics of patients with combined spinal cord and brachial plexus injuries.

**Methods:** A retrospective review of adult patients with traumatic brachial plexus injury evaluated at our institution between 2000 and 2008 was performed.

**Results:** Thirty-five (11.3%) of 311 patients with traumatic brachial plexus injury had symptoms and/or signs of a spinal cord lesion, including motor, sensory and/or sphincter deficits (n = 22), and/or upper motor neuron lesion signs (n = 28). Eight patients had a spinal cord injury syndrome (Brown–Sequard (4), anterior cord (2), complete cord (2)). Compared to patients without concomitant spinal cord injury, patients with a combined brachial plexus and spinal cord injury had more supravclavicular vascular injuries (8.6% vs 1.8%, p = 0.033), cervical spine fractures (48.6% vs 19.9%, p = 0.0001), pain (VAS 5.5 vs 3.6, p = 0.011), Horner’s syndromes (68.6% vs 37%, p = 0.002), and phrenic nerve palsies (25.7% vs 13.8%, p = 0.043). The available MRI showed spinal cord contusions (n = 22) and epidural hematomas (n = 5).

**Conclusion:** Spinal cord injury associated with a traumatic brachial plexus injury may be subtle and missed secondary to the important deficits caused by the brachial plexus injury. A detailed neurological exam, the presence of associated injuries, and cervical MRI may help identify these concomitant spinal cord injuries, which can influence the prognosis and treatment of these patients.

**471. Is There a Substantial Benefit to Interbody Fusion (IBF)? A Minimally Invasive (MIS) Perspective**

**Ankit Mehta, Chad Cook, Maura Tresch, Kara Penne, Melanie Marshall, Carolyn Hardin, Robert E. Isaacs**

**Introduction:** Increasingly it seems that various parties question the benefit of fusion in the treatment of spine disease. Whereas much of our internal discussions focus on the correct treatment of a disorder, it behooves us to display the results of IBF on the wide variety of pathologies encountered that require arthrodesis. Herein we describe a consecutive series of patients undergoing MIS IBF for a variety of pathologies.

**Methods:** A retrospective cohort study of prospectively collected data was performed. A consecutive series of fifty-nine patients who underwent a 1–2 level MIS fusion using two IBF techniques (MITLIF and XLIF) over a three-year period was analyzed. ODI and VAS scores were used to determine the percentage of
patients to reach substantial clinical benefit (SCB). Primary pathologies treated included spondylolisthesis (26), post-decompression instability (8), DDD (6), deformity (5), adjacent level disease (4), infection (2), and nonunion (1).

Results: The net improvement in VAS at one year was 9/11 (MITLIF/XLIF, respectively), almost all of which (89%/93%) was seen at 6 weeks. Both groups had a 20 point average improvement in ODI (20.7/19.5). Over 79% (74%/84%) reached SCB based on ODI while 94% (87%/100%) had substantial benefit based on VAS. Every diagnostic category had at least an 80% likelihood of obtaining SCB with respect to pain, and all diagnoses but deformity had at least a 75% chance of gaining SCB with respect to disability.

Conclusion: Nearly all of the patients, despite the MIS technique used, received a substantial reduction in their pain and the vast majority reached a substantial improvement in their functioning. This data furthers our understanding of the ability of IBF to address in a substantive way the symptoms and disabilities of our patients. Moreover, this data shows that for a wide variety of pathologies, MIS IBF techniques can yield a significant improvement in the quality of our patients’ lives.

Timothy Flerlage, Can Solacoglu, Ziya L. Gokaslan, Jean-Paul Wolinsky, Ali Bydon, Timothy F. Witham, Daniel M. Sciuabba

Introduction: Giant cell tumors (GCT) occur infrequently in the spine. Though histologically benign, these tumors behave aggressively, attain significant vascularization, and grow quickly. Thus, these lesions can reach a large size prior to clinical presentation, causing marked neurological dysfunction and complicating significantly surgical resection. Prevention of recurrence following surgical resection is a major consideration. Several treatments have been proposed, but consensus opinion on the optimum management has not been reached.

Methods: All cases of benign GCT at Johns Hopkins Hospital between 2004 and 2008 were examined retrospectively. In our review, we gathered information on demographics, presentation, treatment, and recovery, with special focus on morbidity and recurrence.

