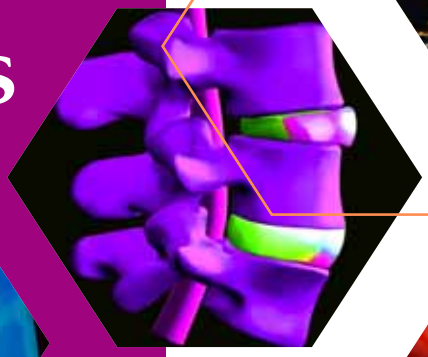
PROGRAM BOOK

22nd Annual Meeting of the
AANS/CNS Section on
Disorders of the

Spine and Peripheral Nerves



March 15-18, 2006

Buena Vista Palace
in the Walt Disney World® Resort
Lake Buena Vista, Florida

American Association of Neurological Surgeons

CONGRESS OF NEUROLOGICAL SURGEONS 1951 ERUDITIO OBSERVANTIA SOCIETAS

Jointly Sponsored by the AANS

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FUTURE MEETINGS

March 7-11, 2007
Phoenix, Arizona

February 27- March 1, 2008
Lake Buena Vista, Florida

PREVIOUS MEETINGS

2005 Phoenix, Arizona
2004 San Diego, California
2003 Wesley Chapel, Florida
2002 Lake Buena Vista, Florida
2001 Phoenix, Arizona
2000 Rancho Mirage, California
1999 Lake Buena Vista, Florida
1998 Rancho Mirage, California
1997 Newport Beach, California
1996 Lake Buena Vista, Florida
1995 Phoenix, Arizona
1994 Fort Lauderdale, Florida
1993 Tucson, Arizona
1992 Miami, Florida
1991 Rancho Mirage, California
1990 Captiva Island, Florida
1989 Cancun, Mexico
1988 Phoenix, Arizona
1987 Boca Raton, Florida
1986 San Diego, California
1985 Greenleaf, Florida

Dear Colleague:

It is our pleasure to welcome you to the 22nd Annual Meeting of the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves. The Annual Meeting Committee is delighted that you could join us for a program that promises to be an excellent educational opportunity.

We thank the members of the Scientific Program Committee for developing this year's program, as well as the speakers and moderators who have volunteered to speak on their areas of expertise in the scientific sessions and special courses. The Scientific Program Committee has put together a fabulous program. This year's sessions cover the gamut of cutting-edge techniques and long standing clinical challenges. The meeting continues to grow in stature and we are fortunate to have speakers with us from the upper echelons of spinal surgery. Several of this year's topics were selected from last year's evaluation comments and the membership, so we trust the program reflects the objectives of the Spine Section.

This program reflects the interdisciplinary nature of your daily work. World-renowned investigators from the orthopaedic community have been invited to share their aptitude. The collaboration with the American Association of Neurological Nurses continues to be an important part of the program. Through our close work together, we are able to offer contact hours to non-physician attendees in recognition of the importance of their participation in the meeting, which grows each year.

Beyond the scientific program, Buena Vista Palace in the Walt Disney World® Resort has many activities for you and your family to enjoy in your free time. Enjoy swimming, tennis and volleyball, then stroll to Downtown Disney® at sunset for shopping, dazzling entertainment and nightlife. Enjoy the resort's guest privileges like continuous transportation to all Disney World® theme parks, dining with favorite Disney characters, and access to championship Disney® golf courses. We hope these activities enhance your experience at the meeting.

The evaluation incentive program will be in place again this year. We take a moment to mention it here because your feedback is vital to the ongoing success of the meeting. At the end of each day, we randomly select one completed evaluation to award a prize to one lucky attendee.

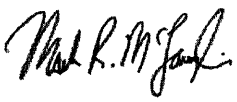
We also wish to acknowledge the exhibitors and sponsors of this year's meeting. Without their support, we could not organize this high-quality scientific program. We strongly encourage you to visit our exhibitors and sponsors in the exhibit hall. It's an efficient way to ensure you are up-to-date with the broad array of state-of-the-art technology relevant to spinal surgery.

We welcome you to the 22nd Annual Meeting and hope that you will enjoy both the didactic material as well as the camaraderie of your friends and colleagues for the next few days.

Sincerely,

Robert F. Heary, MD
Section Chairperson

Michael W. Groff, MD
Annual Meeting Chairperson



Mark R. McLaughlin, MD
Scientific Program Chairperson

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Sagun K. Tuli, MD, FRCS(C)

PROGRAM AT-A-GLANCE

	WEDNESDAY MARCH 15	THURSDAY MARCH 16	FRIDAY MARCH 17	SATURDAY MARCH 18
MORNING	7:00 AM – 5:00 PM Registration 7:00 AM – 12:45 PM Special Course I 8:00 AM – 12:30 PM Special Course II 9:00 AM – 6:00 PM Speaker Ready Room	6:00 AM – 6:00 PM Speaker Ready Room 6:30 – 7:45 AM Continental Breakfast 6:30 AM – 6:00 PM Registration 6:45 AM – 12:15 PM Scientific Session 9:00 AM – 7:00 PM Exhibit Hall Open E-Poster Viewing 9:45 – 10:30 AM Beverage Break & Demonstration Theater Presentations – Exhibit Hall	6:00 AM – 1:00 PM Speaker Ready Room 6:30 – 7:45 AM Continental Breakfast 6:30 AM – 1:00 PM Registration 7:00 AM – 12:30 PM Scientific Session 9:00 AM – Noon Exhibit Hall Open E-Poster Viewing 10:15 – 11:00 AM Beverage Break & Demonstration Theater Presentations – Exhibit Hall	6:00 AM – 1:00 PM Speaker Ready Room 6:30 – 7:45 AM Continental Breakfast 6:30 AM – 1:00 PM Registration 9:00 AM – 12:30 PM Scientific Session 9:00 – 11:30 AM Exhibit Hall Open E-Poster Viewing 9:50 – 10:30 AM Beverage Break & Demonstration Theater Presentations – Exhibit Hall
AFTERNOON	1:00 – 5:00 PM Special Courses III & IV	12:15 – 1:00 PM Lunch & Demonstration Theater Presentations – Exhibit Hall 1:00 – 5:30 PM Scientific Sessions 3:30 – 4:15 PM Beverage Break & Demonstration Theater Presentations – Exhibit Hall	1:00 – 6:00 PM Golf Outing 1:00 – 5:00 PM Special Course V 1:00 – 5:00 PM Special Symposium for Nurses, Nurse Practitioners, and Physician Assistants	1:00 – 5:00 PM Special Course VI
EVENING	5:30 – 8:00 PM Opening Reception	5:30 – 7:00 PM Reception in the Exhibit Hall *(no children, please)*		*Hours, Special Course Options and Placement are subject to change*

EVALUATION FORM REWARDS PROGRAM

The evaluation process is a key component in providing cutting-edge programming at the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves Annual Meeting. Medical registrant feedback on the quality and diversity of the entire program helps to determine future annual meeting programming. **Your views and opinions are valued!**

We are providing an opportunity to qualify for prize drawings by completing your evaluations forms. Each time you complete an evaluation form, deposit the form into the designated evaluation drop box and you will become eligible to win a prize in the daily drawing.

NO SMOKING POLICY

Smoking is not permitted at any official AANS/CNS Section on Disorders of the Spine and Peripheral Nerves Annual Meeting event.

DISCLAIMER

The material presented at the 22nd Annual Meeting has been made available by the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves and the AANS for educational purposes only. These materials are not intended to represent the only, nor necessarily the best method or procedure appropriate for the medical situations discussed, but rather is intended to present an approach, view, statement, or opinion of the faculty, which may be helpful to others who face similar situations.

All drugs and medical devices used in the United States are administered in accordance with the Food and Drug Administration (FDA) regulations. These regulations vary depending on the risks associated with the drug or medical devices compared to products already on the market, and the quality and scope of the clinical data available.

Some drugs and medical devices demonstrated or described within the print publications of the AANS/CNS Section of Disorders of the Spine and Peripheral Nerves jointly sponsored by AANS have FDA clearance for use for specific purposes, or for use only in restricted research settings. The FDA has stated that it is the responsibility of the physician to determine the FDA status of each drug or device he or she wants to use in compliance with applicable laws.

Neither the content (written or oral) of any course, seminar, or other presentation in the program, nor the use of a specific product in conjunction therewith, nor the exhibition of any materials by any parties coincident with the program, should be construed as indicating endorsement or approval of the views presented, the products used, or the materials exhibited by the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves jointly sponsored by AANS, or by its committees, commissions or affiliates.

CME CREDIT

This activity has been planned and implemented in accordance with the Essentials and Standards of the Accreditation Council for Continuing Medical Education (ACCME) through the joint sponsorship of AANS and the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves. The ACCME accredits the AANS to provide continuing medical education to physicians. The AANS designates this educational activity for a maximum of **18.25 credits** in Category I credit toward the AMA Physician's Recognition Award (PRA). An additional **16.50 credits** are available through optional programming.

Each physician should claim only those credits that he/she actually spent in the educational event.

PHYSICIAN ASSISTANT CREDIT

Physician assistants will receive a certificate of credit at the general scientific program and for any optional events attended. Each physician assistant should contact his or her individual membership association and certification board to determine the requirements for accepting certificates of credit.

NURSING CONTACT HOURS

The Special Symposium for Nurses, Nurse Practitioners and Physician Assistants, *Meeting the Challenges of Caring for the Patient with a Spinal Tumor*, is planned in conjunction with the American Association of Neuroscience Nurses, which is accredited as a provider of nursing continuing education by the American Nurses Credentialing Center's Commission on Accreditation (ANCC-COA).

To meet CE standards, receive the appropriate number of contact hours and a certificate of attendance, participants who are registered nurses (RNs) will be expected to complete and return an evaluation form for this symposium. See pages 24 & 25 for additional information.

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1986
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John F. Howe, MD
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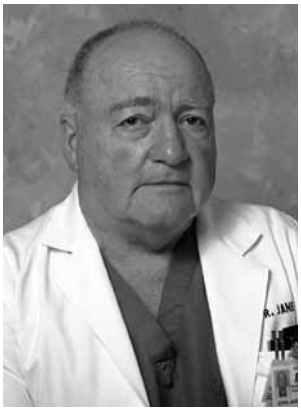


John Anthony Jane was born in September 1931 in Chicago, Illinois. He graduated from the University of Chicago with a B.A., cum laude in 1951. He then attended the University of Chicago School of Medicine, receiving his Doctor of Medicine in 1956. He did his internship at the Royal Victoria Hospital at McGill University and returned to begin his neurosurgical residency at the University of Chicago clinics in 1957 with Dr. Sean Mullan. In 1958 he was a Fellow in Neurophysiology at Montreal Neurological Institute with Dr. Herbert Jasper.

In 1959 he was a Senior Fellow in Neuropathology and in 1960 a Demonstrator in Neuropathology, both at McGill University in Montreal. In 1961 he was a Research Assistant in Neurosurgery to Sir Wylie McKissock at Atkinson Morleys Hospital in London, England. In 1962, he was a Research Associate with the Department of Psychology at Duke University with Irving T. Diamond who was his PhD advisor. He then completed his neurosurgical residency in 1963-1964 at the University of Illinois Research and Educational Hospital and the Illinois Neuropsychiatric Institute with Oscar Sugar and Eric Oldberg. The year 1965 found Dr. Jane as Senior Instructor in Neurosurgery at Case Western Reserve University. In 1967, Dr. Jane completed and was awarded a PhD from the University of Chicago, Division of Biological Sciences, Section of Biopsychology. After 4 years at Case Western Reserve, Dr. Jane assumed in 1969, his present position as Professor and Chairman of the Department of Neurosurgery, University of Virginia School of Medicine in Charlottesville, Virginia.

While at Case Western Reserve with Frank Nulsen, he was involved in the training of Donald Becker, Harold Young, and Martin Weiss. Subsequently, at the University of Virginia, in the training of 17 Professors, 11 of whom became Chairmen, 6 Associate Professors, and 8 Assistant Professors. Dr. Jane became a member of the Editorial Board of the *Journal of Neurosurgery* in 1984. He became the Chairman of the Editorial Board in 1990, the Associate Editor in 1991 and in 1992, he was elected Editor. He is also Editor and founder the of *The Journal of Neurosurgery: Spine* and *Journal of Neurosurgery: Pediatrics*.

He is the past Director of the American Board of Neurological Surgery completing his term in 1996. Dr. Jane was elected to be Vice President of the Society of Neurological Surgeons in 1988, and was also elected to be President of the Society in 1993. Among his awards, he received the Grass Prize and Medal of the Society of Neurological Surgeons for Meritorious Research (1985), Herbert Olivecrona Lectureship of the Karolinska Institute of Stockholm, Sweden (1985), 29th Annual Fellows Day Lecturer, Montreal Neurological Institute, Montreal, Quebec, Canada (1986), Alumni Award for Distinguished Service, University of Chicago (1988), Honored Guest, Congress of Neurological Surgeons (1995), Honored Guest, Joint Annual Congress of the Surgical Society, Taipei, Taiwan (1996), Sir Wylie McKissock Neuroscience Lecturer, Atkinson Morley Neuroscience Centre, London, England (1997), William Feindel Lecturer, Montreal Neurological Institute (1998), Jamieson Memorial Lecturer, Neurosurgical Society of Australasia, Australia (1998), Lifetime Achievement Award, American Cleft Palate-Craniofacial Association (1999), Recipient of Kurt Schurmann Professorship, Hannover, Germany (1999), Decade of the Brain Medalist, CNS/AANS (1999),the Decade of the Brain Award, American Association of Neurological Surgeons (2000), Schneider Lecturer, American Association of Neurological Surgeons (2000), the Distinguished Service Award by the American Association of Neurological Surgeons (2002), the NSA Medallist, Neurosurgical Society of America (2002), the Distinguished Service Award, Society of Neurological Surgeons (2003), the Cushing Medalist, American Association of Neurological Surgeons (2004), the WFNS Medal of Honour at the XIII World Congress of Neurosurgery Meeting (2005), the Congress of Neurological Surgeons Founder's Laurel Award (2005), and the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves Meritorious Service Recognition (2006).

He is married to Noella Fortier of Montreal, Quebec, Canada. The Jane's have four grown children (3 daughters and 1 son), six grandsons and two granddaughters.

MERITORIOUS SERVICE AWARD RECIPIENTS

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

AWARDS

On pages 8–13, general information regarding section sponsored research and fellowship awards are listed. For more information, visit the Spine Section 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: the **Ronald Apfelbaum Research Award**, the **David Kline Research Award**, and the **Sanford Larson Research Award**. These awards are intended to establish funding for clinical relevant research related to the spine and 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 awards are 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. Depending upon the quality of the award submissions, there may be one award in each category annually.

INTERNATIONAL FELLOWSHIP FUNDING

The **H. Alan Crockard International Fellowship**, will not be awarded in 2006. The **Volker K. H. Sonntag International Fellowship**, sponsored by Medtronic Sofamor Danek, is awarded annually to a neurosurgical resident or neurosurgeon from outside of the U.S. 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 curriculum vitae.

DOMESTIC FELLOWSHIP FUNDING

The **David Cahill Fellowship** will not be awarded in 2006.

The **Ralph Cloward Fellowship**, sponsored by Medtronic Sofamor Danek, is awarded annually to one U.S. 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, 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 curriculum vitae.

RONALD APFELBAUM RESEARCH AWARD

The Ronald Apfelbaum Research Award, sponsored by Aesculap, is dedicated to basic or clinical spine research and includes funding up to $15,000.

It is intended for primary investigators with proposed research requiring national level funding, to support the preparation of grant proposals and external consultations and to assist in the development of the proposal, planning meetings, and the collection of pilot data. Work that can be completed without such support (such as literature review and preliminary protocol design) should be completed before applying for this award.

The format of the proposal should follow that of the NIH grant package. The applicants should clearly define their specific aims, include a pertinent literature review, describe the proposed methodology and plan for analysis of data. This part of the proposal should not exceed 10 double-spaced pages. A detailed budget and budget justification should also be included. The budget should not include salary support for the primary investigator or co-investigators. Also, institutional indirect costs are not to be met using the awards.

DANIEL M. SCIUBBA, MD

Daniel M. Sciubba, MD, is a senior resident in the department of neurological surgery at Johns Hopkins University. His research interests include spinal column and spinal cord tumors, and the main goal of his research time is to conduct translational spinal oncology research under the direction of Dr. Ziya Gokaslan, MD. Specifically, he hopes to improve treatment of metastatic spine tumors by combining local delivery of small inhibitory RNA (siRNA) with radiation therapy in a rat spine tumor model. He plans on an academic career focused on complex spine and spine tumor surgery.

DAVID KLINE RESEARCH AWARD

The David Kline Research Award, sponsored by Integra, is dedicated to basic or clinical peripheral nerve research and includes funding up to $15,000.

It is intended for primary investigators with proposed research requiring national level funding, to support the preparation of grant proposals and external consultations and to assist in the development of the proposal, planning meetings, and the collection of pilot data. Work that can be completed without such support (such as literature review and preliminary protocol design) should be completed before applying for this award.

The format of the proposal should follow that of the NIH grant package. The applicants should clearly define their specific aims, include a pertinent literature review, describe the proposed methodology and plan for analysis of data. This part of the proposal should not exceed 10 double-spaced pages. A detailed budget and budget justification should also be included. The budget should not include salary support for the primary investigator or co-investigators. Also, institutional indirect costs are not to be met using the award.

MARCELO MAGALDI RIBEIRO DE OLIVEIRA, MD, MS

A native of Brazil, Dr. Magaldi Ribeiro de Oliveira was born in Sao Paulo and raised in Rio de Janeiro. He studied at the Federal University of Minas Gerais-UFMG. In 1997, he completed his neurosurgery residency and traveled to France, completing a one-year general neurosurgery fellowship in Amiens, followed by a one-year neuro-oncology fellowship in Paris. In 2000, he began a radiosurgery research fellowship at the University of Virginia, where he earned a Master of Science degree, completed in 2003. He also spent nine months at British Columbia Children's Hospital working on a pediatric fellowship.

SANFORD LARSON RESEARCH AWARD

The Sanford Larson Research Award, sponsored by DePuy Spine, is limited to clinical research, and includes funding up to $30,000.

It is intended for primary investigators with proposed research requiring national level funding, to support the preparation of grant proposals and external consultations and to assist in the development of the proposal, planning meetings, and the collection of pilot data. Work that can be completed without such support (such as literature review and preliminary protocol design) should be completed before applying for this award.

The format of the proposal should follow that of the NIH grant package. The applicants should clearly define their specific aims, include a pertinent literature review, describe the proposed methodology and plan for analysis of data. This part of the proposal should not exceed 10 double-spaced pages. A detailed budget and budget justification should also be included. The budget should not include salary support for the primary investigator or investigators. Also, institutional indirect costs are not to be met using the awards.

NEIL DUGGAL, MD

Dr. Duggal is an Assistant Professor at the University of Western Ontario and an Associate Scientist at the Robarts Research Institute in London, Canada. Born in Toronto, Dr. Duggal received his medical degree from the University of Ottawa. He completed his residency in neurological surgery at the University of Western Ontario and a fellowship in spinal surgery at the Barrow Neurological Institute. During his residency Dr. Duggal obtained a Masters in Science with a focus on stem cell proteins. His present research efforts focus on the clinical, radiographic and biomechanical outcomes of spinal arthroplasty as well as the epidemiology and biomechanics of spinal trauma. Dr. Duggal's research has been recognized by the Cervical Spine Research Society and the Royal College of Physicians and Surgeons of Canada.

DAVID CAHILL FELLOWSHIP

The David Cahill Fellowship is awarded annually to one U.S. 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, 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 curriculum vitae.

The David Cahill Fellowship will not be awarded in 2006.

CLOWARD FELLOWSHIP

The Ralph Cloward Fellowship, sponsored by Medtronic Sofamor Danek, is awarded annually to one U.S. 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, 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 guide and a current curriculum vitae.

ZIV WILLIAMS, MD

Dr. Williams is a currently chief resident in neurosurgery at Massachusetts General Hospital, Harvard Medical School, and will be undertaking a peripheral nerve fellowship at the Mayo Clinic in 2007. He received his degree in biochemistry and cell biology from UC San Diego, and medical degree from Stanford University. His principle aims are to integrate his interests in functional neurosurgery, peripheral nerve surgery and basic primate neurophysiology in order to understand cognitive signals responsible for motor control, and to develop new techniques for functionally bypassing spinal cord and peripheral nerve injuries.

CLOWARD FELLOWSHIP RECIPIENTS

2006 Ziv Williams, MD, Boston, MA
2005 John O'Toole, MD, New York, NY
2004 John K. Song, MD, Nashville, TN
2003 Michael P. Steinmetz, MD, Cleveland, OH
2002 Langston T. Holly, MD, Los Angeles, CA
2001 Jason E. Garber, MD, Houston, TX
2000 Larry T. Khoo, MD, Los Angeles, CA
1999 No Award Presented
1998 No Award Presented
1997 No Award Presented
1996 Simcha J. Weller, MD, Boston, MA
1994 Christopher I. Shaffrey, MD, Charlottesville, VA
1995 R. John Hurlbert, MD, PhD, Toronto, ON, Canada
1993 Ziya L. Gokaslan, MD, Houston, TX

VOLKER K. H. SONNTAG INTERNATIONAL FELLOWSHIP

The Volker K. H. Sonntag International Fellowship is sponsored by Medtronic Sofamor Danek and is awarded annually to a neurosurgical resident or neurosurgeon from outside of the U.S. 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 the 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 research goals, and a current curriculum vitae.

ASHOK GUPTA, MD, MCh

A native of India, Dr. Gupta is presently working as associate professor and head of the Department of Neurosurgery at the University of Rajasthan at Govt. Medical College, Kota. He received an International Guest Scholarship from the German Society of Surgeons in May, 2005. Dr. Gupta obtained his magister chirurgery in neurosurgery in 1996. In 1999, he completed a fellowship in radiosurgery and stereotactic neurosurgery at Karl Franzes University in Graz, Austria. He is a life member of both the Neurological Society of India and the Indian Medical Association.

The Mayfield Award is presented annually by the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves to the neurosurgical resident or BC/BE fellow in North American training, who authors an outstanding manuscript 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 it to the related abstract in the call for abstract process.

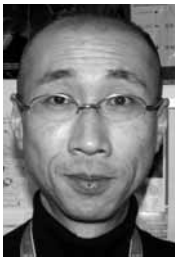
Two awards are available, one for clinical research and one for basic science research. Each recipient will receive a $1,000 cash award, and an honorarium up to $2,000 to cover the expenses of attendance at the Section's annual meeting.

Abstracts to be considered for the Mayfield Award should be identified as such on the annual meeting abstract submission form, and submitted prior to deadline.

MAYFIELD AWARDS

BASIC SCIENCE AWARD

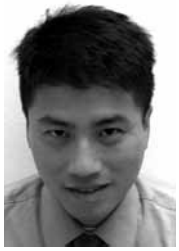
TOSHITAKA SEKI, MD



Toshitaka Seki received his medical degree from Asahikawa Medical University in Japan. After completing his residency training in neurological surgery at the Asahikawa Medical University Hospital, Dr. Seki undertook a clinical and research fellowship in spine and spinal cord surgery at the University of Hokkaido Graduate School of Medicine where he received a PhD in medical science. Since September 2004, Dr. Seki has been a postdoctoral research fellow in the laboratory of Michael G. Fehlings, MD, PhD, FRCSC at the University of Toronto where he has been examining the cellular and molecular mechanisms of posttraumatic syringomyelia.

CLINICAL SCIENCE AWARD

BENSON YANG, MD



Benson Yang, MD is currently a resident at Northwestern University. He received his undergraduate degree in electrical engineering and computer science from the Massachusetts Institute of Technology and his medical degree from Yale University. Dr. Yang recently completed subspecialty training in complex and minimally invasive spine surgery at Northwestern. His interests lie in the development and application of novel technologies.

MAYFIELD AWARD RECIPIENTS

2005
Basic Science
John Y. K. Lee, MD
Pittsburgh, PA

Clinical Science
Nicholas H. Post, MD
New York, NY

2004
Basic Science
Bryan B. Barnes, MD
Atlanta, GA

Clinical Science
Michael Y. Wang, MD
Los Angeles, CA

2003
Basic Science
No Award Presented

Clinical Science
No Award Presented

2002
Basic Science
Edward R. Smith, MD
Quincy, MA

Clinical Science
Ketan R. Bulsara, MD
Durham, NC

2001
Basic Science
Ketan R. Bulsara, MD
Durham, NC

Clinical Science
Gordon W. Tang, MD
Atlanta, GA

2000
Basic Science
Neill M. Wright, MD
St. Louis, MO

Clinical Science
Viswanathan Rajaraman, MD, FRCS
Newark, NJ

1999
Basic Science
Steven Casha, MD
Toronto, ON, Canada

Clinical Science
Nicholas Theodore, MD
Phoenix, AZ

1998
Tord D. Alden, MD
Charlottesville, VA

1997
Michael A. Morone, MD, PhD
Atlanta, GA

1996
Basic Science
Paul C. Francel, MD
Troy, VA

Clinical Science
Paul D. Sawin, MD
Iowa City, IA

1995
Simcha J. Weller, MD
Boston, MA

1994
Timothy C. Ryken, MD
Iowa City, IA

1993
Clinical Science
Gerald F. Tuite, MD
Ann Arbor, MI

Basic Science
Allan D. Levi, MD, PhD, FRCS
Miami, FL

1992
Rajiv Midha, MD
Toronto, ON, Canada

1991
Peter G. Gianaris, MD
Eau Claire, WI

1990
R. John Hurlbert, MD, PhD
Toronto, ON, Canada

1989
Richard K. Simpson, Jr., MD
Houston, TX

1988
No Award Presented

1987
John A. Feldenzer, MD
Ann Arbor, MI

1986
No Award Presented

1985
Abhijit Guha, MD
Toronto, ON, Canada

1984
Mark N. Hadley, MD
Phoenix, AZ

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John Pollina, Jr., MD
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Jeffrey C. Wang, MD
Jenifer Wolff
Shokei Yamada, MD
Benson P. Yang, MD
Wenru Yu, MD
Zafer Yuksel, MD
Eric L. Zager, MD

WEDNESDAY, MARCH 15

7:00 AM – 12:45 PM **SPECIAL COURSE I**

GREAT HALL EAST

Interventional Spine Surgery – Didactic and Hands On

Capacity: 32
Additional $200 for medical registrants, includes lunch.