Results: Nine cases were found with a mean follow up time of 22 months. Local pain was the most common complaint (100%). Other symptoms included bowel and bladder dysfunction (60% sacral lesions), myelopathies (77%), paresthesias (22%), radiculopathies (22%), and pathologic fracture (11%). Seven patients (77%) underwent intralesional resection with coredectomy or vertebrectomy, one (11%) underwent en bloc resection, and one (11%) underwent transpedicular resection. Preoperative embolization was performed in 7 (77%) patients. Symptoms improved in seven (77%) patients. There were two (22%) confirmed cases of recurrence, both subsequent to intralesional resection, with a mean time to recurrence of 7 months (range 5–9 months). Adjunct therapy was given in cases of recurrence. During follow-up, no significant long-term complications were seen.

Conclusion: GCTs are aggressive tumors that can compromise neurologic function. En bloc resection may obtain a cure, but carries with it possible significant morbidity. Intralesional resection can ameliorate presenting symptoms, but it increases risk of recurrence. In this series, en bloc resection was undertaken with acceptable morbidity and with lower rates of recurrence than intralesional resection. Therefore, in select patients who can tolerate it, it is recommended that en bloc resection be performed to reduce risk of recurrence.

473. Evidence that Atypical Juxtafacet Cysts are Joint-Derived

Introduction: Juxtafacet cysts (JFC) in usual locations have frequently been shown to have joint connections. The pathogenesis of JFCs in unusual locations has remained obscure. We hypothesize that all JFCs, including atypical ones, would be joint-derived.

Methods: In this study we sought to explain the occurrence and formation of clinical outliers of spinal JFCs. In part I, an extensive literature search was performed to identify case reports of spinal intralesional cysts which have been unappreciated despite the fact that they should occur. In part II, far lateral (extraforaminal) cysts treated at our institution and in the literature were studied. The presence of a joint connection was specifically looked for since this finding has not been widely appreciated.

Results: In part I, three isolated case reports of spinal intralesional JFCs without reported joint connections were identified: two involving L5 and one, C8. In part II, six patients with far lateral JFCs treated at our institution were reviewed and all had joint connections. Two of these had been previously published, although their joint connections were not appreciated. In two of the newly reported cases, arthrography confirmed a communication between the facet and the cyst. Only one of five cases in the literature had a recognized joint connection.

Conclusion: We believe that all JFCs are joint-derived. This explanation for intraneural and extraneural JFCs in typical locations would be consistent with the unified articular (synovial) theory and the pathogenesis for intraneural and extraneural ganglion cyst formation in the limbs. Facet joints appear no different than other synovial joints occurring elsewhere. Understanding the pathogenesis of these cysts will help target treatment to the joint, improve surgical outcomes and decrease recurrences.

474. Cone Beam CT Scan vs. Fluoroscopy: A Cadaveric Study Comparing Accuracy, Time and Radiation Doses
Anthony G. Gibson, Dean G. Karahalios, Eric A. Poit, Jean-Pierre Mobasser, Shane Burch

Introduction: Intraoperative Cone Beam CT Scanning (O-ARM) is currently indicated for complex and MIS spinal procedures. This cadaveric study compared the efficiency, accuracy and radiation dose of O-ARM with conventional fluoroscopy (C-ARM). Our hypothesis is that O-ARM is a more accurate and efficient technique.

Methods: Four participating surgeons operated on eight cadavers without deformity. Instrumentation was placed bilaterally at T1–6 and L5–S1 using open technique and MIS at L3–4. A total of 160 screws were placed, 80 using O-ARM and 80 using C-ARM. Dosimeters were placed on the cadaver and over the surgeon and scrub techs lead. Postoperative CT scans were performed on O-ARM and with a stationary CT scanner. An independent radiologist assessed CT scans for malpositions.

Results: Setup time for O-ARM cohort was 592 vs. 297 for C-ARM (p less than 0.05). The mean time to place screws was 1037s for O-ARM and 1342s for C-ARM (29% difference, p=0.06). The mean total time showed no statistical difference (O-ARM= 1629s, C-ARM= 1639s, p=0.96). 5 breaches were identified in O-ARM cohort and 7 in C-ARM. The difference in these rates was not statistically significant (Chi2=0.63, p=0.4). Surgeons received higher radiation doses using C-ARM in
lumbar and MIS procedures (p less than 0.05). No statistical difference was detected in radiation doses for cadavers except in lumbar procedures on lateral dosimeters, O-ARM dose 49.23±14.3 mSv vs. 21.2±9.9 mSv (p=0.0001).

Conclusion: In cadavers without deformity, O-ARM gives lower doses of radiation to the surgeon but higher to the patient, it allows more rapid placement of screws, but slower setup. The two methods showed similar total time and accuracy.

John W. German

Introduction: Only limited results have been presented for the management of cervical spondylotic myelopathy (CSM) with a minimally invasive (MI) technique.

Methods: A retrospective review was undertaken of 26 CSM patients undergoing a MI posterior cervical decompression for myelopathy. Clinical outcomes were assessed by physician derived Nurick grade and modified JOA score (mJOA), as well as patient derived neck and arm visual analog scores (VAS), neck disability index (NDI), SF-12, and patient satisfaction index (PSI).

Radiographic outcomes were assessed by curvature index (CI), Cobb angle (CA) and range of motion (ROM).

Results: At a mean clinical follow-up of 14.2 months, a difference was observed in the Nurick grade (Pre-op: 3.3±1.3; post-op: 2.4±1.2; p less than 0.05), mJOA score (Pre-op: 11.3±2.9; post-op: 14.0±2.8; p less than 0.05), neck VAS (Pre-op: 4.7±3.1; post-op: 3.2±3.0; p less than 0.05), and NDI (Pre-op: 45.8±20.0; post-op: 36.1±26.6; p less than 0.05). No change was seen in right arm VAS (Pre-op: 2.7±2.8; post-op: 2.5±2.8; NS), left arm VAS (Pre-op: 3.4±3.1; post-op: 2.4±2.8; NS), SF-12 physical component score (Pre-op: 28.9±6.2; post-op: 33.2±12.7; NS) and SF-12 mental component score (Pre-op: 40.9±12.6; post-op:45.9±12.4; NS). The PSI for the procedure was high (3.9±1.3).

At a mean radiographic follow-up of 5.7 months, a difference was observed in range of motion (Pre-op: 42.6±10.4 degrees; post-op: 37.1±12.1 degrees; p less than 0.05). No difference was noted in CI (Pre-op: 14.3±14.0; post-op: 15.5±11.9) or CA (Pre-op: 15.0±10.1; post-op: 12.6±9.0).

Conclusion: MI posterior cervical decompression can be applied in the setting of CSM with good clinical and radiological results. This technique improves or stabilizes neurological function in the majority of patients and may have advantages over open posterior cervical approaches by limiting some risks associated with open posterior cervical surgery.

476. Four-level ACDF Utilizing Two Dynamic Plates To Provide Angular Dynamic Movement in Addition to Vertical Setting
Fred H. Geisler, Daniel T. Laich

Introduction: Four level ACDF with single plate screw stabilization historically has a high failure rate, with the plate dislodging from the vertebral bone in up to 30% of the cases. It was hypothesized that using two plates with a butt joint in the middle, allowing angular setting, would prevent the dislodgment seen in a single long plate construct.

Methods: A retrospective consecutive case series of four level ACDF in 35 patients was analyzed. Both the Aesculap and Rhasuler dynamic plate screw constructs were utilized. The middle vertebral body, the site of the butt joint, had 4 screws placed (2 from the superior and 2 from the inferior plate).

Results: No screw or plate failure occurred. The vertical setting of the construct was 6.6mm mean with 3.3mm standard deviation. The angular settling was 1.85 degrees mean with 3.88 standard deviation. The PSI for the procedure was high (3.9±1.3).

Conclusion: The use of two dynamic plates, each of two levels, with a butt joint creating a dynamic angular element similar to a hinge at the center of the construct has been demonstrated to be dynamically active and to prevent mechanical failure of the plate screw construct.

477. Modest Hypothermia for Spinal Cord Untethering: An Historical Cohort Comparison Study
Matthew D. Cummock, Barth A. Green, Jeremiah N. Johnson, Allan D. Levi, Michael Y. Wang

Introduction: Operative intervention to untether the spinal cord carries significant risk for neural injury. Moderate hypothermia (32 – 33 Co) is a neuroprotective strategy that has conferred significant neural protection in animal models and is currently being investigated for possible benefit in human traumatic brain and spinal cord injury. We investigated the safety of controlled modest hypothermia on patients undergoing elective spinal cord untethering surgery.

Methods: A retrospective chart review was performed on two groups: 36 patients of a single surgeon that underwent spinal cord untethering with intraoperative modest hypothermia (33 Co) between 2005-2008 and a historical control group consisting of 66 patients of the same surgeon who underwent spinal tumor resection at normothermia (37 Co) from 2001-2004. Intraoperative hypothermia was achieved over 30 minutes and maintained using an intravascular cooling catheter. After the procedure, patients were re-warmed to normothermia at 1 Co per 8 hours. The primary endpoint was blood loss and length of surgery.