Director: John C. Oakley, MD
Faculty: Ray M. Baker, MD; Isador Lieberman, MD; Kevin E. Macadaeg, MD; Mark R. McLaughlin, MD, Richard M. Spiro, MD, MPH

COURSE DESCRIPTION

This session will offer didactic and hands on sessions with various techniques used for the diagnosis and treatment of common conditions affecting the spine. Topics will include: Epidural Injections, Selective Nerve Root Injections, Facet and Nerve Root Rhizotomy, Nucleoplasty, Discogram, Vertebroplasty and Kyphoplasty techniques.

LEARNING OBJECTIVES

Upon completion of this course, participants should be able to:
- Describe basic spinal injections.
- Review the indications for spine interventional procedures.
- Recognize patients with vertebral compression fractures.

7:00 AM	Welcome and Announcements John C. Oakley, MD
7:10 AM	Epidural Injections Ray M. Baker, MD
7:30 AM	Nerve Root Injections Kevin E. Macadaeg, MD
7:50 AM	Facet and Nerve Root Rhizotomy Richard M. Spiro, MD, MPH
8:10 AM	Nucleoplasty Kevin E. Macadaeg, MD
8:30 AM	Discogram Ray M. Baker, MD
8:50 AM	Vertebroplasty and Kyphoplasty Isador Lieberman, MD
9:10 AM	Panel Discussion Ray M. Baker, MD; Isador Lieberman, MD; Kevin E. Macadaeg, MD; John C. Oakley, MD; and Richard M. Spiro, MD, MPH
9:45 AM	Beverage Break
10:00 AM	Participants walk to OR trucks outside for the hands-on skills lab.
10:15 AM	Hands-on Skills Lab
12:30 PM	Questions & Answers
12:45 PM	Adjournment

8:00 AM – 12:30 PM **SPECIAL COURSE II**

GREAT HALL WEST

Coding Update and Review

Additional $200 for medical registrants, includes lunch.

Director: Gregory J. Przybylski, MD
Faculty: Robert R. Johnson, II, MD, FACS

COURSE DESCRIPTION

This course will present current issues in spine coding and review various coding scenarios for correct coding of complex spinal procedures.

LEARNING OBJECTIVES

Upon completion of this course, participants should be able to:
- Recognize the newest changes in CPT coding.
- Review the methodology for correct spine coding.
- Identify specific coding scenarios that can be difficult to code and bring clarity to the relevant scenarios.

8:00 AM	Introduction and New Codes for 2006 Gregory J. Przybylski, MD
8:15 AM	Surgical Modifiers Gregory J. Przybylski, MD
9:15 AM	22000 Series Codes Robert R. Johnson, II, MD, FACS
10:15 AM	63000 Series Codes Robert R. Johnson, II, MD, FACS
11:15 AM	Beverage Break
11:30 AM	Coding Scenarios Robert R. Johnson, II, MD, FACS
12:15 PM	Panel Discussion Robert R. Johnson, II, MD, FACS and Gregory J. Przybylski, MD
12:30 PM	Adjournment

1:00 – 5:00 PM **SPECIAL COURSE III**

GREAT HALL EAST

Moving Your Practice to the Digital Age/Office Automation

Capacity: 100
Additional $200 for medical registrants, includes lunch.

Director: Joel D. MacDonald, MD
Faculty: Brian R. Greer; David W. Polly, Jr., MD; Ashwini D. Sharan, MD

COURSE DESCRIPTION
This course will address how to evaluate, purchase, and implement a practice management system and electronic health record into your office. The pearls and pitfalls of implementing a "paperless" office will be discussed.

LEARNING OBJECTIVES
Upon completion of this course, participants should be able to:
- Describe the criteria by which to evaluate utilization and effectiveness of electronic medical records.
- Discuss negotiating contracts with vendors and pricing protection.
- Discuss market trends and vendor performance.

1:00 PM Welcome and Announcements
Joel D. MacDonald, MD

1:10 PM EMR and PMIS: Alphabet Soup
Ashwini D. Sharan, MD

1:55 PM Telemedicine and the Handshield
Joel D. MacDonald, MD

2:40 PM Beverage Break

2:55 PM Using the Internet as a Medical Resource
Brian R. Greer

3:40 PM Pay For Performance (P4P)/
Outcomes Assessments in YOUR Practice
David W. Polly, Jr., MD

4:25 PM Panel Discussion
Brian R. Greer; Joel D. MacDonald, MD; David W. Polly, Jr., MD; Ashwini D. Sharan, MD

5:00 PM Adjournment

1:00 – 5:00 PM SPECIAL COURSE IV
GREAT HALL WEST

Motion Maintenance and Disc Regeneration

Capacity: 100
Additional $200 for medical registrants, includes lunch.

Director: Christopher I. Shaffrey, MD
Faculty: Stephen Badylak, DVM, PhD, MD; Vadim N. Bikmullin, MD, PhD; Rick Delamarter, MD; Fred H. Geisler, MD, PhD; Brian R. Subach, MD; Charles D. Theofilos, MD; Jeffrey C. Wang, MD

COURSE DESCRIPTION
World Leaders and investigators will discuss the benefits and detriments of current technology and research in disc repair, biological replacement, and arthroplasty.

LEARNING OBJECTIVES
Upon completion of this course, participants should be able to:
- Recognize indications and pitfalls of arthroplasty.
- Identify the advantages of motion preservation.
- Recognize indications for less invasive treatments of spinal disorders.

1:00 PM Introduction
Christopher I. Shaffrey, MD

1:10 PM Artificial Disc Replacement Using Charité: Overview and Update
Fred. H. Geisler, MD

1:30 PM Artificial Disc Replacement Using Maverick: Overview and Update
Brian R. Subach, MD

1:50 PM Artificial Disc Replacement Using Flexicor: Overview and Update
Charles D. Theofilos, MD

2:10 PM Artificial Disc Replacement Using Prodisc: Overview and Update
Rick Delamarter, MD

2:30 PM Beverage Break

2:45 PM A Case for Anatomy Preservation Surgery
Vadim N. Bikmullin, MD, PhD

3:10 PM Stem Cell Technologies
Jeffrey C. Wang, MD

3:45 PM Tissue Regeneration
Stephen Badylak, DVM, PhD, MD

4:20 PM Annular Repair
Christopher I. Shaffrey, MD

4:45 PM Panel Discussion
Stephen Badylak, DVM, PhD, MD; Vadim N. Bikmullin, MD; Rick Delamarter, MD; Fred H. Geisler, MD; Christopher I. Shaffrey, MD; Brian R. Subach, MD; Charles D. Theofilos, MD; Jeffrey C. Wang, MD

5:00 PM Adjournment

5:30 – 8:00 PM OPENING RECEPTION
CROWN HALL

THURSDAY, MARCH 16

6:45 – 7:00 AM WELCOME & ANNOUNCEMENTS
GREAT HALL NORTH & CENTER

Robert F. Heary, MD, Section Chair
Michael W. Groff, MD, Annual Meeting Chair
Mark R. McLaughlin, MD, Scientific Program Chair

7:00 – 9:25 AM SCIENTIFIC SESSION I

The Evolution of Cervical Spine Surgery

Moderator: Vincent C. Traynelis, MD
Faculty: Regis W. Haid, Jr., MD; Praveen V. Mummaneni, MD; Gregory R. Trost, MD

SESSION DESCRIPTION
This course will present the current cutting edge techniques for the treatment of cervical spine disease.

LEARNING OBJECTIVES

Upon completion of this session, participants should be able to:

- Recognize the newest technologies for cervical fusion.
- Recognize the biological and biomechanical aspects of cervical arthroplasty.
- Review the current experiences of senior surgeons that have experience with this technology.

7:00 AM Cutting-Edge Cervical Fusion: BMP/Biologics/Polymers
Praveen V. Mummaneni, MD

7:30 AM Current Status of Cervical Arthroplasty
Regis W. Haid, Jr., MD

8:00 AM Early Experience with Cervical Discs: Materials and Imaging
Gregory R. Trost, MD

8:30 AM Pearls and Pitfalls of Cervical Arthroplasty
Vincent C. Traynelis, MD

9:00 AM Panel Discussion
Regis W. Haid, Jr., MD; Praveen V. Mummaneni, MD; Vincent C. Traynelis, MD; and Gregory R. Trost, MD

9:25 – 9:40 AM **The Future of Spine**
Robert F. Heary, MD

9:40 – 9:45 AM **Meritorious Service Recognition**
Recipient: John A. Jane, Sr., MD, PhD

9:45 – 10:30 AM **BEVERAGE BREAK WITH EXHIBITORS**
EVENT CENTER

"What's New" Session #1

in the Exhibit Hall Demo Theater
Moderator: Daniel K. Resnick, MD

10:30 AM - 12:15 PM **ORAL ABSTRACT PRESENTATIONS**

Moderator: Ziya L. Gokaslan, MD, FACS

- **10:30 – 10:37 AM**
  100. Revisability of the Charité Artificial Disc Replacement – Analysis of 688 Patients Enrolled in the US IDE Study of the Charité Artificial Disc
  Paul McAfee, MD, Sparks, MD; Fred H. Geisler, MD, Chicago, IL; Sam Saiedy, MD, Baltimore, MD; Richard Guyer, MD, Dallas, TX; John Regan, MD, Los Angeles, CA; Scott Blumenthal, MD, Dallas, TX

- **10:37 – 10:44 AM**
  101. Comparison of Osteophyte Formation in Patients with the BRYAN Disc and Patients with ACDF
  Stephen M. Papadopoulos, MD, Phoenix, AZ; Vincent C. Traynelis, MD, Iowa City, IA; Jeffrey P. Rouleau, PhD, Minneapolis, MN

- **10:44 – 10:51 AM**
  102. Complications with Cervical Arthroplasty
  Neil Duggal, London, ON, Canada; Gwynedd E. Pickett, MD FRCS(C), London, ON, Canada; Lali Sekhon, MD, PhD, Spine Nevada, NV; William Sears, Sydney, Australia

- **10:51 – 10:56 AM Discussion**

- **10:56 – 11:03 AM**
  103. Schwann Cell Transplantation Improves Reticulospinal Fiber Growth and Forelimb Strength After Severe Cervical Spinal Cord Contusion
  Kyoung-Suok Cho, MD, PhD, Seoul, Republic of Korea; Chun-Kun Park, MD, PhD, Seoul, Republic of Korea; Seok-Gu Kang, MD, PhD, Seoul, Republic of Korea; Pil-Woo Huh, MD, PhD, Seoul, Republic of Korea; Do-Sung Yoo, MD, PhD, Seoul, Republic of Korea; Dal-Soo Kim, MD, PhD, Seoul, Republic of Korea; Damien Pearse, PhD, Miami, FL; Dalton Dietrich, Miami, FL

- **11:03 – 11:10 AM**
  104. A Prospective, Multi-Center, Randomized Clinical Trial Evaluating Minimally Invasive Versus Open Pedicle Screw Instrumentation
  Mick Perez-Cruet, MD, MSc, Southfield, MI; Hormoz Sheikh, Southfield, MI; Boyd Richards, DO, Southfield, MI; Ali Aragi, MD, Plano, TX; Mark Spoonamore, MD, Los Angeles, CA; Randall McCafferty, MD, Dayton, OH; Peter Lennarson, MD, Dayton, OH; William Tobler, MD, Cincinnati, OH

- **11:10 – 11:17 AM**
  105. The Nerve Grafting, Nerve Transfer, End-To-Side Neurorrhaphy and Muscle Transfer in the Treatment of Brachial Plexus Injury
  Pavel Haninec, MD, Prague, Czech Republic; Robert Tomáš, MD, Prague, Czech Republic; Filip Sámal, MD, Prague, Czech Republic; Ladislav Houst'ava, MD, Prague, Czech Republic; Petr Dubovy, RN, Brno, Czech Republic

- **11:17 – 11:22 AM Discussion**

- **11:22 – 11:29 AM**
  106. The Use of Allograft Bone for Posterior C1-2 Fusion (Revisited)
  Virany Huynh Hillard, MD, Salt Lake City, UT; Daniel Fassett, MD, Salt Lake City, UT; Meic H. Schmidt, MD, Salt Lake City, UT; Ronald I. Apfelbaum, MD, Salt Lake City, UT

- **11:29 – 11:36 AM**
  107. Complications and Retrieval Management of the Charité Lumbar Artificial Disk: A Prospective 3-Year Experience with 250 Disks
  Luiz Pimenta, MD, PhD, São Paulo, Brazil; Roberto C. Diaz, MD, São Paulo, Brazil; Luis E. Guerrero, MD, São Paulo, Brazil; Claudio Tatsui, MD, São Paulo, Brazil

- **11:36 – 11:43 AM**
  108. Strategies and Techniques for Correction of Degenerative and Post-Surgical Cervical Kyphotic Deformity
  Brian Perri, DO, Los Angeles, CA; Adetokunbo Oyelese, MD, Los Angeles, CA; Robert S. Bray, MD, Los Angeles, CA; J. Patrick Johnson, MD, Los Angeles, CA

- **11:43 – 11:48 AM Discussion**

- **11:48 – 11:55 AM**
  109. Thoracolumbar Vertebral Reconstruction After Surgery for Metastatic Spinal Tumors: Long-Term Outcomes
  Alan Villavicencio, MD, Boulder, CO; Rod Oskouian, MD, Charlottesville, VA; Clifford Roberson, MD, Los Angeles, CA; John K. Stokes, MD, Austin, TX; Jongsoo Park, MD, Stanford, CA; Christopher Shaffrey, MD, Charlottesville, VA; J. Patrick Johnson, MD, Los Angeles, CA

- **11:55 AM – 12:02 PM**
  110. Segmental Kyphosis after Bryan Disc Arthroplasty
  Shee Yan Fong, MBBS, FRCS, Calgary, AB, Canada; Stephan DuPlessis, MD, Calgary, AB, Canada; Steven Casha, MD, PhD, FRCS, Calgary, AB, Canada; John R.. Hurlbert, MD, PhD, FRCS, Calgary, AB, Canada

- **12:02 – 12:09 PM**
  111. Comparison of Multiple Level Versus Single Level Cervical Disk Replacement – 178 Consecutive Prostheses
  Paul McAfee, MD, Sparks, MD; Luiz Pimenta, MD, PhD, São Paulo, Brazil; Alan Crockard, London, United Kingdom; Andy Cappuccino, Buffalo, NY; Bryan Cunningham, Baltimore, MD

12:09 – 12:20 PM Discussion

12:20 – 1:00 PM **LUNCH WITH EXHIBITORS**

"What's New" Session #2

in the Exhibit Hall Demo Theater
Moderator: Michael W. Groff, MD

1:00 – 3:30 PM **SCIENTIFIC SESSION II**

The Evolution of Lumbar Spine Surgery Anterior/Posterior

Moderator: Joseph T. Alexander, MD
Faculty: Ray M. Baker, MD; Charles L. Branch, Jr., MD; Richard G. Fessler, MD; Fred H. Geisler, MD; Paul McAfee, MD; William C. Welch, MD, André Van Ooij, MD

SESSION DESCRIPTION
This course will review the advantages and disadvantages of anterior and posterior approaches to the spine. Panel discussions will allow experts to voice their opinions regarding benefits of each technique.

LEARNING OBJECTIVES
Upon completion of this session, participants should be able to:
- Explain the various options in treating lumbar spine disease from an anterior approach.
- Identify patients that may have better outcomes with posterior approaches.
- Recognize the rationale for approaching the spine either anteriorly or posteriorly.

PART I: ANTERIOR

1:00 PM Lumbar Arthroplasty is Better Than ALIF
Fred H. Geisler, MD

1:15 PM ALIF is Better Than Arthroplasty
Richard G. Fessler, MD

1:30 PM Current Status of Lumbar Arthroplasty
Ray M. Baker, MD

2:00 PM Complications of Lumbar Arthroplasty
André Van Ooji, MD

2:15 PM Lumbar Arthroplasty: My Perspective
Paul McAfee, MD

PART II: POSTERIOR

2:30 PM Dynamic Stabilization is the Way to Go
William C. Welch, MD

2:45 PM PLIF or TLIF is Better Than Dynamic Stabilization
Charles L. Branch, Jr., MD

3:00 PM Panel Discussion
Joseph T. Alexander, MD; Ray M. Baker, MD; Charles L. Branch, Jr., MD; Richard G. Fessler, MD; Fred H. Geisler, MD; Paul McAfee, MD; William C. Welch, MD, André Van Ooji, MD

3:30 – 4:15 PM **BEVERAGE BREAK WITH EXHIBITORS**

"What's New" Session #3

in the Exhibit Hall Demo Theater
Moderator: Paul M. Arnold, MD, FACS

4:15 – 5:30 PM **CONCURRENT ORAL POINT PRESENTATIONS**

Session I

Moderator: Ehud Mendel, MD, FACS

- **4:15 – 4:19 PM**
  200. Safety of Outpatient Anterior and Posterior Cervical Spine Surgery in a Community Hospital
  Gregory J. Przybylski, MD, Edison, NJ; William Mitchell, MD, Edison, NJ

- **4:19 – 4:23 PM**
  201. Comparison of Radiographic Outcomes of Anterior Lumbar Interbody Fusion (ALIF) Versus Transforaminal Lumbar Interbody Fusion (TLIF)
  Patrick C. Hsieh, MD, Chicago, IL; Sean Salehi, MD, Chicago, IL; Stephen Ondra, MD, Chicago, IL; Tyler R. Koski, MD, Chicago, IL; John C. Liu, MD, Chicago, IL

- **4:23 – 4:27 PM**
  202. Lumbar Total Disc Replacement: A 2 To 3 Year Report from the United States Clinical Trial for the Prodisc-L Prosthesis
  Hyun W. Bae, MD, Santa Monica, CA; Ben B. Pradhan, MD, MSc, Santa Monica, CA; Michael A. Kropf, MD, Santa Monica, CA; Linda EA Kanim, MA, Santa Monica, CA; Rick B. Delamarter, MD, Santa Monica, CA

- **4:27 – 4:31 PM**
  203. Biomechanical Comparison of the Charité and Prodisc-L Lumbar Disc Prostheses
  Kevin T. Foley, MD, Memphis, TN; Denis J. DiAngelo, PhD, Memphis, TN; Brian Morrow, BS, Memphis, TN; John German, MD, Albany, NY; Rudolph Bertagnoli, MD, Straubing, Germany; Jung Song, PhD, Memphis, TN; Thomas Mroz, MD, Cleveland, OH

- **4:31 – 4:35 PM**
  204. A Retrospective Comparative Study of Intraoperative EMG-Based Neuromonitoring of Percutaneous Pedicle Screw Placement and Post-Operative Computed Tomgraphic Scan Confirmation
  Hormoz Sheikh, MD, Southfield, MI; Mick Perez-Cruet, MD, MSc, Southfield, MI

- **4:35 – 4:39 PM**
  205. MRI Morphologic Predictors of SPECT Positive Facet Arthropathy in Patients with Axial Back Pain
  Keun-Young A. Kim, MD, Los Angeles, CA; Michael Y. Wang, MD, Los Angeles, CA

- **4:39 – 4:43 PM**
  206. Multimodality Intraoperative Neurophysiological Monitoring for Adult Tethered Cord Syndrome Micro-neurosurgery
  Guillermo Paradiso, Toronto, ON, Canada; Gabriel Lee, MBBS, FRACS, Toronto, ON, Canada; Roger Sarjeant, BS, Toronto, ON, Canada; Ly Hoang, BS, Toronto, ON, Canada; Eric M. Massicotte, MD, FRCS(C), Toronto, ON, Canada; Michael Fehlings, MD, PhD, FRCS, Toronto, ON, Canada

- **4:43 – 4:47 PM**
  207. Unilateral Versus Bilateral Cage and Pedicle Screw Placement for Single Level Fusion. A Prospective Comparison
  Douglas B. Moreland, MD, Buffalo, NY; Gregory A. Czajka, MPAS, PA-C, Buffalo, NY; Jennifer Weaver, RPA-C, Buffalo, NY

- **4:47 – 4:54 PM Discussion**

- **4:54 – 4:58 PM**
  208. Development of an Animal Model of Post-Traumatic Syringomyelia Associated with Adhesive Arachnoiditis: Implications for an Enhanced Understanding of the Pathobiology and for the Development of Novel Therapeutic Approaches
  Toshitaka Seki, MD, PhD, Toronto, ON, Canada; Michael G. Fehlings, MD, PhD, FRCS, Toronto, ON, Canada

- **4:58 – 5:02 PM**
  209. Minimally Invasive Lateral Mass Screw Fixation in the Cervical Spine: Initial Clinical Experience with Long-Term Follow-Up
  Michael Y. Wang, MD, Los Angeles, CA; Allan D.O. Levi, MD, PhD, Miami, FL; Bryan C. Oh, MD, Los Angeles, CA

- **5:02 – 5:06 PM**
  210. Posteromedian Extracavitary Approach to the Thoracolumbar Spine: A Single Incision Approach for Circumferential Decompression, Reconstruction, and Arthrodesis
  Nicholas B. Levine, MD, Cincinnati, OH; Charles Kuntz, MD, Cincinnati, OH; Robert J. Bohinski, MD, PhD, Cincinnati, OH

- **5:06 – 5:10 PM**
  211. CGRP and GAP43 Increase and Colocalize in Allodynic Rats Following SCI and Stem Cell Transplantation
  Melissa Y. Macias, MD, PhD, Milwaukee, WI; Mara C. Bacon, BS, Milwaukee, WI; Shekar N. Kurpad, MD, PhD, Milwaukee, WI

- **5:10 – 5:14 PM**
  212. Neodisc – Design, Testing and Early Clinical Results of a Textile/Elastomeric Cervical Disc Replacement
  Alan McLeod, PhD, Taunton, United Kingdom; Chris Reah, PhD, Taunton, United Kingdom; Andre Jackowski, MD, Birmingham, United Kingdom

- **5:14 – 5:18 PM**
  213. Spinal Deformity Following Selective Dorsal Rhizotomy for Spasticity
  Jeff D. Golan, MD, Montreal, PQ, Canada; Jeffery A. Hall, MD, FRCS(C), Montreal, PQ, Canada; Jean-Pierre Farmer, MD, FRCS(C), Montreal, PQ, Canada

- **5:18 – 5:30 PM Discussion**

- **5:30 PM Adjournment**

4:15 – 5:30 PM **CONCURRENT ORAL POINT PRESENTATIONS**

Session II

Moderator: Jay Y. Chun, MD, PhD

- **4:15 – 4:19 PM**
  214. Comparison of Outcomes After Lumbar Artificial Disc Replacement Surgery in Worker's Compensation Versus Non-Compensation Patients
  Hyun W. Bae, MD, Santa Monica, CA; Ben B. Pradhan, MD, MSc, Santa Monica, CA; Michael A. Kropf, MD, Santa Monica, CA; Linda E.A. Kanim, MA, Santa Monica, CA; Rick B. Delamarter, MD, Santa Monica, CA

- **4:19 – 4:23 PM**
  215. Effects of Age on Perioperative and Intermediate-Term Clinical Outcomes and Fusion Rates After Multilevel 360-Degree Lumbar Fusion
  Frank L. Acosta, Jr., MD, San Francisco, CA; Henry E. Aryan, MD, San Francisco, CA; Christopher P. Ames, MD, San Francisco, CA

- **4:23 – 4:27 PM**
  216. A Key Role for FAS Mediated Apoptosis in the Pathobiology of Cervical Spondylotic Myelopathy: Evidence from Human Tissue and a Mutant Mouse Model
  Wenru Yu, MD, Toronto, ON, Canada; Tianyi Liu, Toronto, ON, Canada; Darryl C. Baptiste, PhD, Toronto, ON, Canada; Michael G. Fehlings, MD, PhD, Toronto, ON, Canada

- **4:27 – 4:31 PM**
  217. Artificial Cervical Pedicle Screw Reconstruction for Degenerative and Neoplastic Disease: Intermediate-term Clinical and Radiographic Results
  Frank L. Acosta, Jr., MD, San Francisco, CA; Henry E. Aryan, MD, San Francisco, CA; Christopher P. Ames, MD, San Francisco, CA

- **4:31 – 4:35 PM**
  218. Results of a Modified Paramedian Transpedicular Approach with Radical Bone Resection for Intradural, Extramedullary Tumors of the Ventral Cervicothoracic Spine
  Frank L. Acosta, Jr., MD, San Francisco, CA; Henry E. Aryan, MD, San Francisco, CA; Christopher P. Ames, MD, San Francisco, CA

- **4:35 – 4:39 PM**
  219. Evaluation of Correction of Sagittal Plane Cervical Spine Deformities with Anterior ACDF with Dynamic Plating
  Daniel R. Fassett, MD, Salt Lake City, UT; Kyle Judd, BS, Salt Lake City, UT; Randy Clark, BS, Salt Lake City, UT; Ronald Apfelbaum, MD, Salt Lake City, UT

- **4:43 – 4:52 PM Discussion**

- **4:52 – 4:56 PM**
  221. MR Imaging Clarity of the Bryan, Prodisc-c, Prestige LP and PCM Cervical Arthroplasty Devices
  James J. Lynch, MD, FRCS, Reno, NV; Lali Sekhon, MD, PhD FRCS, Reno, NV; Paul A. Anderson, MD, Madison, WI; Neil Duggal, MD FRCS(C), London, ON, Canada; Regis W. Haid, MD, Atlanta, GA; John Heller, MD, Atlanta, GA; Dan Riew, MD, St. Louis, MO; Kevin Seex, MBBS, FRACS, Sydney, Australia

- **4:56 – 5:00 PM**
  222. Correction of Cervical Kyphotic Deformity via 360° Fusion: Long Term Follow Up with a Standardized Analysis
  Praveen V. Mummaneni, MD, Atlanta, GA; Sanjay Dhall, MD, Atlanta, GA; Gerald E. Rodts, MD, Atlanta, GA; Regis W. Haid, MD, Atlanta, GA

- **5:00 – 5:04 PM**
  223. Mortality, Neurological Outcome and Axonal Survival following Spinal Cord Injury in a Geriatric Population
  Julio C. Furlan, MD, PhD, MBA, Toronto, ON, Canada; Michael G. Fehlings, MD, FRCS(C), Toronto, ON, Canada

- **5:04 – 5:08 PM**
  224. Inosine Versus Oscillating Field Stimulation Plus Inosine in Treating Experimental Chronic Spinal Cord Injury
  Scott A. Shapiro, MD, Indianapolis, IN; Scott Purvines, MD, Indianapolis, IN; Richard Borgens, PhD, Indianapolis, IN

- **5:08 – 5:12 PM**
  225. Clinical Outcome in Patients Undergoing Anterior Cervical Discectomy and Fusion Using Anterior Plating System
  Alan T. Villavicencio, MD, Boulder, CO; Sigita Burneikiene, MD, Boulder, CO; Evan Pushchak, BA, Boulder, CO; Jeffrey J. Thramann, MD, Boulder, CO

- **5:12 – 5:16 PM**
  226. Spinal Cord Uptake and Targeted Motor Neuron Delivery using the Crushed Sciatic Nerve Model
  Thais Federici, Cleveland, OH; James K. Liu, Cleveland, OH; Qingshan Teng, Cleveland, OH; Mary Garrity-Moses, Cleveland, OH; Jun Yang, Cleveland, OH; Nicholas M. Boulis, Cleveland, OH

- **5:16 – 5:20 PM**
  227. Initial Experience in C1/2 Arthrodesis Using BMP-2 and Allograft Chips
  John K. Houten, MD, Bronx, NY

- **5:20 – 5:30 PM Discussion**

- **5:30 PM Adjournment**

5:30 – 7:00 PM **RECEPTION IN THE EXHIBIT HALL**

FRIDAY, MARCH 17

7:00 – 7:05 AM **ANNOUNCEMENTS**

GREAT HALL NORTH & CENTER

Robert F. Heary, MD, Section Chair
Michael W. Groff, MD, Annual Meeting Chair
Mark R. McLaughlin, MD, Scientific Program Chair

7:05 – 9:45 AM **SCIENTIFIC SESSION III**

Special Technology Session

Director: Gerald E. Rodts, Jr., MD
Faculty: Deborah L. Benzil, MD; Christopher H. Comey, MD; Richard Fessler, MD; Kevin T. Foley, MD; Brian R. Greer; Iain H. Kalfas, MD; Isador Lieberman, MD; Najeeb Thomas, MD

SESSION DESCRIPTION

This course will give an overview to the participants on what new technologies are available for the spine surgeon in the year 2006. Focus will be on usable, practical devices and improvements in the OR that can improve spine surgery.