Results: There was no statistical difference in the demographic variables including age 45 for the hypothermia group and 49 for the control group. There is a statistically significant difference between the two groups with a mean surgical length of 7.2 hours for the hypothermia group and 6.1 hours for control. There was no significant difference in EBL between the groups.

Conclusion: In our series of 36 patients, we found intraoperative modest hypothermia during spinal cord untethering procedures to be feasible and safe.

478. Surgical Interventions for Traumatic Lesions of the Brachial Plexus
Rabi Narayan Sahu, Raj Kumar, Vijendra K. Jain, Ashok Mahapatra, Sanjay Behari, Arun K. Srivastava, Sushila Jaiswal

Introduction: Brachial plexus injuries cause a devastating loss of function in the upper limb. The aim of this study was to review the results of surgical treatment of patients with brachial plexus injuries in a referral hospital of northern India.

Methods: This was a retrospective study between years 2000 to 2008. Twenty patients were included. All patients clinical records scrutinized and results were analyzed with respect to the motor functions of the upper limb both pre and post operatively.

Results: Twenty patients were reviewed. Four patients didn’t undergo surgery. Sixteen patients had exploration and primary surgery done with neurolysis, nerve graft or neurotization or a combination. The surgery of the brachial plexus was followed by an intensive physiotherapy and the result of the plexus surgery was evaluated by Medical Research Council (MRC) grade. Causes of injury included road traffic accidents (n=19) and firearm injury (n=1). Nine patients had cable grafting of the plexus while one patient had neurotization of the plexus in addition to grafting. Six patients
Toshiko Nobuto, George Berci, Adam N. Mamelak, Brian Perri, Ali Shirzadi, Khawar Siddique, Operating Microscope in Spine Surgery (VITOM) as an Alternative to the operation is performed between 3 and 6 months after trauma will be discussed.

479. Use of a High-definition Telescope (VITOM) as an Alternative to the Operating Microscope in Spine Surgery
Ali Shrizadi, Khawar Siddique, Adam N. Mamelak, Brian Perri, Toshiko Nobuto, George Berci
Introduction: The operating microscope (OM) is commonly used in spine surgery, but has limitations including size, cost, poor teaching aid, ergonomics, and field of view. We evaluated a high-definition rigid lens telescope (VITOM) as an alternative to the OM. VITOM is cheaper, easy to setup, provides high-definition and large field of view, and is an excellent teaching aid. We propose the VITOM provides excellent visualization of structures, is efficient and does not sacrifice patient safety compared to the OM.

Methods: 28 microsurgical lumbar spine operations were performed with the VITOM or OM. Patient demographics, duration of procedure, intraoperative complications, and postoperative assessments (ODI, VAS) were prospectively collected and compared between the VITOM and OM groups.

Results: Of the 14 patients in the VITOM group, 5 patients underwent single level TLIF and 2 patients undergoing 2 level TLIF. 7 additional patients had a 1 to 3 level lumbar decompression. Results were compared to an equivalent group that were operated using the OM. There was no statistical difference in the operative time between the VITOM and the OM groups [single level TLIF n=10 (VITOM 185 min vs OM 150 min with p=0.12); two level TLIF n=4 (VITOM 276 min vs OM 214 min with p=0.15); one to three level lumbar decompression n=14 (VITOM 145 min vs OM 135 min with p=0.48)]. Additionally, there were no intraoperative complications (dural tears, nerve injury, return to surgery) with either group. Follow up data shows equivalent clinical outcomes based on ODI and VAS scales. However, there was less surgeon fatigue, increased participation of the OR team and easier transportation and handling of the VITOM.

Conclusion: Use of VITOM in spine surgery provides a high-definition view of the surgical site with same clinical outcomes as the OM. Benefits of VITOM include improved ergonomics, cost savings, improved teaching capabilities and better transportability.

480. Kinematics of Lateral-Approach Interbody Spinal Fusion Fixation
Huy The Duong, Kee Duk Kim, Alex Turner, Bryan Cornwall, Rudolph J. Schrot
Introduction: Lateral trans-psoas surgical approach is a new method in the armamentarium for lumbar spine fusion. These approach typically involve removal of intervertebral disc material from the level to be fused, insertion of an interbody implant in the newly formed space, and instrumentation such as pedicle screws/rods or plates to increase the stability of the construct. Bilateral pedicle screw/rod construct is considered the standard for providing the most rigidity. The lateral approach has many advantages including retaining the anterior and posterior longitudinal ligament to sustain stability, allowing generous intervertebral disc removal, and providing a large fusion surface for placement of a large, stable interbody implant. In this study, the kinematics of lateral-approach interbody fusion are investigated using multi-segment, pure moment, flexibility testing in a human cadaveric model. The influence of various supplemental instrumentation techniques on the stability of the index level is also examined.

Methods: Eight fresh-frozen cadaveric specimens (L1-L5) were subjected to multi-directional flexibility testing. Motion segment kinematics were obtained using an optoelectronic system. After testing the intact specimen, the stand-alone interbody condition was evaluated at L3-L4, followed by various supplemental fixation configurations: ipsilateral pedicle screws (PS), contralateral PS, bilateral PS, lateral plate, and lateral plate plus contralateral PS. Results were compared using repeated-measures ANOVA and the Holm–Sidak test.

Results: Range-of-motion at the L3-L4 index level was significantly decreased with respect to the intact spine for all test conditions and under all three directions of loading. The lateral plate plus contralateral PS condition was equivalent to bilateral PS in lateral bending and axial rotation. Bilateral PS were significantly more rigid in flexion-extension.

Conclusion: The addition of bilateral pedicle screws to the stand-alone construct provided the most rigid construct, however the combination of the lateral plate with contralateral pedicle screws was statistically equivalent in lateral bending and axial rotation, and the next most rigid construct in flexion-extension. This data suggests that with lateral-approach interbody fusion, surgeons have fixation alternatives to bilateral pedicle screws, depending on the desired degree of rigidity for the operative level.

481. Fractional Anisotropy and DTI Tractography Enhance Nerve Identification in MR Neurography of the Lumbo-Sacral Plexus
Aaron G. Filler
Introduction: MR Neurography using fat suppression and T2 weighting is used on an increasingly common basis in neurosurgery for localization and diagnostic characterization of pathology in the lumbar-sacral plexus. However, for distal plexus elements and smaller branching nerves, it is often difficult to distinguish vessels from nerves. Diffusion tensor Imaging (DTI) can provide very significant contrast differential between vessels and neurological structures. This study explored the lumbar-sacral plexus and posterior pelvis.

Methods: Patients undergoing routine MR Neurography were additionally imaged using an echo planar DTI protocol with 7 to 15 acquisitions in a 1.5Tesla GE scanner. Nerve elements classified as presenting ambiguous identification were reassessed using fractional anisotropy and tractography.

Results: In about 40% of ambiguous cases, DTI was capable of resolving the nerve identification. The smaller nerves that posed ambiguity problems were typically near the signal to noise threshold for DTI and this limited the utility of the method. In addition motion and magnetic susceptibility effects from the adjacent abdominal contents decreased the reliability.

Conclusion: DTI solves nerve identification ambiguities in MR Neurography, however, the utility is limited by signal to noise ratio and other technical image constraints. Better coils and higher field strengths may improve the efficacy.

482. Brachial Plexus Injuries Complicating Video Assisted Thoracic Surgery
Marin F. Stancic
Introduction: Video-assisted thoracic surgery (VATS) is less invasive alternative to open thoracotomy commonly used in the spinal surgery. According to Evidence
Based Medicine (EBM) methodology VATS is associated with better outcomes and the same complication rate as open thoracotomy.

Methods: Two girls (19, 21) underwent VATS for the treatment of pneumothorax. In an attempt to perform hemostasis, the subclavian arteries had to be occluded. Total sensomotoric deficit in both patients on the side surgery was performed was noticed postoperatively. In the first patient nerve roots C5 and C6 were neurolyzed (Fig.1). Neuromas of roots C7, C8 and T1 were resected and graft repair with sural nerves was performed with medial and lateral fascicles (Fig.2). In the second patient the entire plexus was in severe fibrosis. Following neurolysis positive nerve action potentials were recorded.

Results: The first patient after the 4-year follow-up and the second patient after the 1-year follow-up had full range of motion of the shoulder and elbow. Extension and flexion in the wrist and fingers recovered to M4/5. Pain sensation and 2 point discrimination recovered in all fingers.

Conclusion: Presented cases showed that VATS is not without severe complications as EMB methodology suggests. Surgical findings of our patients imply that if this type of complication happened, early surgical exploration could be the best option for the patients.

483. Craniocervical Surgery of the Complex Medullary Compression
Basar Atalay, Kaan Cumhur Yaltirik, Hatice Türe
Introduction: Craniocervical instability and high level compression of the medulla is a challenging situation. Surgical techniques should be planned meticulously to prevent untreatable consequences. Highly complex anatomy of the craniocervical junction needs detailed knowledge of the surgeon to have good surgical results. We have presented complex cases with craniocervical junction compression and instability to emphasize different surgical approaches in this region.