LEARNING OBJECTIVES

Upon completion of this session, participants should be able to:

- Recognize available radiological guidance systems that can be implemented in the OR.
- Summarize the newest diagnostic imaging techniques.
- Explain the benefits and pitfalls of frameless stereotactic guidance.
- Discuss how telemedicine can be incorporated into spine practices to increase efficiency.

7:05 – 7:20 AM	The OR and Tools of the Future Gerald E. Rodts, Jr., MD
7:20 – 7:35 AM	Current and Future Minimally Invasive Techniques Kevin T. Foley, MD
7:35 – 7:50 AM	Microendoscopic Discectomy (MED) Christopher H. Comey, MD
7:50 – 8:05 AM	Spinal Endoscopic Approaches to the Thoracic/Lumbar Spine Richard Fessler, MD
8:05 – 8:20 AM	Minimally Invasive Lumbar Fusion Najeeb Thomas, MD
8:20 – 8:35 AM	Vertebral Augmentation Isador Lieberman, MD
8:35 – 8:50 AM	Telemedicine, the Internet and the Spine Surgeon Brian R. Greer
8:50 – 9:05 AM	Spine Surgery: Image Guidance of the Future Iain Kalfas, MD
9:05 – 9:20 AM	Radiosurgery of the Spine Deborah L. Benzil, MD
9:20 – 9:45 AM	Panel Discussion with ARS Deborah L. Benzil, MD; Christopher H. Comey, MD; Richard Fessler, MD; Kevin T. Foley, MD; Brian R. Greer, MD; Iain Kalfas, MD; Isador Lieberman, MD; Gerald E. Rodts, Jr., MD; Najeeb Thomas, MD

9:45 – 10:15 AM **Fellowship Awards & Update**

3:30 – 4:15 PM **BEVERAGE BREAK WITH EXHIBITORS**

"What's New" Session #4

in the Exhibit Hall Demo Theater

Moderator: Richard M. Spiro, MD, MPH

11:00 AM – 12:30 PM **ORAL ABSTRACT PRESENTATIONS**

Moderator: R. John Hurlbert, MD, PhD

- **11:00 – 11:07 AM**
  112. Cervical Disc Replacement – Longer-Term (2-year) Range of Motion and Clinical Outcomes Follow-Up with the ProDisc-C Prosthesis
  Rick B. Delamarter, MD, Santa Monica, CA; Hyun W. Bae, MD, Santa Monica, CA; Linda E.A. Kanim, MA, Santa Monica, CA; Michael A. Kropf, MD, Santa Monica, CA; Ben B. Pradhan, MD, MSc, Santa Monica, CA

- **11:07 – 11:14 AM**
  113. Radiographic Analysis of the Prestige® ST Cervical Disc: Results from a Prospective Randomized Controlled Clinical Trial
  J. Kenneth Burkus, MD, Columbus, GA; Thomas A. Zdeblick, MD, Iowa City, IA; Vincent C. Traynelis, MD, Iowa City, IA

- **11:14 – 11:21 AM**
  114. Lumbar Intervertebral Disc Stabilization (LIDS): A Stand-alone, Unilateral, Lumbar Fusion Technique
  Madhavan Pisharodi, MD, Brownsville, TX; Amayur P. Chandran, PhD, Brownsville, TX

- **11:21 – 11:27 AM Discussion**

- **11:27 – 11:34 AM**
  115. eXtreme Lateral Interbody Fusion (XLIF): The Initial U.S. Experience 2003-2004
  Neill M. Wright, MD, St. Louis, MO

- **11:34 – 11:41 AM**
  116. Positional Peripheral Nerve Injury in Spine Surgery: Is There a Potential Role for Intraoperative Monitoring?
  Arthur Grigorian, MD, PhD, Macon, GA; Vassilios Dimopoulos, MD, Macon, GA; Induk Chung, PhD, Macon, GA; Bridget Fuhrmann, BSN, RN, Macon, GA; Kim Holderfield, MSc, Macon, GA; Joe S. Robinson, MD, Macon, GA

- **11:41 – 11:48 AM**
  117. Long-term Radiographic Evaluation of 331 Patients after Anterior Cervical Discectomy and Fusion with Dynamic Plating
  Daniel R. Fassett, MD, Salt Lake City, UT; Kyle Judd, BS, Salt Lake City, UT; Randy Clark, BS, Salt Lake City, UT; Ronald Apfelbaum, MD, Salt Lake City, UT

- **11:48 – 11:55 AM Discussion**

- **11:55 AM – 12:02 PM**
  118. Extraforaminal Lumbar Interbody Fusion: A New Technique for Outpatient Lumbar Fusion Surgery
  Gregory J. Przybylski, MD, Edison, NJ; William Mitchell, MD, Edison, NJ

- **12:02 – 12:09 PM**
  119. Minimally Invasive Transforaminal Lumbar Interbody Fusion and Pedicle Screw Fixation: An Excellent Technique For Treatment of Chronic Lower Back Pain Secondary to Spondylolisthesis or Degenerative Disc Disease With or Without Associated Stenosis
  Mick Perez-Cruet, MD, MSc, Southfield, MI; Hormoz Sheikh, MD, Southfield, MI

- **12:09 – 12:16 PM**
  120. Cervical Arthroplasty Versus Fusion at Two Levels: What are the Biomechanical Differences?
  Kevin T. Foley, MD, Memphis, TN; Denis J. DiAngelo, PhD, Memphis, TN

- **12:16 – 12:23 PM**
  121. Cervical Disc Arthroplasty with the Prestige ST Device: One and Two Year Results from a Multi-Center Randomized Controlled Trial
  Praveen V. Mummaneni, MD, Atlanta, GA; Regis W. Haid, MD, Atlanta, GA; Joseph B. Stachniak, MD, Richardson, TX; Wade M. Ceola, MD, Springfield, MO; Paul D. Sawin, MD, Winter Park, FL

12:30 – 1:00 PM **Annual Business Meeting**

1:00 – 6:00 PM **Golf Outing**
Pre-registration is required.

1:00 – 5:00 PM **CONCURRENT SESSION**
SPECIAL COURSE V

ABC's of Peripheral Nerve Surgery

Additional $200 for medical registrants, includes lunch. Complimentary for Residents and Fellows

Co-Director: Robert J. Spinner, MD and Eric L. Zager, MD
Faculty: Allan J. Belzberg, MD; Aaron G. Filler, MD, PhD; Holly S. Gilmer-Hill, MD; Line Jacques, MD; Allen H. Maniker, MD; John E. McGillicuddy, MD; Robert L. Tiel, MD

COURSE DESCRIPTION

This didactic course will detail the ABC's of peripheral nerve surgery. It is targeted to practicing surgeons, senior level residents and fellows.

LEARNING OBJECTIVES

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

- Convey basic information on diagnosis and management of common nerve injuries, nerve entrapments and nerve disorders.
- Prepare the residents for the written board examinations and the young neurosurgeons for the oral board examinations on nerve topics and questions.
- Review the diagnosis and differential diagnoses of nerve conditions, particularly those that have overlap to medical and spinal conditions.
- Distinguish those nerve conditions needing emergent and urgent management versus those that can be managed in a more delayed fashion.
- Recognize common peripheral nerve conditions and distinguishing these from the unusual conditions, which should be referred to subspecialists.

1:00 PM Introduction
Robert J. Spinner, MD

1:05 PM Nerve Emergencies: Pearls and Pitfalls
Allen H. Maniker, MD

1:25 PM Entrapment Neuropathies: Upper Extremity
Eric L. Zager, MD

1:45 PM Entrapment Neuropathies: Lower Extremity
Holly Gilmer-Hill, MD

2:05 PM Basics of EMG
Robert L. Tiel, MD

2:25 PM Basics of MR Neurography
Aaron G. Filler, MD, PhD

2:45 PM Questions & Answers

3:00 PM Beverage Break

3:20 PM Brachial Plexus Injuries: Anatomy and Management
John E. McGillicuddy, MD

3:40 PM Outcomes for Nerve Injury and Reconstructive Strategies
Robert J. Spinner, MD

4:00 PM Painful Neuromas
Allan J. Belzberg, MD

4:20 PM Peripheral Nerve Tumors
Line Jacques, MD

4:40 PM Questions & Answers with Illustrated Cases

5:00 PM Adjournment

1:00 – 5:00 PM **CONCURRENT SESSION**

A Special Symposium for Nurses, Nurse Practitioners and Physician Assistants– **Meeting the Challenges of Caring for the Patient with a Spinal Tumor**

Additional $110 for medical registrants, includes lunch.

Co-Directors: Shannon Hagy, BSN, CNRN and Andrea L. Strayer, NP, CNRN
Faculty: Edward C. Benzel, MD; Robert D. Hager, MMSC, PAC; Michael P. Steinmetz, MD; Christina M. Stewart-Amidei, MSN, RN, APN, CNRN, CCRN

COURSE DESCRIPTION

This special symposium for nurses and physicians assistants will focus on meeting the challenges of caring for the patient with a spinal tumor. After a discussion of the significance of the problem, neurosurgical decision making and goals of treatment will be presented. Perioperative care considerations and adjunctive treatment options will be reviewed. The symposium will close with a thought provoking session on "When Enough is Enough."

LEARNING OBJECTIVES

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

- Discuss the significance of spinal tumors and the neurosurgical decision making for patients with a spinal tumor.
- Analyze perioperative care considerations, adjunctive treatment options and when neurosurgical treatment is no longer indicated.

1:00 PM Introduction
Shannon Hagy, BSN, CNRN and Andrea L. Strayer, NP, CNRN

1:05 PM Spinal Tumors Demographics
Shannon Hagy, BSN, CNRN

1:35 PM Neurosurgical Treatment
Michael P. Steinmetz, MD

2:05 PM The Role of the Physician Assistant
Robert D. Hager, MMS, PAC

2:35 PM Post-Operative Care
Shannon Hagy, BSN, CNRN

3:05 PM Beverage Break

3:20 PM Adjunctive Treatment Options
Christina M. Stewart-Amidei, MSN, RN, APN, CNRN, CCRN

3:50 PM When Enough Is Enough
Edward C. Benzel, MD

4:20 PM Questions & Answers

5:00 PM Adjournment

SATURDAY, MARCH 18

7:00 AM ANNOUNCEMENTS

7:05 – 9:00 AM

David Cahill Memorial Controversies Session

Moderators: R. John Hurlbert, MD, PhD and Christopher I. Shaffrey, MD

Faculty: Ronald I. Apfelbaum, MD; Ray M. Baker, MD; Edward C. Benzel, MD; Richard G. Fessler, MD; Anthony K. Frempong-Boadu, MD; Larry T. Khoo, MD; Stephen M. Papadopoulos, MD; William C. Welch, MD

SESSION DESCRIPTION

Through a debate presentation format, controversial clinical management decisions will be presented with experts arguing their perspective on what the literature supports.

LEARNING OBJECTIVE

Upon completion of this session, participants should be able to:

- Discuss the indications for surgery in the management of asymptomatic spinal cord compression.

NEUROPHYSIOLOGICAL MONITORING

7:05 AM Monitoring: Standard of Care in Spine Surgery
William C. Welch, MD

7:10 AM Monitoring Is Not the Standard of Care
Larry T. Khoo, MD

7:15 AM Monitoring: Standard of Care in Spine Surgery Rebuttal
William C. Welch, MD

7:17 AM Monitoring Is Not the Standard of Care Rebuttal
Larry T. Khoo, MD

7:19 AM Audience Vote Using ARS

LUMBAR ARTHORPLASTY

7:20 AM Is the Best Treatment for Lumbar DDD
Fred H. Geisler, MD

7:25 AM Is Not a Good Treatment for Lumbar DDD
André Van Ooji, MD

7:30 AM Is the Best Treatment for Lumbar DDD Rebuttal
Fred H. Geisler, MD

7:32 AM Is Not a Good Treatment for Lumbar DDD Rebuttal
André Van Ooji, MD

7:34 AM Audience Vote Using ARS

ADJACENT LEVEL DISEASE

7:35 AM Arthroplasty Will Decrease Adjacent Level Disease
Stephen M. Papadopoulos, MD

7:40 AM Arthroplasty Will Not Decrease Adjacent Level Disease
Edward C. Benzel, MD

7:45 AM Arthroplasty Will Decrease Adjacent Level Disease Rebuttal
Stephen M. Papadopoulos, MD

7:47 AM Arthroplasty Will Not Decrease Adjacent Level Disease Rebuttal
Edward C. Benzel, MD

7:49 AM Audience Vote Using ARS

LUMBAR DISCOGRAPHY

7:50 AM Lumbar Discography Is Efficacious for Dx and Rx
Ray M. Baker, MD

7:55 AM Lumbar Discography Is Not Efficacious
Richard G. Fessler, MD

8:00 AM Lumbar Discography Is Efficacious for Dx and Rx Rebuttal
Ray M. Baker, MD

8:02 AM Lumbar Discography Is Not Efficacious Rebuttal
Richard G. Fessler, MD

8:04 AM Audience Vote Using ARS

ASYMPTOMATIC CERVICAL CORD COMPRESSION

8:05 AM A Case for Observation
Anthony K. Frempong-Boadu, MD

8:10 AM A Case for Surgery
Ronald I. Apfelbaum, MD

8:15 AM A Case for Observation Rebuttal
Anthony K. Frempong-Boadu, MD

8:17 AM A Case for Surgery Rebuttal
Ronald I. Apfelbaum, MD

8:19 AM Audience Vote Using ARS

8:20 AM Questions & Answers

8:40 – 10:10 AM **SCIENTIFIC SESSION IV**

Pain and the Spine Surgeon

Director: John C. Oakley MD
Faculty: Giancarlo Barolat, MD; Richard K. Osenbach, MD; David S. Sinclair, MD; John J. Moossy, MD

SESSION DESCRIPTION

This session will review state-of-the-art uses of pharmacology and neural augmentation devices for the treatment of pain. Special attention will be devoted to the management of the opioid dependant patient in clinical practice.

LEARNING OBJECTIVES

Upon completion of this session, participants should be able to:
- Review appropriate narcotic weaning regimens for patients undergoing spinal surgery.
- Describe the current pharmacological options available for caring for these patients.
- Recognize indications for surgical pain management with neural augmentations and stimulation.

8:40 AM RSD/CRPS/SMP Management
Giancarlo Baralot, MD

8:55 AM Pharmacologic Options for the Spine Surgeon
Richard K. Osenbach, MD

9:10 AM Surgical Planning for the Opioid Dependent Patient
David S. Sinclair, MD

9:25 AM Pain Pump/SCS for Failed Back
John J. Moossy, MD

9:40 AM Panel Discussion Using the ARS
Giancarlo Baralot, MD; John J. Moossy, MD; Richard K. Osenbach, MD; David S. Sinclair, MD

10:10 – 10:50 AM **BEVERAGE BREAK WITH EXHIBITORS**

"What's New" Session #5

in the Exhibit Hall Demo Theater
Moderator: James S. Harrop, MD

10:50 AM -12:30 PM **SCIENTIFIC SESSION V**

Your Environment: The Spine Playing Field

Co-Directors: Mark R. McLaughlin, MD and John A. Jane, Sr., MD, PhD
Faculty: James Bean, MD; Paul B. Nelson, MD; Katie Orrico, JD; Troy M. Tippett, MD; Paul Starr, PhD

SESSION DESCRIPTION

This session will focus on the socioeconomic environment of the spine surgeon. The forces in place and the potential future scenarios will be discussed. Insights into what spine surgeons can do to improve their position within the political environment will be discussed.

LEARNING OBJECTIVES

Upon completion of this session, participants should be able to:
- Outline the current infrastructure that exists with regards to medical politics.
- Recognize the competing factors and compelling reasons to implement a concerted effort to unify and align our society's interests with other spine lobby organizations.

10:50 AM The Public Image of the Physician
James Bean, MD

11:00 AM Mr. Spine Surgeon Goes to Washington
Troy M. Tippett, MD

11:10 AM Cooperation of Societies with a Common Interest/Doctors for Medical Liability Reform
Katie Orrico, JD

11:20 AM The State of Medical Liability in the US
Paul B. Nelson, MD

11:30 AM **Key Note Address:** The Medical Liability Crisis and What Physicians Can Do About It
Paul Starr, PhD

12:20 PM Questions & Answers

12:45 PM Adjournment

1:00 – 5:00 PM **SPECIAL COURSE VI**

Board Review for Spine Surgery and Peripheral Nerve

Additional $110 for medical registrants, includes lunch.

Director: Ehud Mendel, MD, FACS
Faculty: Daniel K. Resnick, MD; Allen H. Maniker, MD; Alan Levi, MD, PhD, FRCS

COURSE DESCRIPTION

In a case presentation format participants will engage in a simulated oral boards examination covering spine and peripheral nerve cases commonly seen at the ABNS examination.

LEARNING OBJECTIVES

Upon completion of this session, participants should be able to:
- Summarize the most common peripheral nerve cases that might be presented on an oral board examination.
- Review common spine case scenarios that might be presented.
- Discuss incorporating an alga rhythm format in creating a systematic approach to the answering oral examination questions.

1:00 PM Introduction
Ehud Mendel, MD, FACS

1:05 PM Spine Cases
Alan Levi, MD, PhD, FRCS and Daniel K. Resnick, MD

2:35 PM Beverage Break

2:50 PM Peripheral Nerve Cases
Alan Levi, MD, PhD, FRCS and Allen H. Maniker, MD

5:00 PM Adjournment

EXHIBIT HOURS

Thursday, March 16
9:00 AM – 7:00 PM

Friday, March 17
9:00 AM – Noon

Saturday, March 18
9:00 – 11:30 AM

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F: (760)727-8891
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F: (651)256-8505
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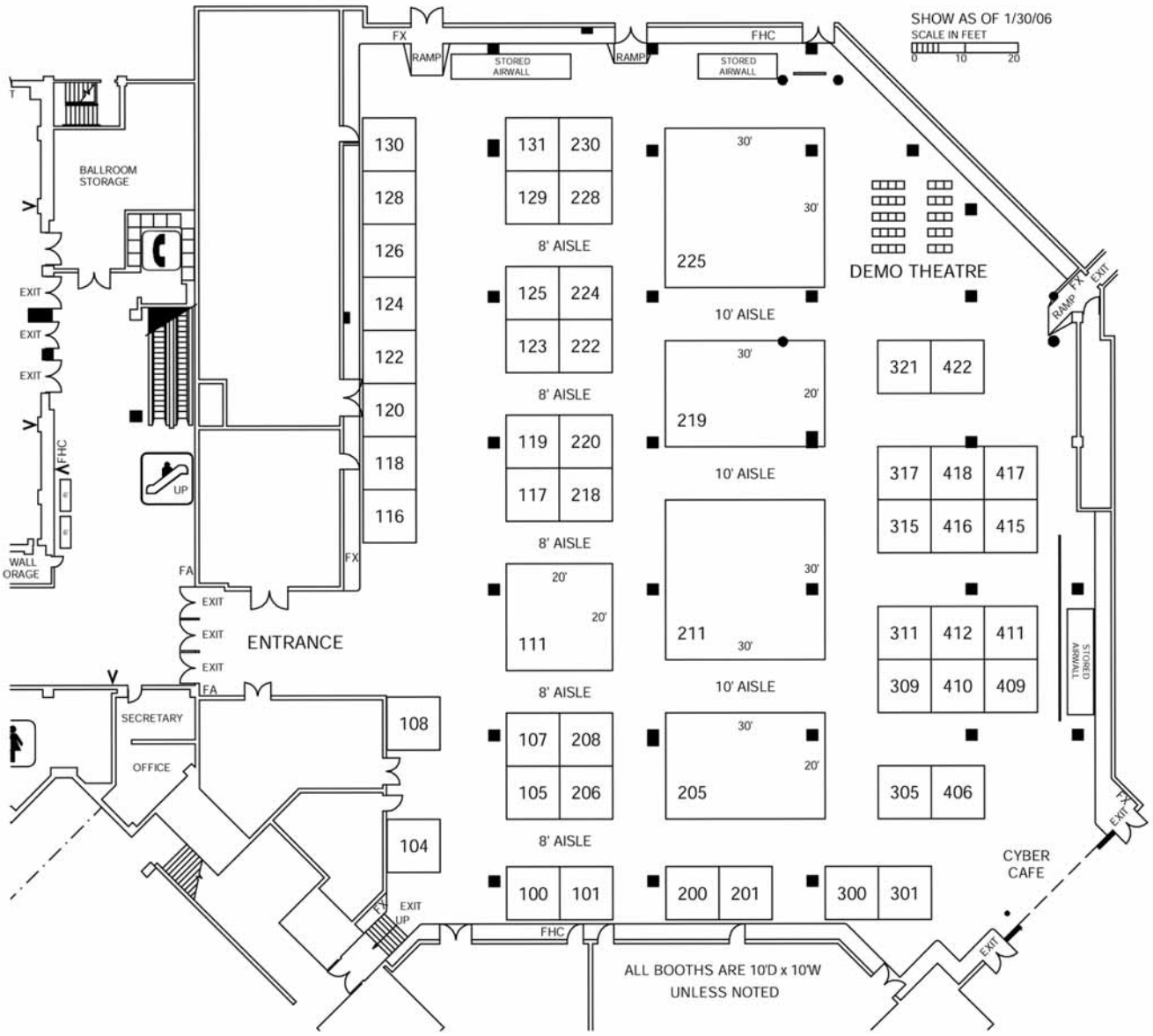

E- POSTERS

To assist you in finding specific posters that you may be interested in viewing, e-posters are located in the back of the exhibit hall on five computer terminals. E-posters are located behind Booth 422 to the right of the demo theater. The scientific poster abstracts can be found on pages 56-90.

Three poster awards will be given at this meeting. The top three e-posters will be announced during the Awards Session on Friday, March 17th. All posters displayed by Thursday, March 16 at 12:00 PM will be eligible for these awards.

300

Open Versus MAST Lumbar Interbody Fusion

Sean D. Christie, MD, FRCS(C), Halifax, NS, Canada; John K. Song, MD, Chicago, IL; Edward Abraham, MD, FRCS(C), Saint John, NB, Canada; Melody Hrubes, Chicago, IL; Richard G. Fessler, MD, Chicago, IL

301

Targeted Microinjection of Cells into the Ventral Horn Utilizing a Novel Delivery System in Pigs

John B. Butler, MD, Cleveland, OH; Nicholas Boulis, MD, PhD, Cleveland, OH; Dileep Nair, MD, Cleveland, OH; Baker Ken, PhD, Cleveland, OH; Clive Svendson, PhD, Madison, WI; Shearwood McClelland, III, MD, Cleveland, OH

302

Operative Failure of Percutaneous Endoscopic Lumbar Discectomy: A Radiological Analysis of 55 Cases.