Methods: We have chosen 5 complex cases with craniocervical junction who were treated with different surgical approaches and we have emphasized different surgical techniques in these patients. The primary pathologies were severe craniocervical stenosis with congenital malformations, rotational dislocations and vertebral artery occlusion, previously treated patient with a craniocervical cordoma and patients with craniocervical tumors.

Results: Precise radiological investigation with 3 dimensional pictures were evaluated preoperatively. Neurophysiological tests were completed preoperatively. All patients underwent craniocervical decompression with or without instrumentation. Patients were Neuromonitorised during surgery with SEP, MEP continuously. All patients recovered from surgery without any complications.

Conclusion: Surgery of the craniocervical junction is highly challenging. Patients need to be evaluated precisely with multiple radiological and neurophysiologic investigations. Surgery should be planned carefully to have favorable results.

484. Minimally Invasive Vertebral Augmentation in High Risk Patients
Basar Atalay, Kaan Cumhur Yaltirik, Hatice Türe
Introduction: Vertebral body compression fractures are common in patients with osteoporosis, vertebral body metastasis, multiple myeloma. Patients in the geriatric age group mostly suffer from the complications of general anesthesia and longer surgical procedures. Percutaneous techniques under local anesthesia with or without sedation provide a quick restoration and stabilization of the vertebral body

Methods: Geriatric patients and patients with high medical risk grades were included in this study. 20 patients with vertebral body compression were treated under local anesthesia. The neurological examination of the patients were normal. Mean age was 66, ASA grades were 1 to 3. Prilocaine 20mg and Bupivacaine 5mg were used for local anesthesia and Midazolam 5mg or remyphenetanol HCl 2mg were used for sedation and analgesia.

Results: Etiology of the vertebral body fracture was osteoporotic in 13 (65%), metastatic in 4 (20%) and traumatic in 3 (10%) patients. In 13 patients one level, in 7 patients multiple level vertebral body compression fracture was treated. In 6 patients only vertebroplasty, in 12 patients only kyphoplasty and in 2 patients both vertebroplasty and kyphoplasty were used in multiple levels. There were not any further neurological deficit or any complication after the procedure in any patient. VAS scores of the patients were improved 85% after 6 months of follow up in 20 patients.

Conclusion: Our results suggest that minimally invasive vertebral augmentation techniques of either vertebroplasty or kyphoplasty are safe procedures under local anesthesia with or without sedation mainly in high risk patients.

485. Novel Trajectory Guidance Technology to Lessen X-rays Need during Pedicular Procedures (Pilot Study)
Hector Humberto Gomez-Acevedo
Introduction: The exposure to ionizing radiation during surgical procedures is a motive of concern that is being also studied under legal and ethical scopes (1,2). The use of fluoroscopic guidance in transpedicular procedures is still needed, even with the aid of CT scan or navigational systems, despite the high radiation exposure, especially for eyes and hands (3,4,5,6). It is known that once that the entry point is set in a transpedicular procedure, it is necessary to visualize or to know with x-rays the sagittal angle (Alpha) of any pedicle referred to a vertical axis once the patient is on the operating table. The transverse angle (Beta) of the same pedicle referred to the vertebral middle line has also to be visualized or known with a AP fluoroscopy or a CT scan respectively. That information allows the operator to plan a trajectory that has to be frequently reviewed with fluoroscopy during the procedure. We present a technology that allows the surgeon to match and keep the angles from the awl, needle, screw driver, etc. with the Alpha and Beta target angles during the transpedicular pass or even further, lessening the need of X-rays confirmation.

Methods: In order to disable as a variable, the ability of the surgeon to detect the hard cortical pedicle walls from the soft core bone, forty lumbar (L1 to L5, eight anatomic specimens ) pedicles were approached transpedicular in a standard fashion with a vertebroplasty needle having the Alpha and Beta angles previously investigated. The needle trajectory was set and kept using only the novel technology.

Results: No trajectories were out on any of the forty pedicles. In two cases the needle was closer than 3mm to the pedicle medial wall.

Conclusion: Further studies are needed to confirm these results. We anticipate this technology might be also of use in other neurosurgical areas.

486. ALIF with Anterior Instrumentation for Discogenic Low Back Pain: Long-term Results
W. Craig Clark
Introduction: With the availability of artificial discs and other hardware that tout the benefits of motion preservation, it has become even more critical to evaluate our experience with lumbar fusion performed for back pain alone. The IDEs for various
devices use ALIF with posterior instrumentation as the standard for comparison, and these studies have had failure rates as high as 28%. Now that more experience has been gained with anterior instrumentation, these data must be re-examined.

Methods: This study consists of forty consecutive cases of anterior lumbar interbody fusion (ALIF) performed for the relief of chronic back pain without radiculopathy. The cases were performed by one neurosurgeon and two access surgeons between October 2004 and July 2006. Patients were assessed using the Oswestry Disability Index (ODI) before and after surgery. Operative levels were selected using provocative discography. Long-term followup of at least 24 months was performed via telephone interview and clinical exam.

Results: Thirty-nine of the forty patients have returned to their previous occupations and do not require pain medication. There were 12 worker’s compensation cases in the series. The short-term ODI scores decreased form 58% (severe) to 6% (minimal) (p<0.05) following the ALIF with anterior instrumentation. Average LOS was one day. At a minimum of 24 months, the mean ODI was minimally increased to 8% (minimal), and remained statistically significant (p<0.05). The mean VAS remained ~2. ALL surveyed patients, including the one failure said they would do it again.

Conclusion: Based on these excellent results, it would appear that in properly selected patients ALIF with anterior instrumentation raises the standard of comparison for arthroplasty and nonfusion methodologies with regards to short and long-term pain relief and functional recovery. This study does not address the question of adjacent segment pathology or possible long-term effects of the fused segment. It does suggest a durable and excellent result.

487. Avoidance of Wrong Level Thoracic Spine Surgery: Intraoperative Localization with Preoperative Percutaneous CyberKnife Fiducial Screw Placement
Cheerag D. Upadhyaya, Cynthia Chin, Praveen V. Mummaneni
Introduction: The accurate intraoperative localization of the correct thoracic spine level remains a challenging problem.
Methods: In order to avoid wrong level surgery in the T–spine, we preoperatively placed a percutaneous CyberKnife fiducial screw at the level of intended surgery. The MRI compatible Cyberknife fiducial screw (3 mm long) is placed by a neuroradiologist using CT guidance. CT images with reconstruction views can then be referenced intraoperatively to verify the surgical level (Figure 1), and the fiducial screw is easily identified on intraoperative fluoroscopy (Figure 2). We compared a group of 21 patients who underwent a preoperative (often outpatient) fiducial screw placement prior to open or miniopen thoracic spine surgery to a historical group of 11 patients who had intraoperative localization with fluoroscopy alone.
Results: In the group of 21 patients undergoing preoperative thoracic spine fiducial screw placement, no complications related to fiducial screw placement have occurred, and there have been no problems with wrong level surgery. In comparison, the historical cohort of 11 patients who underwent mini-open or open thoracic spine surgery without placement of a fiducial screw also had no wrong level surgeries. However, the senior author found that the localization fluoroscopy time was reduced by greater than half when a fiducial screw localization technique was employed.
Conclusion: This technique for intraoperative localization is safe and useful for all thoracic spine exposures. The fiducial marker screw can be placed using CT guidance on an out–patient basis. There is a reduction in the amount of fluoroscopy time needed for localization in the fiducial screw group.

488. The Treatment of Thoracolumbar Fractures with Minimally Invasive Pedicle Screw Stabilization
Jonathan Andrew Grossberg, Thomas W. Belknap, Adetokunbo A. Oyelese
Introduction: Thoracolumbar (T–L) fractures may be managed conservatively with bracing if they are stable or operatively with fusion procedures if they are unstable. However, bracing of biomechanically stable (2-column) T–L fractures may be limited by body habitus and concomitant injuries. We report our experience using Minimally Invasive Stabilization (MIS) without fusion in the management of T–L fractures as an alternative to bracing in unsuitable patients, or fusion in select complex fractures.
Methods: Demographic and outcome data was collected in 18 patients with fractures of the T–L spine treated using MIS without fusion.
Results: Seven patients had fractures involving multiple vertebral levels; the most common levels treated were T12 and L1 (7 patients each). Mean age was 45.9 years (range 22–85); Mean number of treated levels: 4.2 (range 3.8); Mean operative time: 137 minutes (range 70–232); Mean blood loss: 62.5 cc (range 25–100). Three patients had concomitant kyphoplasty performed at the fracture level at the time of MIS. Follow-up with postoperative imaging ranged from 2 to 21 months. There were no instances of hardware fracture or screw loosening, and all fractures showed stable healing at follow-up. Three directly related complications and one mortality from medical complications within 30 days were noted. At last follow-up, 17 of the 18 patients reported good pain control.
Conclusion: Minimally invasive stabilization is a safe and effective treatment option in biomechanically stable T–L fractures. It represents a novel and attractive option in poly-trauma patients due to short operative times, reduced blood loss and early mobilization without bracing.