Sang-Ho Lee, MD, PhD, Seoul, Republic of Korea; Byeng Uk Kang, MD, Seoul, Republic of Korea; Yong Ahn, MD, PhD, Seoul, Republic of Korea; Gun Choi, MD, PhD, Seoul, Republic of Korea; Young-Geun Choi, MD, Seoul, Republic of Korea; Kwang Up Ahn, MD, Seoul, Republic of Korea

303

Objective Clinical Outcome Following Microendoscopic Discectomy (MED) for Lumbar Herniated Intervertebral Disks Using SF-36, Visual Analog Scale, and Oswestry Disability Index

Dae-Hyun Kim, MD, Chicago, IL; Kurt M. Eichholz, MD, Chicago, IL; John Song, MD, Chicago, IL; Sean Christie, MD, PhD, Chicago, IL; Melody Hrubes, BS, Chicago, IL; John E. O'Toole, MD, Chicago, IL; Richard G. Fessler, MD, PhD, Chicago, IL

304

Bioabsorbable Cervical Spacers in the Treatment of Multilevel Degenerative Disc Disease

Kaveh Khajavi, MD, FACS, Decatur, GA; Erin G. Mihelic, PA-C, Decatur, GA; James Malcolm, MD, FACS, Marietta, GA

305

Corpectomy Followed by Instrumentation with Titanium Cages and rhBMP for Vertebral Osteomyelitis

Henry E. Aryan, MD, San Francisco, CA; Frank L. Acosta, Jr., MD, San Francisco, CA; Christopher P. Ames, San Francisco, CA

306

Modified Pedicle Subtraction Osteotomy to Correct Thoracic Kyphotic Deformity: A Cadaveric Study

Peter M. Grossi, MD, Durham, NC; Shahid M. Nimjee, PhD, Durham, NC; Louis N. Radden, DO, Durham, NC; Ashtoush A. Pradhan, MD, Durham, NC; Robert E. Isaacs, MD, Durham, NC

307

Bryan Cervical Disc Prosthesis Implantation Causes Kyphotic Deformity: A Myth? Decreased Pain and Improved Functioning Seen Without Kyphosis in Patients Treated for Spondylotic Radiculopathy

Neil J. Cochrane, Southport, Australia

308

In Vitro Study of Traumatic Loading After Implanting the Bryan Cervical Disc Prosthesis

Neil Duggal, MD, FRCS(C), London, ON, Canada; Neil Crawford, PhD, Barrow Neurological Institute, AZ; Robert Chamberlain, MS, Barrow Neurological Institute, AZ; Seungwon Baek, Barrow Neurological Institute, AZ

309

Return to Work Analysis of Patients Treated with an Artificial Cervical Disc or an Arthrodesis

Vincent Traynelis, MD, Iowa City, IA; Paul Anderson, MD, Madison, WI; Newton H. Metcalf, BS, Memphis, TN

310

Clinical and Radiographic Outcomes of Thoracic and Lumbar Pedicle Subtraction Osteotomy for Fixed Sagittal Imbalance.

Benson P. Yang, MD, Chicago, IL; Stephen L. Ondra, MD, Chicago, IL; Larry A. Chen, BS, Chicago, IL; HeeSoo Jung, BA, Chicago, IL; Tyler R. Koski, MD, Chicago, IL; Sean A. Salehi, MD, Chicago, IL

311

Porous Coated Motion Cervical (PCM) Disk Replacement in Adjacent Segment Disease – Clinical Follow up of 40 Cases

Paul McAfee, MD, Sparks, MD; Luiz Pimenta, MD, PhD, Sao Paulo, Brazil; Matthew Scott-Young, Queensland, Australia; Andy Cappuccino, Buffalo, NY

312

Intervertebral rhBMP-2 for Transforaminal Lumbar Interbody Fusion

Alan T. Villavicencio, MD, Boulder, CO; Sigita Burneikiene, MD, Boulder, CO; E. Lee Nelson, MD, Boulder, CO; Ketan R. Bulsara, MD, Columbia, MO; Jeffrey J. Thramann, MD, Boulder, CO

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Comparison of Sagittal and Coronal Alignment of the Cervical Spine After One to Three-level Artificial Disc Replacements (ProDisc-C) Versus fusion

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Harel Deutsch, MD, Chicago, IL

ORAL ABSTRACT PRESENTATIONS

These scheduled presentations will be held in the plenary session room Thursday, March 16th and Friday, March 17th. Each presentation is made by the primary author and will be seven minutes long, followed by short discussion periods through out each session.

100. Revisability of the Charité Artificial Disc Replacement — Analysis of 688 Patients Enrolled in the US IDE Study of the Charité Artificial Disc

Paul McAfee, MD, Sparks, MD; Fred Geisler, MD, Chicago, IL; Sam Saiedy, MD, Baltimore, MD; Richard Guyer, MD, Dallas, TX; John Regan, MD, Los Angeles, CA; Scott Blumenthal, MD, Dallas, TX

Introduction: This study analyzes the revision cases evolving from the prospective, randomized, multi-center, FDA-regulated IDE clinical trial of the Charité disk replacement.

Methods: A total of 668 patients meeting the inclusion and exclusion criteria were enrolled at 14 centers across the United States.

Results: Of the 589 patients with TDR in this review, 52 (8.8%) required reoperation. Of the 99 patients with lumbar fusion, 10 (10.1%) required reoperation. Of this group, 29 patients with TDR (4.9 %) and 10 patients with lumbar fusion (10.1 %) required supplemental fixation. There were 24 TDR patients who underwent a repeated anterior retroperitoneal approach with removal of the prosthesis. 7 of the 24 TDR prostheses requiring removal were revised to another Charité Artificial Disc, usually of smaller size. The mean time to removal in all patients was 9.6 months (range = 3 days - 34 mos). Overall, 29 patients had posterior exploratory laminectomies and pedicle screw instrumentation performed as a salvage procedure. All 13 patients with iatrogenic neurological signs resolved following posterior nerve root decompression.

Conclusions: Lumbar TDR with the Charité Artificial Disc did not "burn any bridges" during primary insertion with one third being revisable to a new motion preserving prosthesis and two thirds being successfully converted to anterior interbody fusion or posterior pedicle screw arthrodesis, the original alternative procedure. At two years or more follow-up, 92.4% (544/589) of patients receiving TDR with the Charité Artificial Disc had a successfully functioning prosthesis with a mean of over 7 degrees of flexion/extension mobility.

101. Comparison of Osteophyte Formation in Patients with the Bryan Disc and Patients with ACDF

Stephen M. Papadopoulos, MD, Phoenix, AZ; Vincent C. Traynelis, MD, Iowa City, IA; Jeffrey P. Rouleau, PhD, Minneapolis, MN

Introduction: Cervical arthroplasty not only maintains motion at the operative level, but also may reduce adjacent level degeneration in comparison to ACDF. Evidence of degenerative changes can be detected on lateral radiographs.

Methods: Pre-operative, 12-month, and 24-month lateral films were retrospectively digitized for 139 patients with the Affinity® Anterior Cervical Cage System, 64 patients with the Bryan® Cervical Disc prosthesis, and 15 patients with the Cornerstone-SR® Allograft Implant. Anterior osteophyte area and protrusion were quantified for both the inferior and superior aspects of the vertebrae at the operative disc space and the disc spaces above and below. Data was compared using ANOVA with Bonferroni's adjustment for multiple comparisons.

Results: The changes in total osteophyte area at the index disc space from the pre-operative time point to both the 12- and 24-month time points were statistically less for Bryan than Affinity and Cornerstone. Bryan had less new osteophyte area than Cornerstone on the inferior vertebra at the disc space above the operative level over the period from 0 to 12 months. Bryan had less new osteophyte protrusion than Affinity on the inferior vertebra at the disc space below the operative level over the period from 0 to 24 months.

Conclusions: Osteophyte formation at or adjacent to a Bryan disc was either statistically similar or less than the osteophyte formation at or adjacent to Affinity or Cornerstone-SR ACDF devices. This result suggests that implantation of BRYAN disc results in a reduction in the rate of adjacent level degeneration compared to ACDF.

102. Complications with Cervical Arthroplasty

Neil Duggal, London, ON, Canada; Gwynedd E. Pickett, MD, FRCS(C), London, ON, Canada; Lali Sekhon, MD, PhD, Spine Nevada, NV; William Sears, Sydney, Australia

Introduction: Spinal arthroplasty is becoming more widely available for the treatment of degenerative cervical disc disease. While this new technology may offer benefit over arthrodesis, it also requires the acquisition of new operative techniques, and introduces new potential complications. We analyzed our early series of patients treated with the Bryan® cervical disc prosthesis to determine the frequency of perioperative complications.

Methods: We prospectively recorded operative data, complications, clinical and radiographic outcomes in all patients who received the Bryan® artificial cervical disc in two tertiary care centers since 2001. Patients underwent standard anterior cervical discectomy followed by arthroplasty at one to three levels.

Results: Ninety-six discs were implanted in 74 patients. The perioperative complication rate was 6.2% per operated level. One patient developed a retropharyngeal hematoma requiring evacuation. Neurological worsening occurred in 3 patients. Intraoperative migration of the prosthesis was observed in one bi-level case, while delayed migration occurred in one patient with post-operative segmental kyphosis. Another patient with severe post-operative segmental kyphosis required revision with a custom lordotic prosthesis. Heterotopic ossification and spontaneous fusion occurred in 2 cases; motion was preserved in the remaining 94 prostheses. Partial dislocation of the prosthesis in extension occurred in 1 patient with preoperative segmental hypermobility, the first reported failure of a Bryan® prosthesis. Twenty-five percent of patients reported neck and shoulder pain in late follow-up. There was a trend towards increased kyphosis of the C2-7 curvature post-operatively.

Conclusions: The Bryan® disc prosthesis was effective in maintaining spinal motion. Major perioperative and device-related complications were infrequent.

103. Schwann Cell Transplantation Improves Reticulospinal Fiber Growth and Forelimb Strength After Severe Cervical Spinal Cord Contusion

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Introduction: Schwann cells (SC), the myelinating glial cells of the peripheral nervous system, have been previously shown to promote regeneration of propriospinal neurons and brainstem neurons (only in the presence of neurotrophic factors or cAMP elevation) after grafting into the injured spinal cord. In the current study we examined if fluid SC grafts transplanted into a clinically-relevant moderate contusion injury of the cervical (C5) spinal cord, a location closer to the cell bodies of axotomized neurons, could support supraspinal axon growth.

Methods: Adult female Fischer rats received a severe (C5) cervical contusion (1.1 mm displacement injury with a single, brief displacement of <20 msec) using the Electromagnetic Spinal Cord Injury Device (ESCID) developed at Ohio State University. At 1 wk post-injury, 2 million SCs transduced to express green fluorescent protein (GFP) by lentiviral vectors were transplanted in DMEM media into the injury site. Injury-only animals served as controls. After behavioral assessment, animals were anterogradely traced from the reticular formation using dextran rhodamine.

Results: Histological analysis showed that numerous labeled reticulospinal fibers had penetrated the SC grafts, a phenomenon not seen following transplantation of SCs into the injured thoracic spinal cord. Furthermore, significant improvements in upper limb strength were observed following SC transplantation.

Conclusions: The current study demonstrates that SCs alone are capable of supporting modest supraspinal axon growth when the site of axon injury is closer to the cell body of the axotomized neuron. (Supported by the CRPF, NINDS09923, NIHPOINS38665, Buoniconti Fund and The Miami Project).

104. A Prospective, Multi-Center, Randomized Clinical Trial Evaluating Minimally Invasive Versus Open Pedicle Screw Instrumentation

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Introduction: Interest in minimally invasive spine (MIS) surgery is due in part to technological advances and a desire to reduce approach related morbidity. The benefits of MIS vs open surgery particularly as it applies to spinal instrumentation has not been thoroughly investigated.

Methods: We conducted a randomized prospective, multi-center clinical trial of 54 patients (33 males and 21 females) receiving either minimally invasive (n=39) or open (n=15) pedicle screw instrumentation for the treatment of degenerative lumbar spine disorders. Levels instrumented included 3 at L3-4, 16 at L4-5, 22 at L5-S1, and 13 at L4-5 and L5-S1. Patients in both groups underwent interbody fusion.

Results: Operative time averaged 317 min open versus 346 min for MIS cases. Blood loss averaged 522 cc for open versus 168 cc for MIS cases. Post-operative VAS scores decrease by 25% in the open versus 34% in the MIS group at 2 weeks, by 57% in the open versus 66% in the MIS group at 3 months and by 46% in the open versus 55% in the MIS group at 6 months. Average hospital stay was 3 days for the MIS group and 4 days for the open group. Complications included 1 graft failure in the MIS group requiring reoperation and 5 complications in the open group.

Conclusions: This study showed increased operative times in patients undergoing MIS instrumentation and fusion while blood loss was less, outcomes over time were improved, and hospital stays were shortened compared to patients undergoing more traditional instrumentation and fusion.

105. The Nerve Grafting, Nerve Transfer, End-To-Side Neurorrhaphy and Muscle Transfer in the Treatment of Brachial Plexus Injury

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Introduction: Despite the improvement over the last decade in surgical techniques for the brachial plexus, surgical outcome and functional restoration of the affected arm are still very limited. Favorable surgical outcomes have been reported in 60% of patients.

Methods: Total of 200 brachial plexus injury operations have been performed by the first author in 192 consecutive patients. Besides the standard techniques, the perineurial suture after creation of epineurial window has been used for end-to-side neurorrhaphy.

Results: Functional recovery was accomplished in 90% of nerves following external neurolysis, 83% following nerve grafting, 54% following end-to-end neurotization, 64,3% following end-to-side neurotization and 89% following muscle transfer. We achieved the best results with regional nerves used as donors for nerve transfer. The difference was significant especially for the musculocutaneus nerve as a recipient: 93% of functional recovery when regional nerves were used, 48% when extraplexal nerves were used (p=0.005). Use of the medial pectoral nerve as a donor led to the most favorable functional recovery in 88% of cases. According to the electrophysiological data, even use of clearly partially denervated intraplexal donor nerves resulted to the more favorable recovery than use of extraplexal nerves. End-to-side neurorrhaphy was performed predominantly for neurotization of the axillary nerve and functional recovery (62%) was very similar to the use of other common donors.

Conclusions: Better functional recovery was achieved using regional (intraplexal) nerves as donors of motor fibers. End-to-side anastomosis is an alternative method with results similar to the other donors of motor fibres.

106. The Use of Allograft Bone for Posterior C1-2 Fusion (Revisited)

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Introduction: Iliac crest autograft is the gold-standard for bone grafting in posterior atlantoaxial arthrodesis procedures. Although autograft has provided excellent fusion results, it can have significant donor site morbidity. Allograft has performed suboptimally for fusion in this procedure, which is primarily an onlay procedure. We have modified the technique to allow placement of bicortical iliac crest allograft in an interpositional manner and describe and review the results of our bone grafting technique between C1 and C2 using allograft.

Methods: We retrospectively reviewed 225 consecutive patients operated on between 1991 and 2005 in whom at least one C1-2 transarticular screw was placed. Age, sex, clinical indication, instrumentation, graft source, operative time, blood loss, and fusion assessment, and complications were all reviewed retrospectively.

Results: One hundred eighty-seven patients underwent iliac crest autograft harvest and 38 patients had donor iliac crest allograft for the posterior atlantoaxial arthrodesis. The average age in the autograft group was 49.7 (range 17-90) and in the allograft group was 59.6 (range 21-89). Operative time was reduced by 30 minutes in the allograft patients and estimated blood loss (mean=240 cc, 70% of patients had less than 150 cc EBL) was reduced by over 30%. All patients with greater than 12 months follow-up achieved fusion.

Conclusions: We describe a technique for interpositional bone grafting between C1 and C2 that has allowed for use of allograft with excellent fusion results. The potential benefits of this allografting technique include reduced operative time, decreased blood loss, and elimination of iliac crest donor site morbidity.

107. Complications and Retrieval Management of the Charité Lumbar Artificial Disk: A Prospective 3 Year Experience with 250 Disks

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Introduction: Total disk replacement (TDR) and motion preservation techniques represent some of the most advanced treatment for lumbar degenerative disk disease, however in some circumstances complications occur and revision of the prothesis is needed. We present our experience with complications in our 250 Charité disk series over a 3 year follow-up period.

Methods: Prospective study of 193 patients that underwent TDR with the Charité artificial disk between January 2002 and September 2005, complications reported throughout the course of the study were reviewed, including the ones that required re-operation. The surgical technique of a novel minimal invasive approach to remove the device is described.

Results: 193 patients with mean age of 42.5 years, underwent TDR with 250 Charité. 9.1% of the total patients reported persistence of pain, 0.6% presented transitional pos-operative neurological defict, no infections. 8.3% had suboptimal implantation and bad aligment (i.e. 2.8% secondary segment scoliosis), 2.8% presented subsidence, and 2.3% presented heterotopic ossification. 5 patients underwent minimally invasive lateral transpsoas XLIF (extreme lateral interbody fusion) for removal of the prosthesis and placement interbody fusion device, that was supplemented with pedicle screws. No intraoperative complications were reported, mean surgical time was 80,3 minutes, and all patients had good clinical outcome.

Conclusions: TDR is not free of complications and the knowledge of low morbidity strategies for revision must be employed to reduce the colateral damage associated substitution or removal of the device, we demostrated that a minimal invasive XLIF can safely achieve this goal.

108. Strategies and Techniques for Correction of Degenerative and Post-Surgical Cervical Kyphotic Deformity

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Introduction: Cervical Kyphotic Deformity (CKF) may result from degenerative disease of the spine, ankylosing spondylitis or may occur following decompressive laminectomy. Patients frequently experience pain with or without progressive neurological deficits and surgical management is often challenging. We present an algorithm for the classification, management and correction of degenerative and post-surgical CKF based upon experience with 15 patients.

Methods: Flexion and extension cervical spine radiographs were obtained in all patients and CKF was classified as reducible (R-CKF), partially reducible (PR-CKF) or fixed (F-CKF) based on the degree of sagittal realignment with neck extension. High-resolution CT scans with reconstructed images were then obtained on PR-CKF and F-CKF 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 restoration of normal lordosis in R-CKF patients and PR-CKF patients without extensive joint fusion. Deformity in PR-CKF and F-CKF patients with extensive joint fusion was corrected utilizing initial posterior facet osteotomies followed by ACDF with or without plating and finally with posterior lateral mass instrumentation. Electrophysiological monitoring under general anesthesia was performed in all cases.

Results: Complete restoration of normal lordosis was achieved in all cases with no perioperative mortality or progression of neurological deficits. We discuss treatment algorithm, strategies and surgical techniques as well as outcomes for patients with this condition.

Conclusions: Surgical correction of complex non-ankylosing spondylitis CKFs may be feasibly and safely approached using a stepwise treatment algorithm and combination of surgical techniques.

109. Thoracolumbar Vertebral Reconstruction After Surgery for Metastatic Spinal Tumors: Long-Term Outcomes

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Introduction: Metastatic spinal tumors continue to represent a major problem for patients and treating physicians. The purpose of this study was to assess quantitatively the functional outcome, quality of life, and survival rates of patients after major reconstructive spine surgery.

Methods: A prospective database was established and 58 patients were identified who had undergone thoracolumbar vertebral reconstruction for metastatic spinal tumors between March 1993 and October 1999. Surgical indications included disabling pain (92%) and/or progressive neurological dysfunction (60%).

Results: Forty-nine patients (85%) had clinical improvement in pain as demonstrated based on the Owestry pain scale (p less than 0.05); 60% demonstrated improvement in their neurological status. The mean neurological improvement in Frankel grade was 1.2 (p less than 0.05). The 12-month survival rate was 65%, and all patients who were ambulatory after surgery remained so until the time of death. Instrumentation failure requiring repeated operation occurred in two patients (3.5%), and in 12 patients (21%) local tumor recurrence necessitated repeated surgery. There were no cases of neurological deficit or death related to surgery.

Conclusions: Major anterior thoracolumbar vertebral reconstruction is an effective treatment for local tumor control. More importantly, we have demonstrated that surgical treatment can significantly improve the quality of life by improvement of pain control and maintenance of ambulation during the patient's remaining life span.

110. Segmental Kyphosis After Bryan Disc Arthroplasty

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Introduction: The aim of this study was to investigate factors associated with segmental kyphosis after Bryan disc replacement.

Methods: Prospective study of a consecutively enrolled cohort of patients treated in a single center using the Bryan cervical disc prosthesis for single-level segmental reconstruction in the surgical treatment of cervical radiculopathy and/or myelopathy. Static and dynamic lateral radiographs were digitally analyzed in 10 patients undergoing Bryan disc arthroplasty throughout a minimum 3 month follow-up period. Observations were compared to pre-operative studies looking for predictive factors of post-operative spinal alignment.

Results: Postoperative endplate angles through the Bryan disc in the neutral position were kyphotic in 9 of 10 patients. Compared to preoperative endplate angulation there was a mean change of -7° (towards kyphosis) in postoperative endplate alignment (p=0.007, 95%CI -6° to -13°). This correlated significantly with postoperative reduction in posterior vertebral body height of the caudal segment (p=0.011, r^2=0.575) and postoperative FSU kyphosis (p=0.032, r^2=0.46). Despite intraoperative distraction, postoperative FSU height was significantly reduced, on average by 1.7 mm (p=0.040, 95%CI 0.5-2.8 mm).

Conclusions: Asymmetrical end-plate preparation occurs because of sub-optimal coordinates to which the milling jig is referenced. Although segmental motion is preserved, Bryan disc arthroplasty demonstrates a propensity towards kyphotic orientation through the prosthesis likely as a result of intra-operative lordotic distraction. FSU angulation tends towards kyphosis and FSU height is decreased in the postoperative state from lack of anterior column support. Bryan cervical disc arthroplasty should not be performed when reconstruction or maintenance of cervical lordosis is desirable.

111. Comparison of Multiple Level Versus Single Level Cervical Disk Replacement-178 Consecutive Prostheses

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Introduction: This prospective study of 178 prosthetic implantations analyzed single level versus multiple level cervical arthroplasty.

Methods: Fifty-five patients underwent single level Porous Coated Motion (PCM) *versus* fifty-four patients underwent 109 multilevel PCM cervical arthroplasties — double level, 43 cases; three levels, 7 cases, and four levels, 4 cases. Sixteen PCM cases had been performed as complex revision procedures. The demographics between Group S and Group M were very similar: mean age of patients, gender, severity of neurologic symptoms and distribution of radicular and myeloradicular symptoms.

Results: There were no deaths, no infections, and no instances of iatrogenic neurologic progression in either the single level or the multiple level arthroplasty group. The mean follow up was 19.6 months. The self assessment outcomes instruments consistently showed more improvement for the multilevel cases. The mean improvement in the NDI for the single cases was 43.8% (+/- 20.9) versus the multilevel cases mean improvement in NDI was 64.8% (+/- 33.7). The Mean improvement in the VAS showed the same relationship — single level mean improvement 58.1% (29.3) versus the multilevel cases mean VAS improvement was 65.5% (+/- 33.0).

Conclusions: With the Porous Coated Motion cervical arthroplasty the incidence of reoperation did not increase proportionately higher as the number of cervical levels requiring instrumentation increased. This study indicates that the current five prospective randomized FDA clinical trials comparing arthroplasty with anterior cervical fusion will underestimate the true benefits of cervical arthroplasty because they are not capturing the data on multiple level application.

112. Cervical Disc Replacement – Longer-Term (2-Year) Range of Motion and Clinical Outcomes Follow-Up with the ProDisc-C Prosthesis

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Introduction: After encouraging results with lumbar arthroplasty, trials for cervical spine arthroplasty have been completed in the US. This paper represents the longest follow-up outcomes studies with cervical disc replacements in the US with (ProDisc-C).

Methods: This is a prospective randomized controlled trial of ProDisc-C intervertebral arthroplasty versus anterior cervical fusion. Thirty patients were enrolled. Clinical outcomes were recorded with the Visual Analog Scale (VAS) for both neck and arm pain, and Oswestry disability questionnaires.

Results: Average flexion-extension motion went from 9 degrees preoperatively to about 1 degree (no motion) at over 12 months postoperatively in the fusion group, but was well-preserved from 11 to 12.5 degrees in the disc replacement group. Side-bending went from 6 degrees to 2 degrees (no motion) in the fusion group, versus 5.9 to 5 degrees in disc replacement patients. Outcome scores revealed significant improvements in VAS and Oswestry scores for both groups. By six months, VAS (neck) was down from 6.6 to 2.4 in arthroplasty patients, and 6.2 to 2.6 in fusion. VAS (arm) was down from 4.7 to 2.4 and 6.5 to 2.9 in arthroplasty and fusion patients respectively. Oswestry scores similarly decreased from 25 to 9 and 24 to 13 at over 12 months in arthroplasty and fusion patients respectively.

Conclusions: Our results suggest that cervical disc replacement is a viable alternative for preservation of motion at affected vertebral levels without compromising clinical outcomes, and with the additional upside of prevention of adjacent segment degeneration. Longer-term safety and efficacy studies are in progress.

113. Radiographic Analysis of the Prestige® ST Cervical Disc: Results from a Prospective Randomized Controlled Clinical Trial

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Introduction: As cervical arthroplasty becomes a potential treatment option, it is important for spine surgeons to understand the performance of disc replacement devices. We looked at the extensive radiographic evaluation required in the IDE study protocol for the Prestige ST Cervical Disc and present the preliminary results of radiographic analysis from the study.

Methods: Five hundred forty-two patients were randomly assigned to either the investigational group (276 patients) who received the Prestige ST disc or the control group (266 patients) who had an arthrodesis with cortical ring allograft and an ATLANTIS anterior cervical plate. Patients are evaluated at the following study intervals: preoperative, 6 weeks, and 3, 6, 12, and 24 months after surgery with anteroposterior, lateral, lateral flexion-extension, and left-right lateral bending radiographic views. An independent radiology firm reviews all radiographs and each radiograph undergoes specific measurements by two physicians. We measured angulation and anteroposterior translatory movement at the treated level and adjacent levels, disc space height, and lateral-bending angulation. Computer pattern recognition technology further quantifies motion-analysis parameters.

Results: At the 12-month interval, the Prestige ST device maintained preoperative angulation to within 1° in investigational patients. In the arthrodesis group, motion dropped to below 1° of angulation, and adjacent-level-angulation measurements show a relative increase in motion at the superior segment. The device maintained disc space height without migration from the implanted position, and computer analysis demonstrated a physiologic center of rotation.

Conclusions: Preliminary radiographic evaluation indicates that the Prestige ST device is performing according to its design intent.

114. Lumbar Intervertebral Disc Stabilization (LIDS): A Stand-alone, Unilateral, Lumbar Fusion Technique

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Introduction: A reliable, 'stand-alone' posterior stabilization and fusion technique has been eluding spine surgeons. Pisharodi Device (PD) is a biconvex implant, assembled inside the disc space that conforms to the shape of the disk space and allows good area of graft to bone contact to give optimal stabilization and fusion. A feasibility study involving PD was performed followed by a multi-center prospective randomized study with cages as control, following a protocol approved by the Food and Drug Administration (FDA).

Methods: The study involved 103 patients (aged 18-59 years) with low back pain. After simple discectomy, the disc space was filled with bone from iliac crest. The biconvex piece of the PD was inserted first horizontally and rotated 90 degrees, the end-piece glided along and fastened with the biconvex piece with a screw, to form a compact unit. PD is implanted unilaterally.

Results: The patients had follow-up evaluations at 3, 6, 12 and 24 months after the surgery and this included, clinical (pain status, work status, muscle strength and reflexes), and radiological (flexion/extension, disc height, implant status including migration) studies. Follow-up evaluation 3 months after the surgery showed significant improvement in pain level and radiological evidence of 100% fusion and maintenance of disc height. Eighty-one patients have completed 24 months' follow-up.

Conclusions: PD is assembled inside the disk space and implanted unilaterally to reduce the tissue loss and to give maximum graft to bone contact for optimal fusion. LIDS procedure using PD is a simple, safe and reliable surgical technique done as a good stand-alone stabilization and fusion procedure.

115. eXtreme Lateral Interbody Fusion (XLIF): The Initial U.S. Experience 2003-2004

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Introduction: The treatment of lumbar DDD with a minimally-invasive lateral trans-psoas technique (XLIF) has previously been presented as small case series, describing the advantages of placement of a large interbody graft with small incisions, short operative times, and short hospital stays. This retrospective study reports the U.S. XLIF experience from 2003-2004 to demonstrate the safety and reproducibility of the XLIF technique in a larger patient series.

Methods: 145 XLIF patients treated by 20 U.S. surgeons were identified from an industry database. Operative data (#levels, operative time, blood loss, complications) and postoperative details (ambulation, length of stay) were analyzed. The XLIF procedure is a direct-lateral, retroperitoneal, trans-psoas approach to the interbody space. Nerve avoidance technology was used to safely traverse the psoas in all patients. After diskectomy, an interbody spacer was placed, and depending on surgeon preference, was either left stand-alone, or was supplemented laterally or posteriorly.

Results: #levels: 72% (1), 22% (2), 5% (3), 1% (4). Site: L4/5 (37%), L3/4 (33%), L2/3 (24%), L1/2 (6%). Filler: BMP (52%), DBM (39%), autograft (9%). 20% of cases were stand-alone interbody, 23% lateral rod-screw, 58% posterior pedicle screws. Nerve detection monitoring identified a nearby nerve in 46% of cases. Average operative time: 74 minutes. Average blood loss: 88ml. Most patients ambulated the same day of surgery and were discharged the next day. No major complications occurred.

Conclusions: All 145 patients were treated successfully, illustrating the technique's safety and reproducibility, with short operative times, low blood loss, early ambulation, and short hospital stays without major or lasting complication.

116. Positional Peripheral Nerve Injury in Spine Surgery: Is There a Potential Role for Intraoperative Monitoring?

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Introduction: The role of neurophysiologic intraoperative monitoring (NIOM) in preventing peripheral nerve injury due to operative positioning has been proposed in the literature. The purpose of our current communication is to assess the contribution of NIOM to early recognition of peripheral nerve compression in lumbar spinal cases with apparent optimal positioning.

Methods: The records and intraoperative neurophysiological monitoring reports of 853 consecutive patients undergoing lumbar spine surgery in our institution have been retrospectively reviewed. Unilateral upper extremity SSEP changes were identified, and intraoperative maneuvers such as repositioning of the involved extremity and intraoperative monitoring response were noted. Intraoperative findings were correlated with postoperative outcome.

Results: All patients were operated in the prone position. Preoperatively, patients' position was found to be optimal with adequate protection of pressure points. Intraoperative monitoring revealed an abrupt decrease of unilateral upper extremity SSEPs amplitude in ten cases. All patients had immediate restoration of SSEPs after repositioning and relief of mechanical compression of the ipsilateral upper extremity. No postoperative upper extremity deficit was observed.

Conclusions: In our series intraoperative monitoring detected position related peripheral nerve mechanical compression in all cases. We believe that in spine surgery NIOM plays an important role in preventing unexpected peripheral nerve injury due to improper extremity position or undetected movement.

117. Long-Term Radiographic Evaluation of 331 Patients After Anterior Cervical Discectomy and Fusion with Dynamic Plating

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Introduction: Dynamic anterior cervical plating is theorized to improve fusion rates in ACDF by allowing for load sharing of the interbody graft to provide for optimum bone healing, but large long-term follow-up studies have not been reported with dynamic plating in ACDF.

Methods: A retrospective review was performed on 395 patients who had ACDF with dynamic plating with at least 6 months follow-up. Sixty-four patients were excluded for acute trauma, previous cervical spine procedures, or supplementation with posterior instrumentation. Anterior-posterior, lateral, and flexion-extension radiographs were reviewed to determine settling and to evaluate for fusion. Measurements of motion between spinous processes were performed under high magnification on a PACS workstation. Magnification-corrected motion less than 1.0 mm was deemed a fusion.

Results: Single-level ACDF was reviewed in 135 patients with fusion rates of 34.6%, 59.3%, 84.8%, and 98.9% at 3, 6, 12, and 24 months follow-up. Two-level ACDF was evaluated over 312 instrumented interspaces in 156 patients with fusion rates of 27.9%, 52.4%, 78.7%, and 93.1% at 3, 6, 12, and 24 months follow-up. Three-level ACDF was evaluated for 135 instrumented levels in 45 patients with fusion rates of 46.8%, 60.2%, 77.5%, and 80.2% at 3, 6, 12, and 24 months follow-up. Five patients had 4-level ACDF with 95% of interspaces fused at 1-year follow-up. Eighty percent of the settling occurred within one month.

Conclusions: Dynamic cervical plating can provide for stability and load-sharing needed to provide for optimum fusion rates in ACDF.

118. Extraforaminal Lumbar Interbody Fusion: A New Technique for Outpatient Lumbar Fusion Surgery

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Introduction: Current minimally-invasive lumbar fusion techniques use expandable retraction through a traditional unilateral PLIF/TLIF approach. This limits access to the contralateral disc space, requires exposure of the thecal sac and two nerve roots, and necessitates a larger diameter device. This prospective study examines application of a fixed 18mm tube to performing an extraforaminal lumbar interbody fusion (ELIF) with pedicle fixation on an outpatient or 23 hour stay.

Methods: 29 patients underwent ELIF and pedicle fixation. Most had spondylolisthesis, mechanical back pain, and unilateral radiulopathy. Pedicle fixation was performed through a single 18mm tube. Patients were discharged on the same day or after overnight stay and underwent follow-up evaluation at one, three, six, and twelve months. Outcomes were measured with preoperative and post-operative SF-36 questionnaires. Additional parameters studied included operative duration, EBL, postoperative pain management, return to work, and radiographic fusion.

Results: More than one third were discharged same day. None required readmission, and none had post-operative CSF leak. Median operative duration was 4 hours; median EBL was 250cc. 13 had sufficient blood for cell saver return with a median volume of 100cc. One patient developed transient foot weakness, and one third developed transient neuropathic pain. Subsequent limited direct root exposure significantly reduced this problem. One had a pseudoarthrosis requiring revision. 22 had significant improvement in multiple SF-36 scales at last follow-up.

Conclusions: ELIF is an effective alternative to performing lumbar interbody fusion using familiar extraforaminal anatomy and minimizing exposure of neural elements. This technique allows performance of instrumented lumbar fusion on an outpatient basis.

119. Minimally Invasive Transforaminal Lumbar Interbody Fusion and Pedicle Screw Fixation: An Excellent Technique For Treatment of Chronic Lower Back Pain Secondary to Spondylolisthesis or Degenerative Disc Disease With or Without Associated Stenosis

Mick Perez-Cruet, MD, MSc, Southfield, MI; Hormoz Sheikh, MD, Southfield, MI

Introduction: Minimally invasive lumbar fusion and instrumentation techniques preserve the normal anatomical integrity of the spine and may improve patient outcomes. However, outcomes using this technique have not been thoroughly evaluated.

Methods: A retrospective review of 51 consecutive patients (28 with spondylolisthesis, 1with retrolisthesis, 1 with spondylolysis and 21 with degenerative disc disease) was conducted. Patients completed visual analoge scale (VAS), Oswestry Disability Index (ODI), and short form-36 (SF-36) pre-operatively and at 2 weeks, 3 months, 6 months and 24 months post-operatively. Post-operative CT was preformed to confirm graft and instrumentation placement.

Results: The average length of pre-operative back pain symptoms was 8.3 years. Twenty-two patients had moderate to severe lumbar stenosis. The average total operative time was 256 +/- 47 min and estimated blood loss was 224 cc +/- 63 cc. The average length of hospitalization was 4.2 days. VAS-score was reduced from 7.7 pre-operatively to 2.89, ODI was reduced from 44.4 pre-operatively to 22.4 and SF-36 scores improved greatly at average 17 month follow-up. Prolo scores were 76.4% excellent, 21.5% good, 1.96% fair. Fusion rate was 98% at one year follow up. No patient returned with transitional syndromes during the course of the study. Complications included one patient with a permanent nerve root injury and one graft failure requiring return to OR.

Conclusions: Minimally invasive transforaminal interbody fusion is an effective and safe method in experienced hands for treating patients with chronic debilitating back pain.

120. Cervical Arthroplasty Versus Fusion at Two Levels: What are the Biomechanical Differences?

Kevin T. Foley, MD, Memphis, TN; Denis J. DiAngelo, PhD, Memphis, TN

Introduction: The purpose of this study was to compare the biomechanical effects of adjacent two-level placement of a cervical disc prosthesis with simulated fusion at the same levels.

Methods: Six fresh human cadaveric spines (C2-T1) were tested in flexion, extension, lateral bending, and axial rotation under displacement control. Three different conditions were evaluated: the harvested spine, the spine with C5-6 and C6-7 disc replacement using the Prestige LP prosthesis, and two-level (C5-7) fusion. Fusion was simulated using a custom-designed screw and clamp apparatus. The spines were tested to a target moment of 3Nm. Measurements included individual vertebral motion, total spine rotation, and applied loads.

Results: The use of the two-level cervical disc prosthesis maintained the biomechanical integrity of the spine relative to the intact harvested state. Motion patterns for the prosthesis at both operated and adjacent segments did not undergo any significant changes relative to the harvested condition. In contrast, the fusion procedure resulted in a significant reduction in motion at the operated levels and increased motion at the adjacent segments compared to both the harvested and arthroplasty spine conditions.

Conclusions: Two-level cervical arthroplasty with the Prestige LP disc produced spinal motion patterns that were comparable to the harvested spine at both the operated and adjacent levels. Simulated fusion, on the other hand, markedly reduced motion at the operated levels and produced a compensatory increase in motion at adjacent segments. From a biomechanical point of view, 2-level cervical arthroplasty yielded a spine that was much closer to the baseline (unoperated) state than did fusion.

121. Cervical Disc Arthroplasty with the Prestige ST Device: One and Two Year Results from a Multi-Center Randomized Controlled Trial

Praveen V. Mummaneni, MD, Atlanta, GA; Regis W. Haid, MD, Atlanta, GA; Joseph B. Stachniak, MD, Richardson, TX; Wade M. Ceola, MD, Springfield, MO; Paul D. Sawin, MD, Winter Park, FL

Introduction: We present preliminary results from four centers participating in the ongoing Prestige ST prospective, randomized IDE study comparing arthroplasty to fusion for treatment of single-level cervical disease.

Methods: 120 patients with symptomatic cervical disc disease were randomized to receive either the Prestige ST device (n=66) or ACDF with plate fixation (n=54). Entrance criteria included single-level (C3-7) disc disease with concordant radiculopathy. Demographics of the treatment groups were similar. The C5-C6 and C6-C7 levels were the most frequently operated. Patients were evaluated with neck and arm visual analog scales (VAS), neck disability index (NDI), and SF-36 preoperatively, and at each postoperative interval. Dynamic X-rays were obtained at all intervals and segmental motion at the operated levels quantified.

Results: Preoperative and operative variables were similar between treatment groups. Postoperatively, all outcome scores improved for both groups. However, outcomes scores for patients receiving the Prestige ST device trend better than those for the fusion group at virtually every data collection point. In most instances the differences are statistically significant. Radiographic analysis shows the Prestige device to maintain/restore segmental motion. No revision surgeries have occurred in the Prestige group and two revisions have occurred in the ACDF group.

Conclusions: Preliminary analysis of data from the Prestige ST IDE study suggests that cervical disc arthroplasty affords at least equivalent outcomes for patients with single-level cervical disc disease.

ORAL POINT ABSTRACT PRESENTATIONS

These scheduled presentations will be held in concurrent sessions on Thursday, March 16th. Each presentation by the primary author will be four minutes in length followed periodically by discussion periods of seven minutes.

200. Safety of Outpatient Anterior and Posterior Cervical Spine Surgery in a Community Hospital

Gregory J. Przybylski, MD, Edison, NJ; William Mitchell, MD, Edison, NJ

Introduction: Cervical surgery is traditionally inpatient. Safety of outpatient cervical surgery is unknown. This prospective study compares inpatient and outpatient results.

Methods: All 101 patients having cervical surgery over a 33 month period in a community hospital were prospectively studied. Procedures, admission method, operative duration, EBL, and complications were compared.

Results: 29/40 having *anterior* surgery (25 1-2 level ACDF, 3 1-level corpectomy) were discharged within 4 hrs. None required readmission; one had transient hoarseness. 11/40 stayed overnight (four were inpatients with fracture/dislocation). Among SDS patients, 1 had transoral surgery, 1 corpectomy for neoplasm, and 5 had ACDF (3 1-level and 2 3-level). 2/2 patients with *anterior-posterior* surgery were inpatients with staged deformity-correction or fracture with ankylosing spondylitis. 36/58 patients having *posterior* surgery (24 1-3 level foraminotomies, 8 mulitilevel laminectomy with instrumented fusion, 4 laminectomy for stimulator electrodes, 1 for C2 schwannoma) were discharged within 4 hrs. None required readmission; none had complications. 22/58 patients stayed overnight (fourteen inpatients had spine/cord injuries or tumor). Among SDS patients, 5 had instrumented PCF, 1 had intradural surgery, 1 had C1C2 fusion, and 2 had laminectomy. 2 postoperative hematomas (3-7 days postoperatively) occurred in inpatients; one from anticoagulation and the other from traumatic epidural rostral to bilateral facet dislocation.

Conclusions: Selected outpatient cervical surgery can be performed safely. Outpatient 1-2 level ACDF and posterior foraminotomy can be routinely performed. Outpatient 1 level corpectomy and multilevel laminectomy with instrumented fusion may be performed as an outpatient, but the smaller number treated requires additional study before recommending routine outpatient surgery.

201. Comparison of Radiographic Outcomes of Anterior Lumbar Interbody Fusion (ALIF) Versus Transforaminal Lumbar Interbody Fusion (TLIF)

Patrick C. Hsieh, MD, Chicago, IL; Sean Salehi, MD, Chicago, IL; Stephen Ondra, MD, Chicago, IL; Tyler R. Koski, MD, Chicago, IL; John C. Liu, MD, Chicago, IL

Introduction: Interbody fusion is an effective treatment for debilitating back pain. Anterior lumbar interbody fusion (ALIF) and transforaminal lumbar interbody fusion (TLIF) are two procedures that are commonly used to achieve lumbar interbody arthrodesis. To date, there is no prospective randomized study demonstrating that one procedure is superior to the other. Particularly, there are no data comparing ALIF versus TLIF regarding their abilities to alter foraminal height, local/regional lordosis, or sagittal balance.

Methods: The medical records and radiographs of 32 ALIF patients and 25 TLIF patients from 2000 to 2004 were retrospectively reviewed. Clinical data and radiographic measurements including pre-operative and post-operative foraminal height, local disc angle, and lumbar lordosis were obtained. Descriptive statistics were determined, and a direct comparison of values obtained from the two studied groups was performed.

Results: Our results indicate that ALIF is superior to TLIF in its ability to restore foraminal height, local disc angle, and lumbar lordosis. On average, ALIF increase foraminal height by 18.1 percent, whereas TLIF decreased it by 0.4 percent. In addition, ALIF increased local disc angle by 8.3 degree and lumbar lordosis by 6.2 degree, but TLIF decrease local disc angle by 0.1 degree and lumbar lordosis by 0.4 degree. A restoration of local disc angle by 8 degree at L5-S1 translates to approximately 5.6 cm improvement in sagittal balance.

Conclusions: Anterior lumbar interbody fusion is superior to transforaminal lumbar interbody fusion in its ability to restore foraminal height, local disc angle, and lumbar lordosis.

202. Lumbar Total Disc Replacement: A 2 to 3 Year Report from the United States Clinical Trial for the Prodisc-L Prosthesis

Hyun W. Bae, MD, Santa Monica, CA; Ben B. Pradhan, MD, MSc, Santa Monica, CA; Michael A. Kropf, MD, Santa Monica, CA; Linda E.A. Kanim, MA, Santa Monica, CA; Rick B. Delamarter, MD, Santa Monica, CA

Introduction: The advantage of TDR over fusion is that motion-prservation may prevent accelerated degeneration at adjacent levels. Recently, the FDA has approved the use of the Charité artificial disc for single-level degenerative disc disease. Often however, disc degeneration is not limited to one level. This is a report on the longest follow-up of a prospective randomized controlled study of TDR (ProDisc-L) versus circumferential fusion for one and two-level DDD.

Methods: This is an analysis of motion and outcome at 2 to 3 years for the first 194 patients enrolled in the study at our institute, including both 'randomized' and 'continued access' arms. In the randomized arm (81 patients), 58 received disc replacements and 23 had fusion procedures. Patients rated themselves with VAS and ODI scores. Pain, disability, motion, and patient satisfaction were evaluated as functions of treatment.

Results: TDR significantly reduced pain and disability at earlier evaluations (6 months). At final follow-up, the improvement on both VAS and ODI were similar for TDR (7.4 to 3.5 and 31 to 16) and fusion patients (7.0 to 3.5, and 30 to 18) (p LT 0.05). Greater motion was seen at L4-L5 for TDR patients (p LT 0.05). A similar trend was noted at L5-S1 (p GT 0.05). There were no device-related complications. Patient satisfaction was over 90%.

Conclusions: Results demonstrate that lumbar TDR is a safe and effective alternative to fusion for intractable multi-level discogenic pain. The ProDisc-L allows safe and effective TDR at more than one-level. Intermediate-term follow-up results, up to three years, are presented.

203. Biomechanical Comparison of the Charité and Prodisc-L Lumbar Disc Prostheses

Kevin T. Foley, MD, Memphis, TN; Denis J. DiAngelo, PhD, Memphis, TN; Brian Morrow, BS, Memphis, TN; John German, MD, Albany, NY; Rudolph Bertagnoli, MD, Straubing, Germany; Jung Song, PhD, Memphis, TN; Thomas Mroz, MD, Cleveland, OH

Introduction: Different paradigms exist in the design of total disc arthroplasty devices. The purpose of this study was to compare the *in vitro* biomechanics of a more constrained ball-and-socket design (Prodisc-L) and a less constrained mobile-bearing design (Charité). The performance of the disc prostheses was compared to harvested and fused spine conditions.

Methods: Twelve human cadaveric lumbar spines (L1-sacrum) were tested in flexion, extension, lateral bending, and axial rotation under displacement control. Four conditions were evaluated: harvested spine (n=12), L5-S1 lumbar disc replacement using Prodisc-L (n=6) or Charité (n=6), and L5-S1 pedicle screw fixation (n=12). The spines were loaded to a target moment of 8Nm. For axial rotation tests, a 100N compressive load was applied. Measurements included vertebral motions, total spine rotation, and applied loads.

Results: There were no significant differences in normalized motion responses at the implanted level for the Prodisc-L spines compared to the harvested spines, except for left axial rotation and extension. Significant differences between the Charité and harvested spines occurred in left and right lateral bending. Significant differences existed between the fused condition and the harvested, Prodisc-L, and Charité conditions for all loading modes.

Conclusions: Compared to the intact spine, both disc prostheses (Prodisc-L and Charité) maintained lumbar mobility and stability. The Prodisc-L design limited motion in extension and axial rotation, whereas the less constrained Charité design provided increased mobility in lateral bending. Although the optimal kinematics for lumbar disc prostheses remains unknown, there are demonstrable biomechanical differences between these devices.

204. A Retrospective Comparative Study of Intraoperative EMG-based Neuromonitoring of Percutaneous Pedicle Screw Placement and Post-operative Computed Tomgraphic Scan Confirmation

Hormoz Sheikh, MD, Southfield, MI; Mick Perez-Cruet, MD, MSc, Southfield, MI

Introduction: Minimally invasive percutaneous pedicle screw instrumentation attempts to reduce approach related morbidity. Intraoperative electrophysiologic stimulation of screws can potentially improve the safety of this procedure. A critical analysis of intra-operative pedicle stimulation correlating with post-operative CT has not been conducted.

Methods: A retrospective chart analysis was conducted of twenty patients receiving percutaneous lumbar pedicle screws. 78 screws were tested intraoperatively using electrical stimulation. The CT-scans were evaluated for screw placement using a 5 tier grading system as follows: grade 1-screw within cortical bone of the pedicle, grade 2-screw violates medial wall of pedicle but did not require return to OR, grade 3-screw violated medial cortical bone and required return to OR, grade 4-screw violated lateral cortical bone but did not require return to OR and finally grade 5 screw violated lateral cortical bone requiring return to OR. Electromyographic thresholds and computed tomographic scans were evaluated separately and compared to assesses the accuracy of electromyographic screw stimulation technique.

Results: Post-operative CT grading of pedicle screws confirmed 69 as grade 1, 8 as grade 4, and 1 as grade 3. None were grades 2 or 5 which would require return to the OR. Average screw stimulation threshold of grade 1 was 26.4 mAmps, grade 3 was 20 mAmps, and grade 4 was 20.3 mAmps. One patient had initial stimulation threshold below 8 mAmps requiring screw repositioning intraoperatively with post-op CT showing grade 1.

Conclusions: Intraopertive percutaneous screw stimulation seems to be an excellent technique to confirm adequacy of screw placement.

205. MRI Morphologic Predictors of SPECT Positive Facet Arthropathy in Patients with Axial Back Pain

Keun-Young A. Kim, MD, Los Angeles, CA; Michael Y. Wang, MD, Los Angeles, CA

Introduction: While it is increasingly clear that facet arthropathy is a significant contributor to axial back pain, a major barrier to understanding this disease has been the lack of studies elucidating the relationship between structural degenerative facet changes and evidence of active joint inflammation. This study investigates structural (MRI) characteristics that predict pathology on functional (SPECT) imaging.

Methods: 431 patients without spondylolisthesis underwent SPECT imaging for chronic back pain. 31 patients had at least one "hot lesion." Exclusion of areas affected by surgery yielded 32 positive joints out of a total of 230 facets. Qualitative features were evaluated, including synovial and cartilaginous discontinuities, heterogeneous bone patterns, synovial hooking, and cupping osteophyte formation in the lateral joint. Quantitative features were evaluated, including asymmetry in size, joint space narrowing, lateral & medial synovial content, and variations in synovial signal intensity.

Results: The MRI characteristic with the greatest sensitivity was synovial space obliteration or narrowing (0.93 sensitivity and 0.35 specificity). Several facet morphologies were highly specific but not sensitive: lateral cupping from osteophytic overgrowth (0.90), and synovial mottling (0.90). Facet asymmetry and enlargement correlated poorly (sensitivity & specificity = 0.50), suggesting that joint hypertrophy may be protective and represent a more advanced stage in natural history of joint degeneration.

Conclusions: Abnormal synovial patterns were the best predictors of "hot" facets. This study suggests that specific abnormalities in the bony, cartilaginous, and synovial architecture may give future insight into the pathophysiology of facetogenic pain syndromes and the natural history of facet degeneration from synovial degeneration to facet enlargement.

206. Multimodality Intraoperative Neurophysiological Monitoring for Adult Tethered Cord Syndrome Microneurosurgery

Guillermo Paradiso, Toronto, ON, Canada; Gabriel Lee, MBBS, FRACS, Toronto, ON, Canada; Roger Sarjeant, BS, Toronto, ON, Canada; Ly Hoang, BS, Toronto, ON, Canada; Eric M. Massicotte, MD, FRCS(C), Toronto, ON, Canada; Michael Fehlings, MD, PhD, FRCS, Toronto, ON, Canada

Introduction: The role of multimodality intraoperative neurophysiological monitoring (M-IOM) in adult tethered cord syndrome (ATCS) has not previously been assessed in detail. The aim of this study is to evaluate the M-IOM in assisting microneurosurgery for ATCS.