489. The Cost of BMP in TLIF
Sanjay S. Dhall, Daniel C. Lu, Regis W. Haid, Jr., Praveen V. Mummaneni
Introduction: The use of BMP adds to implant cost for TLIF. We retrospectively reviewed our data to assess if the use of rh–BMP–2 vs ICBG in TLIF cases is cost effective and advantageous for this procedure.
Methods: We retrospectively reviewed 49 adult nonsmokers with DDD or spondylolisthesis who underwent one level TLIFs. 17 patients underwent TLIF with cages packed with iliac crest (ICBG group). 32 patients underwent TLIF with cages packed with rhBMP–2 (BMP group). Fusion was assessed by dynamic radiographs at routine intervals. Operative times, estimated blood loss (EBL), length of stay (LOS), complications, readmissions, and clinical outcomes (modified Prolo scores) were assessed. Hospitalization cost–analysis included review of the inpatient hospitalization bill.
Results: Mean follow–up was 29 months for the ICBG group and 22 months for the BMP group. Mean EBL was 779 cc in the ICBG group as compared to 381 cc in the BMP group (P<0.05). Mean operative time was 265 minutes in the ICBG group and 227 minutes in the BMP group (P<0.05). Length of stay was longer in the ICBG group (6 days) as compared to the BMP group (5.2 days), but this difference was not statistically significant. There was no statistically significant difference in wound infection rates. Patients’ MPS improved in...
both groups, but there was no significant difference between groups. All patients fused. The total inpatient hospital bill was greater for the BMP group, and this difference was statistically significant (p<0.05).

Conclusion: The use of rhBMP-2 for TLIF is associated with a significant decrease in the operative time and intraoperative blood loss. The use of rhBMP-2 for TLIF does not significantly alter complication rates or hospital stay. The use of rhBMP-2 for TLIF leads to significantly higher cost of hospitalization than the use of iliac crest.

490. PLF vs TLIF: Outcome and Cost Comparison in 191 Patients
Sanjay S. Dhall, Praveen V. Mummaneni

Introduction: Is the added cost of an interbody cage warranted in 1 or 2 level lumbar degenerative disc disease or low grade spondylolisthesis?

Methods: Over a 4 year period, 191 patients underwent instrumented lumbar fusion. Group 1 consisted of 93 who underwent TLIF, 39 of which (Group 1A) had DDD and 54 had spondylolisthesis (Group 1B). Group 2 consisted of 98 who underwent PLF, 38 had DDD (Group 2A), 59 had spondylolisthesis (Group 2B). Clinical evaluation included preoperative and postoperative modified Prolo scores. Complications, length of stay, fusion rate, and adjacent segment disease were studied.

Results: Mean follow up for both groups was 20 months and rate of follow up exceeded 90%. Mean Prolo scores improved by 7 in Group 1, and by 6 in Group 2 (not statistically significant difference). Mean LOS was 5 days for Group 1, and 5.6 days for group 2. In Group 1 (TLIF), the rate of complications requiring reoperation was 7.5%. In Group 2 (PLF), rate of complications requiring reoperation was 4.1%. The reoperation rate for pseudoarthrosis was 5.1% in Group 2 (PLF) and 1.1% in Group 2 (TLIF). The rate of adjacent segment disease requiring surgery in Group 2 (PLF) was 7.1% and in Group 1 (TLIF) was 2.2%. At a mean follow up of 20 months, the overall rate of reoperation for all causes was 16.2% in Group 2 (PLF) and was 10.8% in Group 1 (TLIF).

Conclusion: Complications, pseudoarthroses, and an increased rate of adjacent segment disease requiring reoperation in PLF appear to justify the cost of an additional interbody cage in TLIF. We will present cost analysis detailing the cost of the cage ($4000) vs. cost of reoperation (> $50,000).
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The Speaker Ready Room will be available Wednesday, from 8:00 AM – 6:00 PM, Thursday and Friday, from 6:00 AM – 6:00 PM and Saturday, from 6:00 AM – 12:30 PM in room Wekiwa 1. All speakers and abstract presenters should visit the Speaker Ready Room prior to their presentation.

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