Methods: M-IOM included posterior tibial nerve somatosensory evoked potentials (PT-SSEPs), continuous electromyographic (C-EMG) monitoring of the L2 to S4 myotomes, and evoked electromyography (E-EMG). Statistical analysis included sensitivity, specificity and predictive values.

Results: Between 1994-2004, surgery for ATCS was performed in 62 cases. Of these, detailed neurophysiological records were available in 44 patients (19 males, 25 females, age: 43 ± 15 years, range: 19-72 years), which form the basis of this study. Postoperatively, two patients developed new neurological deficits. One of them showed severe right side PT-SSEP amplitude reduction during surgical manipulation, which persisted to the end of surgery. One patient with transient PT-SSEP amplitude reduction had no new postoperative neurological deficits. For SSEPs, sensitivity was 50% and specificity 97%. EMG bursts were recorded in 36 patients (82%). Spontaneous bursts of EMG activity before surgical manipulation occurred in 8 patients (18%). Patients with postoperative worsening showed EMG activity in the myotomes where their new deficits presented. C-EMG had a sensitivity of 100% and a specificity of 19%. Evoked EMG consistently identified functioning neural elements.

Conclusions: The combination of the highly specific SSEPs, the highly sensitive C-EMG and the E-EMG, provides a potentially useful adjunct to complex microsurgery for ATCS. In our series, microsurgical decision making was particularly influenced by the combined use of C-EMG and E-EMG recording.

207. Unilateral versus Bilateral Cage and Pedicle Screw Placement for Single Level Fusion. A Prospective Comparison

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Introduction: A controversial question in Posterior Lumbar Interbody Fusion (PLIF) is if single side pedicle screw and rod construct is sufficient for selected single level PLIF's which require a posterior construct or tension band.

Methods: PLIF using bilateral cages and bilateral pedicle screws (Group I, N,86) was compared with PLIF using a single midline cage and single side pedicle screws (Group II, N,66). Both Groups included equal proportions of degenerative disk disease (80 vs. 75 percent) and Grade I Spondylolisthesis. At a minimum of 6 months, patients were evaluated for fusion and by a pain VAS and the Oswestry Disability Index (ODI) (compliance, 34 percent).

Results: Comparing Groups I and II, the average length of stay was 4.1 (S.D., 1.4) vs. 3.6 (1.3) days (p,0.014), blood loss was 215 (192) vs. 127 (106) mL (p,0.0003),and operative time was 114 (36) vs. 98 (35) mins. (p,0.007). There were 4 complications in Group I and none in Group II. Outcomes: There were no clinically failed fusions at six months. Improvements were as follows (Group I vs. II): Back pain decreased 55 vs. 46 percent (p,0.88), ODI decreased 36 vs. 28 percent (p,0.90).

Conclusions: There were no detectably significant differences between Groups I and II in fusion rate, back pain relief or ODI improvements. OR Time, blood loss and hospital stay time were extremely favorable for Group II. We conclude that single side pedicle screw and rod construct is sufficient for many single level PLIF's which require a posterior construct.

208. Development of an Animal Model of Post-Traumatic Syringomyelia Associated with Adhesive Arachnoiditis: Implications for an Enhanced Understanding of the Pathobiology and for the Development of Novel Therapeutic Approaches

Toshitaka Seki, MD, PhD, Toronto, ON, Canada; Michael G. Fehlings, MD, PhD, FRCS, Toronto, ON, Canada

Introduction: We have sought to develop a animal model of post-traumatic syringomyelia (PTS) to facilitate the understanding of this disorder so that improved therapeutic approaches can be developed.

Methods: Injured Wistar rats received 35g clip injury was applied to the spinal cord to simulate a moderate spinal cord injury (SCI) at T6 level.(1)Rat PTS model (n=48); The animals were divided into 4 groups. G1 was animals received SCI only, G2 was received SCI and injected kaolin into the subarachnoid space (SAS), G3 was injected kaolin into the SAS only, and G4 was sham group. The survival time was 1, 2, and 6 weeks. (2)Neuroprotective drugs (n=4-5/treatment); Experimental rats were randomly divided into 1 of 5 treatment groups. Beginning 1h after injury, the animals were given either an intraperitoneal injection of saline, vehicle, MPSS, minocycline, or riluzole for 6 days after SCI. All treatment rats were examined by using the BBB for 4 weeks. Quantitative histological and immunohistochemical assessments were undertaken using fluorescence microscopy and image analysis.

Results: (1) Both groups G3 and G4 did not develop syringomyelia. PTS was observed in both groups G1 and G2 at 6 weeks. Especially, G2 was observed larger syrinx compared with G1.(2) Gradual improvement in hind limb function was observed for each group in BBB, although the statistical analysis revealed no significant difference. However the lesion was significantly decreased in the neuroprotective drug groups compared with control groups.

Conclusions: Both compressive injury and adhesive arachnoiditis are required to develop extensive PTS. By understanding the molecular pathogenesis of PTS, improved treatment approaches may be developed.

209. Minimally Invasive Lateral Mass Screw Fixation in the Cervical Spine: Initial Clinical Experience with Long-Term Follow-up

Michael Y. Wang, MD, Los Angeles, CA; Allan D.O. Levi, MD, PhD, Miami, FL; Bryan C. Oh, MD, Los Angeles, CA

Introduction: Lateral mass fixation of the cervical spine has been a major advancement for spinal surgeons. This technique provides three-dimensional fixation from C3 to C7. However, exposure of the dorsal spinal musculature can produce postoperative neck pain. A minimal access approach using tubular dilators can potentially overcome the drawbacks associated with the extensive muscle stripping needed for traditional exposures.

Methods: A retrospective analysis was performed on the first eighteen patients treated with minimally invasive lateral mass screws. All patients, except two who were lost to follow-up, had a minimum of two years' clinical follow-up. All patients had a CT scan in the immediate post-operative period to check the positioning of hardware. Operative time, blood loss, and complications were ascertained. Fusion was assessed radiographically with dynamic radiographs and CT scans.

Results: Sixteen of the eighteen patients underwent successful screw placement. Two patients had the minimal access procedure converted to an open surgery because radiographic visualization was not adequate in the lower cervical spine. Six cases involved unilateral instrumentation and ten had bilateral screws. A total of 39 levels were instrumented. There were no intraoperative complications, and follow-up CT scans demonstrated no bony violations except in cases where bicortical purchase was achieved. All patients achieved bony fusion.

Conclusions: A minimally invasive approach can be a safe and effective means for placing lateral mass screws in the subaxial cervical spine. Up to two levels can be treated in this manner, preserving the muscles and ligaments that maintain the posterior tension band of the cervical spine.

210. Posteromedian Extracavitary Approach to the Thoracolumbar Spine: A Single Incision Approach for Circumferential Decompression, Reconstruction, and Arthrodesis

Nicholas B. Levine, MD, Cincinnati, OH; Charles Kuntz, MD, Cincinnati, OH; Robert J. Bohinski, MD, PhD, Cincinnati, OH

Introduction: Thoracolumbar spine approaches can be divided into three general categories: posterior, posterolateral, and anterolateral. These approaches prohibit 360-degree access to the vertebral column and spinal cord. In this retrospective clinical study, we describe an amalgamated approach, *posteromedian extracavitary,* which allows for circumferential exposure of the spine through a posterior midline incision.

Methods: 18 patients underwent a posteromedian extracavitary approach for complex circumferential lesions secondary to infection, trauma, and tumors of the thoracolumbar spine. An extended posterior midline incision was made. After removal of the posterior elements and associated proximal ribs heads, an extracavitary dissection was performed to expose the lateral portions of each vertebral body. The circumferential view of the vertebra and thecal sac permitted total corpectomy. Three-column reconstruction was achieved with pedicle screw fixation and an expandable vertebral body replacement cage.

Results: Postoperatively, all patients had improvement in visual analog scale (VAS) pain scores and stable or improved Frankel classification scores. Two patients continued to decline due to pre-existing radiation myelitis. One patient died within 30 days of surgery secondary to unrelated malignant pleural effusion complications. Anatomic alignment was restored and remains stable in all patients and no one has required a chest tube.

Conclusions: The posteromedian extracavitary approach provides a uniform approach to the thoracolumbar spine (T2-L2) for complex destructive lesions requiring simultaneous decompression and manipulation of all three vertebral columns. Circumferential exposure, decompression, reconstruction, and arthrodesis via a posterior approach provide an alternative to staged anterior and posterior approaches.

211. CGRP and GAP43 Increase and Colocalize in Allodynic Rats Following SCI and Stem Cell Transplantation

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Introduction: Although transplantation of neural stem cells (NSC) in the injured spinal cord may improve functional outcome, we have consistently observed forelimb allodynia, the mechanism of which remains poorly understood. In the present study, alterations of primary afferent pathways rostral to injury and tranplantation are investigated with GAP-43, which identifies sprouting neurites, and CGRP, a well-characterized nocioceptive neuron marker.

Methods: Reproducible, moderate spinal cord injuries (10g from 25 mm) were produced in 25 Sprague-Dawley rats using the NYU Impactor model. At post-injury day 8, animals were randomly selected to receive either C17.2 NSC, (9); GDNF transfected C17.2 NSC, (13); or normal saline (NS), (3). BBB scoring assessed locomotor function/recovery and hot-plate testing measured sensory responses. Animals survived 42 days post injury. C6-T1 spinal cords were processed for CGRP/GAP43 immunohistochemistry. Density of immunoreactivity (IR) was measured and characterized.

Results: Locomotor function was not significantly improved in NSC treated animals at any time period, p greater than 0.05. Significant forelimb thermal allodynia was observed following transplantation with both NSC populations, p less than 0.05. GDNF transfection failed to show a significant motor or sensory effect when compared to native C17.2 NSC. Marked bilateral axonal sprouting was demonstrated by increased GAP-43-IR in NSC but not NS treated cords. Similarly, CGRP increased and colocalized with GAP-43-IR further suggesting sprouting of nocioceptive primary afferent fibers.

Conclusions: Nocioceptive afferent sprouting may represent aberrant changes in pain pathways that suggest a mechanism for allodynic pain following NSC treatment of the injured spinal cord.

212. Neodisc – Design, Testing and Early Clinical Results of a Textile/Elastomeric Cervical Disc Replacement

Alan McLeod, PhD, Taunton, United Kingdom; Chris Reah, PhD, Taunton, United Kingdom; Andre Jackowski, MD, Birmingham, United Kingdom

Introduction: The Neodisc is a motion-preserving implant comprised of an elastomeric core encapsulated by a polyester textile jacket. The device is designed to replace the nucleus, annulus, and the ALL, while leaving the vertebral endplates intact. The encapsulating fabric is intended to encourage tissue ingrowth, as has been demonstrated in an ovine model. Pre-clinical testing of the device has included biomechanical, biocompatibility and fatigue testing. The implant is CT- and MRI-compatible and easily revisable. Implantation is straightforward: simple discectomy without endplate preparation, device insertion, and fixation to the anterior column with screws.

Methods: Nine single-level (C3-C7) Neodiscs have been implanted since July 2004 in a prospective non-randomized multi-center European clinical trial. All patients presented with single-level DDD with neural symptoms and ranged in age from 31-54. Follow-up is to 6-months in all 9 patients and 12-months in 4. VAS pain scores, SF-36, NDI and European myelopathy scores were collected at 1-month, 3-month, 6-month, and 12-month follow-up. Radiographic measurements include disc height, segmental motion, and sagittal alignment.

Results: Surgical time ranged from 55-104 minutes. Blood loss averaged less than 15cc. All patients have good clinical results: VAS scores improved pre-op to 6-months from 6.6 to 2.0 (arm) and 4.1 to 0.4 (neck), SF-36 scores increased from 41 to 80. Average flexion/extension ROM is 6.7°. There have been no device displacements. Thin-section CT scans have demonstrated no evidence of heterotopic bone formation.

Conclusions: The Neodisc is a nucleus-like disc replacement, representing the first of a new type of motion-preserving device for the cervical spine.

213. Spinal Deformity Following Selective Dorsal Rhizotomy for Spasticity

Jeff D. Golan, MD, Montreal, PQ, Canada; Jeffery A. Hall, MD, FRCS(C), Montreal, PQ, Canada; Jean-Pierre Farmer, MD, FRCS(C), Montreal, PQ, Canada

Introduction: Selective dorsal rhizotomy (SDR) has been shown to provide considerable benefit to children with spastic cerebral palsy. The goal of this study was to examine the incidence of spinal deformities in these patients and to determine risk factors more likely to be associated with deformities.

Methods: All patients who underwent SDR at the McGill University Health Center between 1991 and 2001 were identified. Their hospital charts, preoperative and the latest postoperative spinal radiographs were systematically reviewed.

Results: The study group consisted of 98 patients with a mean age at surgery of 5.1 years (3.0 to 11.0 years) and a mean radiographic follow-up of 5.8 years (1.1-11.5). Thirty-nine (44.8 %) out of 87 patients with postoperative weight-bearing AP radiographs had scoliosis (Cobb angle at least 10 degrees), while 17 (32.1 %) patients with postoperative standing radiographs had hyperlordosis (at least 54 degrees). Ambulatory children requiring assistive devices had more significant coronal misalignment than independent ambulators (p 0.013). Patients that had surgery at 5 years of age or later had more significant hyperlordosis (p 0.007). There were no significant changes in thoracic or thoracolumbar kyphosis. Overall, 18 (19.1%) patients had postoperative L5-S1 anterolisthesis and 11 (11.7%) patients had L5 spondylolysis. Despite these radiological findings, none of these patients had clinically significant deficits requiring bracing or surgical correction.

Conclusions: Ambulatory children requiring assistive devices preoperatively and those who had their surgery at 5 years of age or later had a significantly higher incidence of spinal deformities at follow-up.

214. Comparison of Outcomes After Lumbar Artificial Disc Replacement Surgery in Worker's Compensation Versus Non-Compensation Patients

Hyun W. Bae, MD, Santa Monica, CA; Ben B. Pradhan, MD, MSc, Santa Monica, CA; Michael A. Kropf, MD, Santa Monica, CA; Linda E.A. Kanim, MA, Santa Monica, CA; Rick B. Delamarter, MD, Santa Monica, CA

Introduction: Results of lumbar spinal fusion for disabling back pain can be less than ideal in the workman's compensation (WC) population. Motion-preserving alternatives to fusion surgeries are being developed for improved effectiveness, reduced morbidity, and recovery time. However, how WC status affects outcomes in such newly-developed spinal techniques has not been well-studied.

Methods: Patients randomized to 1-2 level disc replacement (DR) or fusions were evaluated based on WC status. This was part of a randomized prospective controlled trial in a FDA-regulated study. Preoperatively and at 6 weeks, 3, 6, 12, and 24 months, patients completed standardized ODI and VAS questionnaires. Return to work was also evaluated.

Results: 56 WC patients had at least 2 years of follow-up. 47 underwent TDR and 9 underwent fusion. VAS and ODI scores improved significantly (p-values < 0.0001) for both WC and non-WC patients. No significant difference was found in outcome scores between WC and non-WC patients at any time interval. There was no significant difference in patient-satisfaction between the two groups at final follow-up (both at 90%). There was earlier return to work for patients after DR versus fusion in both WC and NWC groups.

Conclusions: WC and non-WC patients had equal clinical improvements at 2-years of follow-up after DR. Return to work rates may be higher and earlier after DR versus fusion. This implies that WC patients may derive as much benefit from this motion preserving technology as non-WC patients, and should be offered this promising surgical alternative.

215. Effects of Age on Perioperative and Intermediate-Term Clinical Outcomes and Fusion Rates After Multilevel 360-degree Lumbar Fusion

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Introduction: Combined (anterior plus posterior, or 360-degree) lumbar fusion across multiple (2 or more) levels is thought to be associated with increased perioperative morbidity and worse clinical outcomes when performed in elderly patients. We evaluated our experience with multilevel 360-degree lumbar fusion for degenerative disc disease (DDD) in elderly versus younger patients.

Methods: Retrospective review of the medical, surgical, and radiological records of 73 patients who underwent multilevel anterior lumbar interbody fusion (ALIF) with posterolateral lumbar fusion with instrumentation (360-degree fusion) for symptomatic lumbar DDD. We compared the perioperative events, clinical outcomes, and fusion rates for patients at least 65 years old versus patients younger than 65 who underwent these procedures.

Results: Average follow-up was 18 months. Thirty patients were at least 65 years old and 43 patients were younger. There were no significant differences in the number of levels fused, operative time, or perioperative complications rates in either group. Although the postoperative hospital stay was slightly longer in the elderly group (9 plus or minus 1.5 days) compared to the younger group (7 plus or minus 2 days), this was not statistically significant. Similarly, there were no statistically significant differences in the improvement in back pain or in the rates of fusion between the groups at last follow-up.

Conclusions: Perioperative events, intermediate-term clinical outcomes, and fusion rates after multilevel 360-degree lumbar fusion in the elderly are comparable to those of younger patients. Age should not be a factor in deciding to perform multilevel 360-degree lumbar fusion for patients with symptomatic lumbar DDD.

216. A Key Role for FAS Mediated Apoptosis in the Pathobiology of Cervical Spondylotic Myelopathy: Evidence from Human Tissue and a Mutant Mouse Model

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Introduction: Although human cervical spondylotic myelopathy (CSM) is a common etiology of chronic spinal cord dysfunction, little is known regarding the molecular mechanisms for the progressive neural degeneration and demyelination. We hypothesized that Fas-mediated apoptosis plays a key role in the loss of neurons and oligodendrocytes in CSM.

Methods: Molecular analyses of post-mortem human CSM were undertaken. This work was complemented by studies in twy/twy mice, which harbor an abnormality in the Npps gene. We used histological and MRI approaches to determine morphological changes in twy/twy mice. Apoptosis was assessed by TUNEL technique and expression of caspase-3 and caspase-9 by Western blotting analysis. The expression of Fas was assessed using immunohistochemistry and Western blotting analysis.

Results: TUNEL and caspase-3 positive neurons and oligodendrocytes, which co-expressed FAS, were observed in cervical spinal cord of CSM patients and of twy/twy mice. Ectopic ossification at C1-C2 was confirmed histologically and by MRI in twy/twy mice. These mice developed spasticity and quantitative neurobehavioral abnormalities on footprint analysis which correlated with progressive loss of neurons and oligodendrocytes, Wallarian degeneration, demyelination and astrogliosis. Using immunoprecipitation and Western blotting techniques we observed that the spinal cord tissue of twy/twy mice had

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activation of the Fas pathway with increased interactions between Fas, FasL and pro-caspase-8 and downstream activation of caspase 3.

Conclusions: Our data not only show an important Fas-mediated apoptotic mechanism in CSM, but also provide evidence that down-regulation of Fas mediated apoptotic pathway is a potentially attractive neuroprotective approach in CSM which could provide a complementary treatment to surgical decompression.

217. Artificial Cervical Pedicle Screw Reconstruction for Degenerative and Neoplastic Disease: Intermediate-term Clinical and Radiographic Results

Frank L. Acosta, Jr. MD, San Francisco, CA; Henry E. Aryan, MD, San Francisco, CA; Christopher P. Ames, MD, San Francisco, CA

Introduction: Three-column stabilization has not traditionally been possible across levels at which a pediculectomy has been performed in the cervical spine. We describe posterior column reconstruction of the cervical spine in which traditional lateral mass screws are used to reconstruct the pedicle and allow for 3-column stabilization in a posterior construct. We report our experience in 10 patients.

Methods: Retrospective chart review of 10 patients who underwent extensive posterior cervical decompression with pediculectomy of at least one level. 'Artificial pedicle screws' (APS) were placed directly into the cervical vertebral body at all levels where a pediculectomy was been performed. We evaluated the clinical and radiographic outcomes in these patients.

Results: We used this technique in a total of 10 patients with an average follow-up of 12 months. Six patients underwent surgery for tumors of the cervical spine and 4 for degenerative disease. There were no intraoperative complications. All patients demonstrated evidence of fusion without evidence of hardware loosening at last follow-up. No patients experienced new or worsening symptoms.

Conclusions: Single-stage cervical pedicle reconstruction after pediculectomy can be achieved using traditional cervical lateral mass screws to serve as artificial cervical pedicles, allowing simultaneous three-column stabilization after radical posterior column resection of the cervical spine for neoplastic disease. APS can be used in degenerative cervical disease for: 1. Fractured lateral mass at top or bottom of the construct, with the pedicle being too small to instrument; 2. Deformity correction by engaging the anterior column in cases in which the pedicles are too small to instrument.

218. Results of a Modified Paramedian Transpedicular Approach with Radical Bone Resection for Intradural, Extramedullary Tumors of the Ventral Cervicothoracic Spine

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Introduction: Changes in intraoperative recordings of spinal cord function during surgery for intradural, extramedullary spinal tumors (IEST) often occur after irreversible neurological damage has already occurred. We therefore developed an aggressive surgical technique with radical spinal deconstruction to eliminate any retraction of the spinal cord and minimize neurological damage. We reviewed the results of patients with ventral IEST of the cervicothoracic spine treated using this technique.

Methods: Twelve patients (5M:7F, average age 35 years) with multilevel IEST of the anterior cervical or cervicothoracic spine were included. Average follow-up was 20 months. All patients presented with pain and/or radiculomyelopathy. The surgical procedure consisted of a paramedian cervical transpedicular, thoracic parascapular approach with partial dorsal corpectomy, wide eccentric dural opening without spinal cord retraction, and posterior spinal reconstruction.

Results: The average period between onset of symptoms and surgery was 2.3 months (range 1-3 months). Tumors extended across an average of 3.3 levels from C1-T3. There were no intraoperative changes in neuromonitoring parameters during any procedure. All patients reported stable or improved neurological symptoms when present and demonstrated radiographic evidence of fusion at last follow-up.

Conclusions: The extreme posterolateral transpedicular approach with partial dorsal corpectomy is useful for treating multilevel ventral IEST from C1 to the upper thoracic spine without spinal cord manipulation. Modern spinal reconstruction techniques allow for radical bone resection to minimize neural element retraction - a principle traditionally used in skull base surgery. Our technique has resulted in less neurological morbidity than more traditional anterior or posterior approaches without evidence of late instability.

219. Evaluation of Correction of Sagittal Plane Cervical Spine Deformities with Anterior ACDF with Dynamic Plating

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Introduction: With advanced cervical spondylosis, loss of cervical lordosis is often significant. We describe an ACDF distraction and interbody grafting technique to restore cervical lordosis, and review initial post-operative correction and long-term maintenance of sagittal plane balance with this technique.

Methods: We identified 387 patients having ACDF with 6 months of follow-up. Preoperative, postoperative, and follow-up radiographs were reviewed for patients with less than 5.0 degrees of lordosis preoperatively. Lordosis was measured over the entire cervical spine and over the instrumented levels.

Results: Sixteen patients underwent 1-level ACDF. Overall cervical lordosis did not change significantly. Mean

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lordosis at instrumented levels improved from -7.4 preoperatively to +3.1 postoperatively and +0.6 at 6-month follow-up.

Nineteen patients had 2-level ACDF. Cervical lordosis improved with means of -9.1, -0.5, and +2.9 degrees preoperatively, postoperatively, and follow-up. The instrumented level had means of -8.9, +4.7 and +2.3 preoperatively, postoperatively, and follow-up. Nineteen patients had 3-level or greater ACDF. Mean cervical lordosis improved from -8.0 preoperatively to +14.0 postoperatively. After 6 months, mean lordosis was 1.8 degrees. Instrumented level lordosis improved 23 degrees with surgery (preoperative mean=-11.7, postoperative mean=+11.2). Almost half of lordosis correction at the instrumented levels was lost by 6 months (mean=1.6).

Conclusions: Our ACDF technique can improve lordosis of the cervical spine, especially with multi-level surgeries. Despite this correction in lordosis, almost 50% of the correction may be lost within 6 months of surgery. Even with the loss of correction, these patients, on average, maintained a lordotic posture as compared to their mean preoperative kyphotic sagittal alignment.

220. Minimally Invasive Lumbar Microdiscectomy Versus Open Microdiscectomy; Comparison of Surgical Time Length of Stay, Narcotic Usage and Complications in Consecutive Cohorts

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Introduction: Lumbar microdiscectomy using muscle retractors is well established. We wondered whether minimally invasive access methods could significantly reduce surgical pain and length of stay compared to open approaches.

Methods: A single surgeon performed consecutive single level lumbar microdiscectomies at a single institution using an open technique (35 patients) from July 2002 to October 2003 and with a minimally invasive access tube (Endius atavi system) from October 2003 to June 2005 (31 patients). Both groups recieved identical pain management orders and a patient controlled option for same day discharge.

Results: Both groups showed no significant differences in age or gender. Blood loss and surgical times were not statistically different. Significantly less dosages of narcotics medications were given in hospital to minimal access patients (p equals .03) and overall number of pain medications taken in hospital were also less in the minimal access group (p equals .01). Average hospitalization times were significantly less in the minimal access group (1052 minutes versus 1494 minutes, p equals .001) More (45 percent versus 6 per cent) minimal access patients were discharged within 12 hours (p equals .001). No wound or neurologic complications occurred in either group.

Conclusions: The use of minimally invasive techniques (Endius atavi System) to lumbar microdiscectomy resulted in less pain and shorter hospital stays compared to open procedures. No increase in morbidity was encountered with use of this technique.

221. MR Imaging Clarity of the Bryan®, Prodisc-C®, Prestige LP® and PCM® Cervical Arthroplasty Devices

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Introduction: The purpose of this study is to compare postoperative imaging characteristics of the four currently available cervical arthroplasty devices at the level of implantation and at adjacent levels.

Methods: Preoperative and postoperative MRI of 20 patients who had cervical arthroplasty were assessed for quality. Five cases each of the Bryan®, Prodisc-C®, Prestige LP® and PCM® devices were analyzed. Sagittal and axial T2-weighted images were scored using the Jarvik 4 point scale from 8 blinded surgeons and statistically analysed. Intraobserver and interobserver were assessed with ICC. A *P* value <0.05 was regarded as significant.

Results: Good intraobserver and intraobserver variability was noted at both time intervals. Preoperative images of patients in all implant groups had high quality images at operative and adjacent levels. The Bryan® and Prestige® devices allowed satisfactory visualization of the canal, exit foramina, cord and adjacent levels after arthroplasty, grade 1 to 2. Visualization was significantly impaired in all PCM® and Prodisc-C® cases at the operated level in both the spinal canal and neuroforamina, grade 3-4. At the adjacent levels images quality was statistically poorer in the PCM® and Prodisc-C® than those of Prestige® and Bryan®.

Conclusions: Postoperative visualization of neural structures and adjacent levels after cervical arthroplasty is variable among current available devices. Devices containing non-titanium metals (Co-Cr-Mb alloys in the PCM® and Prodisc-C®) make postoperative imaging almost unreadable whereas devices with titanium with or without polyethylene still allow for satisfactory monitoring of adjacent levels and the operated level (Bryan® disc or Prestige LP®).

222. Correction of Cervical Kyphotic Deformity via 360 Fusion: Long Term Follow Up with a Standardized Analysis

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Introduction: We examined standardized outcomes and fusion rates of patients undergoing 360 reconstruction for cervical kyphosis.

Methods: 21 patients underwent 360 fusion surgery from 2002 to 2005 for cervical kyphosis. Anterior procedures included discectomies and corpectomies (one or more levels) as the pathology dictated. Posterior operations included lateral mass fusion with decompression and osteotomy when indicated for neural compromise. Typically, autograft was utilized for arthrodesis though Bone Morphogenetic Protein was used in a limited number of cases. Preoperative and postoperative Nurick grades were assigned as well as Odom's outcome measures. Fusion was assessed via dynamic radiographs.

Results: Three patients were lost to follow-up. Of the 18 remaining, 3 died postoperatively. For the remainder follow-up ranged from 6 months to 4 years (Mean 18 months). Preoperative Nurick grades ranged from 0-5 (Mean 2.5). Postoperative grades ranged 0-5 (Mean 1.4). Mean improvement in the patients was one full Nurick grade. Odom's scores were: Excellent 12.5%, Good 50%, Fair 25%, Poor 12.5%. All patients with follow up were radiographically fused at 3 months postoperatively. Ishihara's criteria was used to measure the degree of correction.

Conclusions: The treatment of cervical kyphosis is challenging. Fusion rates and standardized outcomes are rarely cited in prior studies. We have demonstrated (with long term follow up) that aggressive correction with decompression and stabilization via a 360 approach can achieve high fusion rates as well as provide measurable improvements in Nurick grades. Most of our patients had good/excellent Odom's outcomes, but this extensive correction does carry potential morbidity.

223. Mortality, Neurological Outcome and Axonal Survival Following Spinal Cord Injury in a Geriatric Population

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Introduction: The incidence of spinal cord injury (SCI) is rising in the elderly. This study examines the potential age-related differences on outcome and axonal preservation following SCI.

Methods: A *cohort retrospective study* was carried out including all consecutive cases of acute traumatic cervical SCI admitted to a university-teaching hospital from 1998-2000. Younger individuals (age < 65 years) were compared to elderly. Additionally, an *immunohistochemical examination of postmortem spinal cord tissue* was performed in individuals with severe cervical SCI and controls. Using NF200 immunostaining, the number of axons within the corticospinal tracts (CST), dorsal column (DC), and descending vasomotor pathways (DVPs) were quantitated.

Results: In the *cohort*, there were 23 elderly (10F, 13M; age 65-89 years) and 28 younger individuals (4F, 24M; age 18-64 years). The latter showed a significantly higher frequency of SCI (p=0.031). Both groups were similar in regard to the severity of SCI (p=0.116) or survival in the acute care facility (p=0.515). There were no significant differences between the groups regarding neurological recovery assessed by ASIA grade (p=0.356). The *immunohistology* included 7 SCI individuals (2F, 5M; ages 31-82 years) and 5 controls (2F, 3M; ages 30-73 years) with comparable age/gender. In controls, the number of axons within CST, DVPs, and DC were not significantly correlated with age/gender. There were no significant differences between both groups for extent of degeneration or for number of preserved axons within the DC, DVPs and CST post-SCI.

Conclusions: Our results suggest that (1) mortality, (2) neurological outcome, and (2) axonal survival within selected spinal cord tracts was unaffected by age after cervical SCI.

224. Inosine Versus Oscillating Field Stimulation Plus Inosine in Treating Experimental Chronic Spinal Cord Injury

Scott A. Shapiro, MD, Indianapolis, IN; Scott Purvines, MD, Indianapolis, IN; Richard Borgens, PhD, Indianapolis, IN

Introduction: Oscillating field stimulation (OFS) improves recovery from acute spinal cord injury (SCI) in animals/humans but not chronic. Inosine is a neurotrophin that is synergistic with OFS in acute SCI. We tested in a chronic SCI model inosine plus OFS versus inosine.

Methods: Guinea pigs underwent a T10 hemisection with disappearance of their unilateral cutaneous trunchi muscle reflex (CTM). On day 91 post hemisection, 15 animals (Group 1) had a pump placed that delivered inosine (10mM) at 0.25 microliters/hour for 14 days. 15 animals (Group 2) had both an OFS and inosine pump placed. A control group of 15 animals were treated with a sham stimulator and pump. All animals underwent measurement of the (CTM) at 60 days and then had their cord exposed and injected with a 20 microliter fluroesently labeled dextran (fluouro emerald) rostral and (fluoro ruby) caudal to the hemisection for axon labelling to analyze for regenerating axons histologically.

Results: The controls recovered no CTM. Group 1 recovered 23.5% of their preinjury CTM area (p0.001) . Group 2 recovered 27.1% of their preinjury reflex area (p0.01). The difference between groups 1 & 2 was a p0.14. Axon labelling demonstrated more regeneration in the ascending fibers in group 2 as compared to group 1 (p0.03) and both groups regenerated more than controls (p0.0001). Descending regeneration was significantly better in Group 2 versus 1 (p0.02) and again both were better than controls (p0.0004).

Conclusions: Inosine plus OFS significantly improved recovery and regeneration in a chronic SCI model and is the most robust chronic injury treatment seen in our lab to date.

225. Clinical Outcome in Patients Undergoing Anterior Cervical Discectomy and Fusion using Anterior Plating System

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Introduction: The majority of published papers on Anterior Cervical Discectomy and Fusion (ACDF) clinical outcome did not use validated outcome measurement instruments or focused on physiological outcomes. The purpose of this study was to evaluate the clinical outcome for patients undergoing ACDF surgery with anterior cervical plating using Visual Analog Pain scale (VAS), SF-36 Questionnaire, Neck Disability Index, Patient Satisfaction and return to work criteria.

Methods: A total of 110 patients were enrolled into a prospective clinical study and underwent ACDF procedure with anterior cervical plate instrumentation. Diagnoses included: 34 (30.9 %) patients with cervical spinal stenosis, 26 patients (23.6%) had intervertebral disc pathology with myelopathy, 39 patients (35.5%) with herniated disc and 11 patients (10.0%) had cervical spondylosis.

Results: All patients were followed for a minimum of 12 months after the surgery. Neck pain (VAS) decreased by 54% and 57% at 6 and 12 months, respectively. Arm pain (VAS) decreased by 65% at 6 months and 47% at 12 months follow-up. A statistically significant improvement was noted on SF-36 scale, where physical component summary scores increased by 19% at 6 months and 25% at 12 months. Neck Disability Index decreased by 46% at 6 months and 57% at 12 months. Patient Satisfaction was at 78% and 68% at 6 and 12 months, respectively. The mean time to return to work was 32.2 days. The total complication rate was 5.0%.

Conclusions: ACDF with anterior plate instrumentation is an effective procedure with a statistically significant improvement in all measured parameters.

226. Spinal Cord Uptake and Targeted Motor Neuron Delivery using the Crushed Sciatic Nerve Model

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Introduction: With support provided by a Kline Research Award, we have demonstrated the spinal cord uptake and specific neuronal binding of a synthetic peptide that mimics tetanus toxin C fragment. Peripheral nerve injury results in demyelination and axonal degeneration. Nerve cell bodies are important in initiating and controlling axonal regeneration. Based on its efficient uptake, this synthetic peptide might be useful for therapeutic purposes of nerve regeneration.

Methods: The crushed sciatic nerve is a well-established model for the study of peripheral nerve injury. Using a fluorescein-conjugated peptide with the binding characteristics of tetanus toxin, we surveyed its uptake and retrograde transport after injection into the crushed sciatic nerve of rats. We next characterized the time-course of this remote delivery. Finally, to confirm the retrograde transport involvement, colchicine sciatic pretreatment was performed.

Results: Fluorescent microscopy revealed fluorescein-positive motor neurons in the ventral horn of the lumbar spinal cord. Fluorescence was detected as early as 6 hours after injection and increased with time. Intraneural colchicine pretreatment was able to partially block fluorescence detection in the spinal cord, revealing a retrograde axonal transport mechanism.

Conclusions: We have demonstrated neuronal specific labeling and retrograde axonal transport of the synthetic peptide following peripheral administration. Because axonal regeneration can be facilitated by treatment with neurotrophic agents, this peptide might be attractive to deliver therapeutic proteins. This strategy for targeted delivery to motor neurons might be equally applicable to develop gene therapy strategies for the treatment of spasticity, pain and motor neuron diseases.

227. Initial Experience in C1/2 Arthrodesis Using BMP-2 and Allograft Chips

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Introduction: C1-2 arthrodesis is traditionally performed using iliac crest autograft. Recombinant BMP-2 has been used successfully as an alternative to autograft in the lumbar spine, but has not been studied in C1-2 arthrodesis.

Methods: Patients undergoing C1-2 fusion were prospectively identified, excluding those undergoing fusion to the occiput or subaxial spine. C1-2 screws were placed using the Harms technique. The C2 nerve root was routinely coagulated and sectioned. A medium-size INFUSE Bone Graft kit (1.5 mg/ml rhBMP-2 applied to an absorbable collagen sponge for a total volume of 5.6ml) and cancellous allograft chips were packed lateral to the dural tube and between the lamina if no laminectomy was present. Fusion was assessed using flexion-extension x-rays or CT scans a minimum 6 months post-surgery.

Results: Seven patients (3M, 4F) a mean age 47 years (7-81), were followed a mean 16 months (6-24). Indications for surgery were synovial cyst C1/2, chronic type II dens fracture, traumatic atlantoaxial subluxation, and atlantoaxial subluxation from rheumatoid arthritis. All patients complained of neck pain, and six had motor and sensory deficits on neurologic examination. All patients achieved a solid fusion with improvement in the neurologic exam and neck pain. No ectopic bone formation occurred within the spinal canal. No patient complained of C2 dysthesias or pain.

Conclusions: This small series found that recombinant BMP-2 with allograft chips successfully achieved C1-2 arthrodesis without autograft. If these findings are borne out in larger studies, BMP-2 would appear preferable to iliac crest harvest, given the low but well-characterized incidence of graft complications.

E-POSTER ABSTRACT PRESENTATIONS

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300. Open Versus MAST Lumbar Interbody Fusion

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Introduction: Minimal access surgical techniques (MAST) continue to evolve in the surgical management of spinal disorders. It is felt that these approaches minimize tissue damage and allow for a swifter and smoother recovery. To date there has been no published comparison of open versus MAST approaches for lumbar interbody fusion.

Methods: A non-randomized comparison of two similar cohorts of patients undergoing lumbar interbody fusion was performed. The open group received their interbody graft via a posterior (PLIF) approach. The MAST group underwent a transforaminal approach (TLIF). Both groups had supplemental pedicle screw implants, percutaneous in the MAST group. Immediate surgical outcomes and 2-year functional outcomes were compared between groups (VAS and Oswestry).

Results: There were 31 patients in the PLIF group compared to 22 in the TLIF group. The mean ages were 42 (PLIF) versus 52 (TLIF); p=0.004. The PLIF group contained 55% males compared to 41% in the TLIF group. The L4-5 level was the most common level operated followed by L5-S1 in both groups. Grade I spondylolisthesis was equally common in both groups (38.7% versus 40.9%, PLIF versus TLIF, respectively). Blood loss was greater in the PLIF group (553 ± 407 cc versus 208 ± 109 cc; p=0.00007). After two years of follow-up both groups displayed a statistically equivalent improvement in functional scores (p>0.09).

Conclusions: MAST TLIF can be performed successfully on the same patient population as traditional open fusion procedures. Although the clinical outcomes at two years are the same, MAST TLIF had less blood loss.

301. Targeted Microinjection of Cells into the Ventral Horn Utilizing a Novel Delivery System in Pigs

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Introduction: Motor neuron diseases such as ALS and SMA, spinal cord injury, demyelinating diseases such as MS all represent devastating diseases of the spinal cord which at this time are treated supportively. Research is focusing on biologic therapies such as in vivo and ex vivo gene therapies, cellular transplants, and viral vectors for engineered protein delivery. Standard strategies for accurate and safe delivery of these therapies do not exist. We have developed a delivery system utilizing a novel platform and injector to functionally map and deliver a biologic payload to a targeted region of the spinal cord.

Methods: 2-level laminectomies were performed on ten pigs for exposure of the lumbar enlargement. We utilized a novel delivery platform to rigidly fix a microdrive and microinjection system over the spinal cord. Utilizing microrecording, evoked potentials and EMG we located the spinal gray matter and ventral horn. After mapping, varied concentrations and volumes of neuroblastoma cells were pumped into the ventral horn at a controlled rate. Post-operatively the pigs were examined, sacrificed, and their spinal cords harvested for histology.

Results: No neurologic deficit was detected post-operatively. Histologic exam of the spinal cords revealed accurate delivery of cells to the ventral horn of the spinal cord with no damage to surrounding neurons or fiber tracts.

Conclusions: Electrophysiological properties of the spinal cord can be used to confirm and guide targeting for the delivery of biological therapeutics. Rigid fixation of the cannula system and controlled pump delivery can be accomplished without detectable neurological deficits.

302. Operative Failure of Percutaneous Endoscopic Lumbar Discectomy: A Radiological Analysis of 55 Cases

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Introduction: Although several authors have reported the outcomes of percutaneous endoscopic lumbar discectomy (PELD), the current technical limitation of the procedure has not been fully documented. The aim of this study was to elucidate the range of lumbar disc herniation that can be addressed effectively from the analysis of failed PELD.

Methods: The inclusion was an intracanal herniation in which subsequent surgery was performed due to the presence of remnant fragments. All 1586 cases including 55 failed cases were classified as follows. The non-migrated herniations were classified as either low or high-grade based on a 50% canal cross sectional area compromise. The axial locations of these herniations were divided into central or paramedian. The migrated herniations were classified according to the extent of the migration. A high degree of migration larger than the measured height of the posterior marginal disc space placed the herniation in the high-grade migration group.

Results: In the non-migrated herniations, the central located high-canal compromised herniations showed the highest rate of failure (15%), significantly different from the low and high-canal compromise group (1.9% and 11.1%, respectively, $P<0.001$). There was no significant difference in the rate of failure between the non-migrated herniations and the low-grade migration group (2.7% and 3.7%, respectively). However, the high-grade migration group showed a significantly high-incidence of failure (15.7%, $P<0.001$).

Conclusions: Based on these results, open surgery is more advisable for herniations with high-canal compromise and high-grade migration. On the other hand, PELD can be considered as a surgical option in the remaining intracanal disc herniations.

303. Objective Clinical Outcome Following Microendoscopic Discectomy (MED) for Lumbar Herniated Intervertebral Disks Using SF-36, Visual Analog Scale, and Oswestry Disability Index

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Introduction: In recent years, the success rate for minimally invasive techniques such as microendoscopic discectomy (MED) for treatment of lumbar herniated intervertebral disks has approached that of standard microscopic discectomy. However, few studies have quantified recurrence rate or outcome objectively using Visual Analog Scale (VAS), Oswestry Disability Index (ODI), or Short Form-36 (SF-36) questionnaires. The purpose of this study is to determine whether objective outcome after MED is comparable to standard microdiscectomy.

Methods: Between September 2002 and February 2005, 114 patients with classic lumbar radiculopathy underwent MED for lumbar disk herniations. Data was collected prospectively. 87 patients were available for followup. A standard MED was performed, and most procedures were performed on an outpatient basis using general anesthesia. Outcomes were measured using VAS, ODI and SF-36 preoperatively, at 6 weeks, 4.5 months, 10.5 months, and 18 months postoperatively.

Results: No procedures were converted to open discectomy. Average operative time was 109 minutes, mean blood loss was 38 mL, approximate hospital stay was 10.2 hours. Average follow-up was 16.5 months, (range 6-35 months). Improvement was seen in VAS (LBP 3.9 pre-op, 2,1 at followup, RL 3.2 pre-op, 1.2 at followup, LL 3.4 pre-op, 2.2 at followup). ODI (40.5 pre-op vs. 19.1 at followup), and SF-36 scales (physical function subscale 37.1 pre-op vs. 66.1 at followup, role-physical functioning 11.9 pre-op vs. 52.5 at followup, bodily pain 22.3 pre-op vs. 60.2 at followup.)

Conclusions: MED for lumbar disk herniations can be performed safely and effectively. Outcomes for MED are comparable to those associated with standard microdiscectomy.

304. Bioabsorbable Cervical Spacers in the Treatment of Multilevel Degenerative Disc Disease

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Introduction: Fusion rates vary substantially in multilevel ACDF's. Theoretical advantages of bioabsorbable implants (BIs) include their radiolucency, a modulus of elasticity similar to bone, and a strength and degradation profile allowing for gradual transfer of stresses to the bone graft as the implant degrades. To date, little clinical data exists on the use of BIs in the cervical spine.

Methods: We reviewed the charts of 20 consecutive patients who underwent multilevel ACDF and plate fixation, using Cornerstone-HSR bioabsorbable implants (70:30 poly (l-lactide-co-D, L-lactide)). BIs were packed with either morselized iliac crest (obtained using a twist drill) in 11 patients (25 treated levels), or with rhBMP-2 in 9 patients (30 levels).

Results: A total of 55 disc spaces were treated in 20 patients (13 F/ 7 M). Arm and neck pain was reduced from an average score of 8.1 and 7.8 to 0.2 and 1.1 respectively (mean f/u 12 months). No patient exhibited evidence of hardware failure or movement on flexion extension x-rays during the f/u period. Of the 18 patients with greater than 3 months of radiographic f/u, 48 of 49 levels (98%) showed bridging trabecular bone and were considered to have a solid fusion. Immediate postoperative lordosis was largely maintained throughout the f/u period, there were no serious complications, and patient satisfaction was high.

Conclusions: Bioabsorbable implants appear to be safe and efficacious in multilevel ACDFs. Clinical and radiographic outcomes were excellent, fusion rate was high, and immediate postoperative lordosis was largely maintained throughout the follow-up period. Further clinical trials are warranted.

305. Corpectomy Followed by Instrumentation with Titanium Cages and rhBMP for Vertebral Osteomyelitis

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Introduction: Treatment of vertebral osteomyelitis includes antibiotics with/without surgical intervention. The decision to place instrumentation into an infected spinal column remains controversial. We review our experience with corpectomy followed by instrumentation with titanium cages for patients with instability and/or neurological compromise from active vertebral osteomyelitis.

Methods: Sixteen patients treated from 2001-2005 were included in this analysis. Ten patients presented with pain and 6 with radiculomyelopathy. Nine had associated epidural abscess. Cervical spine was affected in 5 patients, thoracic spine in 7, and lumbar spine in 4. All patients were treated with corpectomy of the involved vertebral bodies followed by titanium cage/plate reconstruction with autograft/allograft. Eleven patients underwent supplemental posterolateral screw/rod fixation.

Results: A 1-level corpectomy was perfomed in 1 patient, 2-level corpectomy in 14, and 3-level corpectomy in 1. Titanium cage with allograft was used in 5 patients and autograft in 11 patients. The most common pathogen was staphylococcus aureus. All patients were treated with IV antibiotics for at least 6 weeks postoperatively and life-long antibiotics were used in 3 patients with coccidiomycoses, candida, and tuberculosis osteomyelitis, respectively. There were no recurrent infections. All patients demonstrated radiographic evidence of fusion at last follow-up. Average follow-up was 15 months.

Conclusions: Corpectomy followed by titanium cage/plate reconstruction is a safe and effective surgical treatment for patients with vertebral osteomyelitis and does not lead to recurrent hardware infections. Antibiotic therapy tailored to the specific organism should be continued for at least 6 weeks after surgery, and life-long therapy is required for fungal or tuberculosis infections.

306. Modified Pedicle Subtraction Osteotomy to Correct Thoracic Kyphotic Deformity: A Cadaveric Study

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Introduction: Posterior surgical correction of fixed thoracic kyphotic deformity with standard pedicle subtraction osteotomy (PSO) shortens the spine, which can buckle the spinal cord– a significant concern in the thoracic spine. Our modified PSO involves collapsing an osteotomy centered around a disc space over an interbody cage in an attempt to preserve column height. Herein we compare two PSO techniques in a cadaveric model.

Methods: Nine PSOs were performed in fresh human cadavers: Modified PSOs on six and standard PSOs on three. All PSOs were performed at T6 (standard) or around the T5-6 disc space (modified). All of the wedge osteotomies had a posterior height of 22mm. Intraspinous distance was measured before and after correction; pre- and post- correction regional Cobb angles were measured independently. Loss of height and degree of correction were compared.

Results: Modified PSO resulted in a loss of height of 10.6 ± 7.8 mm compared to 16.7 ± 3.1 mm with standard PSO. Modified PSO allowed for 24.0°± 4.9° of regional correction, standard PSO resulted in 17.7° ± 0.6°of correction. While relatively consistent results were noted with standard PSO, the degree of correction obtained using this modification was more variable. Nevertheless, using this technique, it was possible to obtain up to 30° of correction– a 70% greater improvement than with the standard PSO– with less shortening of the spine.

Conclusions: Our modified PSO attains similar kyphosis correction, and potentially far greater correction, than can be safely obtained with the standard PSO technique in the thoracic spine.

307. Bryan® Cervical Disc Prosthesis Implantation Causes Kyphotic Deformity: A Myth? Decreased Pain and Improved Functioning Seen Without Kyphosis in Patients Treated for Spondylotic Radiculopathy

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Introduction: The Bryan® unconstrained artificial cervical prosthesis maintains cervical motion with relief of neck and arm pain from spondylotic radiculopathy. Literature regarding satisfaction with this device is scarce as are long term trials defining benefits over discectomy and fusion. Concerns of secondary kyphotic deformity have been raised. This study quantified the degree of disability and functional limitation in patients selected for Bryan® disc replacement pre- and post-operatively, whilst observing kyphotic deformity.

Methods: Oswestry Disability Index (ODI) and SF36 Index were used, being robust / reproducible tools. Patients completed questionnaires pre- and from 3 months post-operatively, each having 1 to 3 Bryan® disc prostheses implanted. These scores were compared for 45 patients in one practice (97% response, 69 implants).

Results: Patients reported decreased disability and increased functioning after Bryan® disc implantation. The mean ODI improved from 43.65% (95% confidence interval 37.9 - 49.4) to 19.4% (14.0 - 24.9) post-operatively. The mean SF36 improved from 42.7% (36.7 - 48.6) to 64.9% (57.7 - 72.0). All results were significant ($p < 0.01$). Kyphosis was not increased compared to conventional fusion techniques. In fact pre-existing kyphotic deformity was correctable by implantation.

Conclusions: After Bryan® cervical disc replacement, there is significant decrease in disability and pain as well as improvement in functional ability when compared to pre-operative state. It is proposed that if undertaking cervical discectomy, maintenance of normal cervical motion is associated with higher satisfaction when compared to fusion. Kyphotic deformity is largely a result of surgical technique and can be avoided (and corrected) by Bryan® prosthetic implantation.

308. In Vitro Study of Traumatic Loading After Implanting the Bryan® Cervical Disc Prosthesis.

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Introduction: Insertion of the Bryan® cervical disc prosthesis requires resection of the stabilizing disc and ligaments. Initial stability is achieved by precision milling of the vertebral end plates, creating concavities that hold the biconvex design of the prosthesis. Before bony ingrowth has occurred, patients may be at theoretical risk in the setting of trauma. To explore this potential susceptibility to injury, we studied load to failure in human cadaveric specimens implanted with Bryan® disc prostheses.

Methods: Fifteen cervical spine segments (C3-T1) were implanted with appropriately sized Bryan® disc prostheses at C5-6. Using pure moments, 5 specimens were loaded to failure in flexion, 5 in extension, and 5 in axial rotation at a constant cable uptake rate corresponding to approximately 0.5 degrees per second.

Results: Specimens failed at loads of 9.4 ± 3.2 Nm (mean ± standard deviation) in flexion, 6.2 ± 1.3 Nm in extension, and 11.0 ± 1.7 Nm in axial rotation. The load required for failure during axial rotation was statistically significantly greater than the load required for failure during extension ($p=0.04$, Kruskal-Wallis one-way analysis of variance on ranks followed by Dunn's method). Other pairwise comparisons were not significant.

Conclusions: In all three loading modes, the magnitude of loading to induce failure exceeded the ranges commonly considered physiological, implying that implantation of the Bryan® disc does not render the spine unstable. No case of device expulsion occurred.

309. Return to Work Analysis of Patients Treated with an Artificial Cervical Disc or an Arthrodesis

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Introduction: Return to work data provides valuable information concerning the efficacy of a treatment from a medical and economical perspective. We assessed return to work data for patients enrolled in both the Bryan® and Prestige® Cervical Disc IDE studies.

Methods: Patients from the Bryan® and Prestige IDE studies were examined separately to maintain statistical integrity. Both IDE studies prospectively followed patients with single-level symptomatic cervical spinal disease who were randomly assigned to receive either an instrumented ACDF or a cervical disc replacement. The return to work data was analyzed for both treatment groups.

Results: The Bryan® data included 240 patients Bryan® discs and 222 patients with an arthrodesis. The median returns to work (days) for the Bryan® patients were 50 and for the controls it was 74. There was no statistical difference in the demographics or preoperative status between the treatment groups, however the difference in median return to work time was statistically significant. The Prestige® data consisted of 250 patients who received a Prestige® disc and 260 individuals who were treated with an arthrodesis. There was no statistical difference in the demographics or preoperative status between treatment groups. Patients receiving the Prestige® device had an overall median return to work of 46 days which was significantly different than the median return to work time for patients receiving an arthrodesis which was 63 days.

Conclusions: Patients treated with an artificial cervical disc return to work more rapidly than those treated with an arthrodesis and the difference between the two is statistically significant.

310. Clinical and Radiographic Outcomes of Thoracic and Lumbar Pedicle Subtraction Osteotomy for Fixed Sagittal Imbalance

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Introduction: Few reports for complications and outcomes after pedicle subtraction osteotomy (PSO) exist in the literature. There are no reports pertaining to thoracic PSOs specifically. We evaluate the radiographic and functional outcomes of pedicle subtraction osteotomy (PSO) in general. Furthermore, we compare and contrast these measures between thoracic and lumbar PSO subgroups.

Methods: Thirty-five consecutive patients with sagittal imbalance treated with PSO by a single surgeon with minimum 2-year follow-up were analyzed. Perioperative course and complications were noted. Measurements of standing long-film radiographs of the spine were taken preoperatively, immediately postoperatively, and at most recent follow-up. The Modified Prolo and SRS-22 outcomes instruments were administered.

Results: Early complications after PSO included neurologic injury, wound-related problems, and nosocomial infections. Late complications were limited to pseudoarthrosis and attendant instrumentation failure. Lumbar PSOs were associated with improvements in local, segmental, and global measures of sagittal balance while thoracic PSOs were only associated with local improvement. Most patients rated their functional status as 'fair' to 'good' according to the Modified Prolo scale and reported that they were satisfied with the overall management of their back condition according the SRS-22 questionnaire.

Conclusions: The ability to perform a PSO at both lumbar and thoracic levels is a powerful asset for the spinal deformity surgeon. Radiographic and clinical outcomes were superior with lumbar PSOs secondary to several anatomical and technical obstacles hindering the thoracic procedure. Nevertheless, the thoracic PSO proves to be a useful addition for regional improvement in sagittal balance for patients with a fixed thoracic kyphosis.

311. Porous Coated Motion Cervical (PCM) Disk Replacement in Adjacent Segment Disease-Clinical Follow up of 40 Cases

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Introduction: Adjacent segment disease with radiculopathy and neurologic deficit adjacent to a non mobile spinal segment is the ideal application for cervical arthroplasty. Not only are the stresses and loads increased but unfortunately the previously fused segment is further compromised by being fixed in a kyphotic position.

Methods: This is a prospective study of 40 PCM prostheses inserted in thirty patients with 50 adjacent segments previously fused or rendered immobile.

Results: The mean improvement of cervical lordosis was 9.4 degrees (range (-15 to 23). EBL = 0 to 100 cc with no patients requiring blood transfusions, Length of surgery = mean 104 minutes (60 to 150) and the length of hospital stay = mean 1.17 days (0 to 3 days). The clinical follow up ranged from 6 to 32 months with a mean of 25 months. All patients were neurologically intact at follow up with a mean improvement of NDI = 50 % and mean improvement in VAS = 58.3 %. The range of flexion and extension motion at the level of the prosthesis was a mean of 8.9 degrees (range 4 to 20 degrees).

Conclusions: Naturally, the adjacent segment application of a cervical disk replacement is a challenging clinical environment for cervical arthroplasty–by definition every case had prior surgery–seventeen of the 50 previously fused levels had prior cervical instrumentation. Despite the complicated nature of the presenting pathology, the Porous Coated Motion Cervical prosthesis successfully restored some element of cervical lordosis and restored stability to the cervical segments.

312. Intervertebral RhBMP-2 for Transforaminal Lumbar Interbody Fusion

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Introduction: The purpose of this study was to evaluate the safety of recombinant human bone morphogenetic protein (rhBMP-2) on absorbable collagen sponges (ACS) in conjunction with allograft for the TLIF surgical approach with respect to fusion rates, complications, clinical outcome as patient's perceived global effect and satisfaction.

Methods: Seventy-four consecutive patients undergoing TLIF for degenerative disc disease were divided into five groups depending on whether the patient underwent a minimally invasive or open surgical approach and the number of spinal levels operated on. Operative data, fusion, complications and clinical outcome (Macnab's criteria and patient satisfaction rates) were evaluated. Average follow-up time was 20.6 months (range, 14 to 28 months).

Results: Radiographic fusion rate was 100% at 12 and/or 24 months after the surgery. The mean time to achieve fusion was 4.1 months (range, 2 - 10 months). There was no ectopic bone formation or other complications related to the BMP use identified. Clinical outcome, as patients' perceived global effect was excellent/good in 81.3% in the one-level minimally invasive group and 75.0% in the two-level minimally invasive group, compared to 72.7% and 60.0% in the open approach patients groups (P - 0.1). Patient satisfaction rates were higher in the one-level and two-level minimally invasive groups (P - 0.01).

Conclusions: Our results demonstrate that TLIF surgical procedure with bone morphogenetic protein application is a feasible and safe method of spinal lumbar fusion. There were no significant differences in clinical outcome between the open versus minimally invasive cases. However, patient satisfaction rates were higher in the minimally invasive patients group.

313. Comparison of Sagittal and Coronal Alignment of the Cervical Spine After One to Three-Level Artificial Disc Replacements (Prodisc-C) Versus Fusion

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Introduction: Large-scale clinical trials have shown the efficacy of lumbar disc replacement (DR). DR represents mobile reconstruction of the spinal column, and as such is unproven in spinal deformity, or in preservation of spinal alignment when used for multiple levels. A recent report demonstrated the early loss of local lordosis with DR with the Bryan® prosthesis. This is an analysis of segmental as well as overall sagittal and coronal cervical alignment with one to three-level DR.

Methods: This is a prospective randomized controlled study comparing single-level cervical DR to ACDF. Two and three-level DR were performed in eligible patients after receiving permission from the FDA for compassionate use. Preoperative and postoperative radiographic cobb angle measurements were performed.

Results: 41 patients were included in the study, consisting of 26 DR and 15 ACDF patients. There were 18 1-level DRs and 15 1-level ACDFs. Follow-up ranged from 1 to 2 (mean 1.5) years. There were also 6 3-level and 2 2-level DRs. Segmental lordosis increased immediately postoperatively in both DR and ACDF patients, and this was maintained in both groups. Overall cervical lordosis was maintained by both DR and ACDF. Coronal alignment was also maintained by both DR and ACDF, not changing from neutral pre-op to follow-up.

Conclusions: Single and multi-level cervical DR with the ProDisc-C prosthesis was able to preserve coronal and sagittal cervical alignment, both segmental and overall, at up to two years after surgery. Our results show that the ability of these devices to maintain mobility does not compromise preservation of spinal alignment.

314. Total Disc Replacement Versus Fusion as a Salvage Treatment for Failed Back Surgery Syndrome

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Introduction: Spinal fusion is an accepted salvage for failed prior procedures such as discectomies, laminectomies, nucleoplasties, or IDET annuloplasty – failed back surgery syndrome (FBSS). The semi-constrained ProDisc-L prosthesis is designed to be inherently more stable than a non-constrained disc (eg. Charité-III), has porous-coated endplates, fixation keels, and has undergone trials for multi-level disc replacement (DR). This study examines the outcomes of single and multi-level semi-constrained DR as salvage for failed back syndrome.

Methods: 120 patients were included in the study. 66 patients with intractable low back or leg pain after prior surgery underwent DR or fusion as part of a prospective randomized trial. Outcomes of DR (N=44) were compared to fusion controls (N=22) and DR without prior surgery (N=54). Outcome measures included the Oswestry Disability Index (ODI), Visual Analog Scale (VAS), and radiographs (24 months).

Results: Patients with FBSS described more preoperative pain and disability. After DR, FBSS patients had significantly reduced pain and disability by the ODI and VAS scores (both by over 60%). The results were comparable with DR patients with *no prior surgery.* In the early to intermediate postoperative period, both groups did better than *fusion patients* (VAS from 7 to 3.75, ODI from 30 to 22). Patient satisfaction in both arthroplasty groups (90%) far exceeded the fusion group (55%).

Conclusions: Patients with FBSS are also candidates for DR if other inclusion and exclusion criteria are met. Having had tissue-removing but non-destabilizing prior spinal procedures does not appear to compromise the results of DR with *single or multi-level* ProDisc-L.

315. Biomechanical Evaluation of a Novel Anterior Cervical Plate System

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Introduction: Benefits of cervical plate fixation include immobilization during fusion and possibly increased fusion rates. Concerns relate to implant size and bulk, retraction required to place the implants, and added costs. A unique cervical plate, utilizing a single screw in each vertebra, has been developed to address some of these issues.

Methods: Two plate designs were evaluated; the UNIPLATE system (one-screw/vertebra) and the SLIM-LOC system (two-screws/vertebra). Kinematic testing was performed on 12 fresh-frozen human cervical spines (C3-7) using a custom seven-axis spine simulator applying independent flexion/extension, lateral bending, and axial rotation moments with a 50N compressive axial follower-load. ROM data were collected for the intact state, ACDF with plating of C4-5, and an additional ACDF at C5-6 with plating of C4-6. Stiffnesses were calculated from the moment-rotation data.

Results: *One-level construct:* both plate systems significantly increased the stiffness nearly 4x in flexion/extension, 4.5x in lateral bending, and 1.6x in axial rotation, compared to the intact state with no significant difference. The UNIPLATE system reduced ROM 67%, and the SLIM-LOC system reduced the ROM 33%, compared to the intact state, respectively. *Two-level construct:* both plate systems significantly increased the stiffness at least 6.8x in flexion/extension, 6.9x in lateral bending, and 1.6x in axial rotation, compared to the intact state with no significant difference. Both systems reduced the two-level ROM 67% of the intact state.

Conclusions: The kinematic stability of the one-screw/vertebra construct (UNIPLATE) is statistically equivalent to the two-screw/vertebra construct (SLIM-LOC) in both the one-level and two-level ACDF construct models.

316. In Vitro Biomechanics of Multi-level Cervical Disc Arthroplasty

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Introduction: The purpose of this study was to determine the ability of the PRODISC-C disc prosthesis to restore cervical spine motion and compare this motion to that of harvested and two-level fusion conditions.

Methods: Six human cadaveric cervical spines (C2-T1) were tested in flexion, extension, lateral bending, and axial rotation under displacement control. Three different conditions were evaluated: the harvested spine, spine with C5-C6 and C6-C7 disc replacements using the PRODISC-C, and two-level (C5-C7) fusion. Fusion was simulated by attaching custom designed screws and clamps to the C5, C6, and C7 spinal bodies. The spines were tested to a target moment of 3Nm. Measurements included individual vertebral motions, total spine rotation, and applied loads.

Results: There were no significant differences in the normalized motion data between the PRODISC-C spines and the harvested (H) spines in all loading modes, except for flexion (113% of H), right (124% of H) and left (122% of H) axial rotation. For the fused condition, significant differences occurred in flexion plus extension between Fusion versus Harvested (5% of H) and Fusion versus PRODISC-C (5% vs. 110%). Similar differences occurred in lateral bending between Fusion versus Harvested (33% of H) and Fusion versus PRODISC-C (33% vs. 114%) and in axial rotation between Fusion versus Harvested (21% of H) and Fusion versus PRODISC-C (21% vs. 136%).

Conclusions: Use of multi-level PRODISC-C prostheses did not limit the overall biomechanical integrity of the operated spine. In contrast, fusion caused significant reduction in motion at the operated levels with compensatory increased motion at adjacent segments.

317. Initial Clinical and Radiographic Results of a Minimally Invasive Presacral Approach for L5-S1 Interbody Fusion

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Introduction: Anterior access to the L5-S1 disc space for interbody fusion can be difficult and often requires the assistance of a vascular surgeon for adequate exposure. We reviewed our experience with a novel minimally-invasive technique for L5-S1 interbody fusion that requires no retraction of the great vessels and no dissection of the sympathetic plexus.

Methods: Eight patients (5F:3M, average age 55 years) were included in this analysis. Average follow-up was 5.5 months. Back pain was due to lumbar degenerative disc disease (DDD) in 5 patients, degenerative lumbar scoliosis in 2 patients and lytic spondylolisthesis in one. All patients had evidence of L5-S1 degeneration on imaging studies and underwent percutaneous, presacral fluoroscopically-guided interbody fusion (AxiaLIF) with cage and BMP/mastergraft at this level, with or without interbody fusion at adjacent levels.

Results: Mean operative time for the L5-S1 AxiaLIF procedure was 43 minutes. Four patients underwent AxiaLIF followed by percutaneous L5-S1 pedicle screw-rod fixation. Two patients underwent AxiaLIF followed by percutaneous L4-L5 extreme lateral interbody fusion. Unfavorable anatomy precluded access to the L5-S1 disc space during open lumbar interbody fusion in 2 patients who subsequently underwent AxiaLIF at this level. All patients had radiographic evidence of stable L5-S1 interbody cage placement at last follow-up.

Conclusions: The percutaneous presacral route provides safe and minimally-invasive access to the L5-S1 disc space. It can be used alone or in combination with minimally-invasive or traditional open fusion procedures and can be performed in patients in whom adequate access to the L5-S1 disc space is unachievable from an open lateral approach.

318. Clinical Experience with the Absorbable Anterior Cervical Plate for Single Level ACDF

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Introduction: Anterior cervical discectomy with allograft and plate instrumentation has become a standard of care for treatment of single level cervical radiculopathy and/or myelopathy. Use of metal plates can lead to complications including dislodgement and dysphagia, and is not desirable because of persistant foreign material implantation. Absorbable cervical plates have recently become available but information on fusion rates and outcome for ACDF is limited.

Methods: Patients presenting with one-level cervical radiculopathy and/or myelopathy and without mechanical instability who had failed non-operative treatment underwent single level ACDF using allograft interbody spacers and instrumentation using a resorbable MacroPore 70/30 PLA (Mystique, Medtronic) plate. Visual-Analog scale, Neck Disability Index scores, flexion/extension scores, percent fused, and time to fusion were assessed up to one year post–operatively. Patients did not wear a hard-collar postoperatively.

Results: 10 patients have been included to date. The majority of patients presented with radiculopathy. One patient had a transient Horner's syndrome after surgery. One screw-head broke intraoperatively, and a rescue screw was placed with good results. Immediate postoperative imaging studies revealed good alignment of plate and graft in all patients. Settling of the graft was observed in 2 patients 6 weeks after surgery. There was no failure due to dislodgement of graft or plate; no patient required further surgery. VAS and NDI improved significantly at 6 months after surgery.

Conclusions: Based on these preliminary results, the absorbable anterior cervical instrumentation is safe and effective as an alternative to metallic plates in single level ACDF with the advantage of avoiding permanent implantation of foreign body.

319. Overexpression of Protease Nexin I Provides Neuroprotection and Blocks Neuroinflammation After Spinal Cord Injury in Mice

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Introduction: Thrombin is both a proinflammatory mediator and a neurotoxic factor within the adult spinal cord. Prothrombin mRNA and the most common thrombin receptor, PAR1, are rapidly upregulated after contusion injury in rats (Citron et al., J Neurotrauma 17:1191[[Unsupported Character - Codename]]0S, 2000). Antithrombin (ATIII) is the most potent thrombin inhibitor in blood while a related serpin, protease nexin I (PNI) serves that function in tissue, including CNS. ATIII has potent anti-inflammatory as well as anticoagulant actions. PNI provides neuroprotection and may also be anti-inflammatory.

Methods: We generated transgenic mice genomically overexpressing human PNI (TghPNI) and performed moderate compression spinal cord injury (SCI) in TghPNI and wild type (wt) as described (Farooque, Acta Neuropath 100:13-22,2000). Locomotor rating scores and actometer testing was performed while evolution of SCI was monitored over time using a special surface coil on an MRI scanner with 9.4 Tesla field strength and 1mm slice thickness.

Results: At day 1 in wt mice, grey matter tissue damage was already obvious but became gradually extensive at days 7 and 14 after SCI, extending caudal from the injury epicenter. Damage was much reduced in transgenic TghPNI mice, and motor scores confirmed MRI data. Damage was much reduced in TghPNI mice, and motor scores confirmed MRI data.

Conclusions: Histologic sections supported both anti-inflammatory and neuroprotective effects of the overexpression of PNI on recovery following compression SCI in mice.

320. XLIF: One Surgeon's Interbody Fusion Technique of Choice

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Introduction: The XLIF procedure allows for superior disc-space preparation and stabilization with minimal surgical time or patient morbidity. Previous reports have presented the technique as an alternative to ALIF for DDD. The current report highlights its use in one practice as the preferred interbody fusion technique for a variety of indications.

Methods: 72 XLIF cases were performed by one surgeon from June 2004 - May 2005. Indications included failed-laminotomy syndrome, adjacent-level syndrome, internal disc disruption, stenosis, spondylolisthesis, and degenerative scoliosis, among others. Posterior microdecompression was adjunctively performed in 26/72 cases (36%). Operative and immediate-postoperative details were analyzed to evaluate the efficacy and minimally-disruptive benefits of the technique.

Results: A total of 99 levels were treated: 52/72 cases were single-level, 16/72 2-level, 2/72 3-level, and 1 each 4-level and 5-level; 39/99 procedures were at L4-5, 32/99 at L3-4, 23/99 at L2-3, 3/99 at L1-2, and 2/99 at T12-L1. 19% were stand-alone, 22% were supplemented with unilateral pedicle screws, and 59% with bilateral pedicle screws. XLIF OR time and EBL averaged 66 minutes and 15cc, respectively. No lasting complications occurred. All patients ambulated within 8 hours. 51% were discharged within 48 hours; the remainder mainly elderly with significant comorbidities.

Conclusions: XLIF is a safe and reproducible procedure that can be done quickly, affords an exceptional interbody grafting area, and results in minimal morbidity. It can be used with adjunctive procedures for a variety of back and leg symptoms. It has become my preferred technique for treating lumbar degenerative conditions, especially in an elderly population that previously had few treatment options.

321. Charité Lumbar Artificial Disc Retrieval by Minimally Invasive Lateral Approach (XLIF): Case Report

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Introduction: Most lumbar TDR devices require an anterior abdominal approach, which can be technically demanding at L4-5. Converting a failed TDR to an anterior interbody fusion is especially difficult due to scar formation and risk of vascular injury, and so posterior fixation is alternatively recommended. Still, some circumstances may necessitate removal of the TDR. We used a lateral approach to more safely access the disc space.

Methods: A Charité TDR device (DePuy Spine, Raynham, Massachusetts) was implanted in a 39 year-old woman with L4-L5 DDD. Her back pain reappeared 15 days post-op and x-rays showed instability caused by an unrecognized isthmic pars defect fracture at the implanted level. An instrumented posterolateral fusion was performed, subsequently became infected, and was again revised. Her back pain persisted 18 months later and x-rays revealed rod failure. TDR removal was performed via XLIF through a 2-inch lateral incision using a MaXcess retractor and EMG guidance (NuVasive, San Diego, California).

Results: The polyethylene TDR core was exposed and removed quite easily after annular discectomy. The endplate fixation was separated with a flat chisel without significant force. Standard intradiscal instruments were used for disc-space preparation and a PEEK interbody implant filled with iliac crest autograft was inserted across the peripheral apophyseal ring. A posterior revision was also performed with re-position of the rod. The TDR was successfully revised to an interbody fusion in 100 minutes, with 50cc blood loss. The patient was discharged in 24 hours.

Conclusions: An anteriorly placed Charité TDR device can be successfully and more safely revised using an XLIF approach.

322. Multimodality Evoked Potential Monitoring for Intradural Spinal Cord Lesions of the Cervical and Thoracic Spine: Prospective Long-term Clinical Evaluation of 22 Cases

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Introduction: We hypothesized that changes in intraoperative motor and somatosensory evoked potential responses during surgery for intradural cervical and thoracic spinal lesions correlate with postoperative neurological changes and influence intraoperative surgical decision making.

Methods: Twenty-two patients undergoing resection of cervical and thoracic spinal lesions over a 48-month period were monitored with motor (MEP) and somatosensory evoked potential (SSEP) monitoring. We prospectively examined the relationship among intraoperative monitoring findings and pre- and post-operative neurological examinations.

Results: Twenty-two patients (7 intramedullary lesions, 12 extramedullary lesions,1 syringomyelia and 1 transdural cord herniation) were included in the study and followed postoperatively for 12 months. The correlation between MEP/SSEP changes and motor grade loss on preoperative and post-operative assessments revealed 3 true positive and 19 true negative MEPs and 1 true positive and 19 true negative SSEPs. Specificity was 100% for both MEPs\SSEPs and sensitivity was 100% and 33% for MEPs and SSEPs respectively. Positive predictive value (PPV) and negative predictive value (NPV) were 100% and 100% for MEPs, and were 100% and 90% for SSEPs. The accuracy of MEP and SSEP were 100% and 90% respectively.

Conclusions: These results demonstrate good sensitivity, specificity, PPV and NPV for MEPs. MEP monitoring accurately predicts postoperative decreases in neurological motor function and provides additive information to SSEPs.

323. Total Cervical Artificial Disc Replacement with the PCM (Porous Coated Motion) Disk. Prospective 3 Years Follow Up Clinical and Radiological Study, 230 Discs Performed.

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Introduction: Many surgical options are available to treat the cervical spine disease. Traditional treatment of cervical spondylosis and cervical herniated disc disease with neurological compression is ACDF. Total disc replacement has been reported to restore motion in the cervical spine. The purpose of this prospective study was to evaluate pain relief and radiographics outcomes of the cervical disc replacement utilizing the PCM disc.

Methods: Report of 3 years follow-up total disc replacement study in a consecutive series of 138 patients underwent a total of 230 PCM disc for treatment of cervical degenerative disease with radiculopathy and/or myelopathy. Radiographic and clinical outcomes were collected preoperatively, at 1 week, at 1, 3, 6, 9, 12, 15, 18, 24, 30 and 36 months postoperatively. The NDI, VAS, ODOM and TIGT questionnaires were used to assess pain and functional outcomes.

Results: There were no deaths, no infections, and no instances of iatrogenic neurologic progression. PCM maintains phisiologic ROM. 94% of patients discharged < 24 hours. There were four re-operations for replacement of a low-profile component with a PCM arthroplasty device. 87% of working patients were able to return to their baseline level of employment. The clinical success based on Odom's criteria was 95% or more. The mean VAS and NDI improves at the final of the follow-up.

Conclusions: Following cervical arthroplasty with the PCM disc, radiographic and clinical outcome measures were encouraging when compared to historical data of one level ACDF; is a good treatment option for degenerative disc disease and a viable alternative to fusion.

324. A Novel Biomechanically Superior Means of Minimally Invasive Transfacet Non-Screw-Rod Based Fixation: Early Clinical Experience and Biomechanical Data

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Introduction: We describe a novel means of minimally-invasive transfacet fixation using a novel rivet system that is not dependent on traditional lateral mass screw-rod fixation.

Methods: A biomechanical cadaveric study in a C5 corpectomy model comparing the ROM on rotation, flex-extension, and lateral bending after the following: Mesh Cage alone, Cage+ Ant Plate, Cage +Ant Plate+ lateral mass plates, Cage+Ant Plate+transfacet rivets. Using the transfacet rivets clinically, supplementation of single and multi-level anterior constructs were acomplished. Eight cases were completed and followed over a 2-6 month period with use of radiographic and clinical outcomes assessment.

Results: The cage alone group demonstrated the most motion in all modalities except lateral bending where there was no difference. Comparing the last three groups, there was no statistically significant differences between the plate, plate+lateral mass screws, and plate+transfacet rivets in flexion-extension or lateral bending. The groups with lateral mass screws or transfacet rivets performed equally well in axial rotation and were superior to the group with anterior plates only (p less than 0.05). In the eight clinical patients, there were no gross complications of transfacet fivet fixation with low blood loss, no operative complications, and good early outcomes.

Conclusions: Posterior transfacet fixation is a novel means of subaxial cervical spine stabilization that can be applied in a minimally-invasive percutaneous fashion to supplement an anterior construct or for stand-alone facet arthrodesis. Biomechanically, it appears to provide equal rigidity to traditional dorsal lateral mass fixation techniques.

325. In Vivo Image Based 3-D Finite Element Analysis of L5-S1 Charité Artificial Disc Implant

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Introduction: Since FDA approval, clinical and biomechancial research continues into the complications of Charité artificial disc replacement (ADR), which may include posterior facet joint arthrosis and device subsidence. The objective of this project is to employ an image based 3D finite element model to determine changes in stresses following ADR in the spine segment that may relate to these two potential complications.

Methods: Image based 3-D models were constructed from pre-operative and post-operative fine cut lumbosacral spine CT scans of patients scheduled to undergo L5-S1 Charité artificial disc implant. As a control, a normal healthy disc model was used. Finite element analysis was then performed using VOXELCON 5.0 software on the all models. Two loading conditions, representing compression and flexion loads were used. Displacement, shear, and stress were analyzed in all three spatial dimensions.

Results: All of the models show significant stress at the L5-S1 facet joints without significant differences. High stress was found at the inferior L5 and superior S1 endplates only of the Charité ADR models. Only minimal stress was found in the discs of the normal and degenerative models.

Conclusions: The stress found at the facet joints may be due to the lordotic curve of the L5-S1 spine segment in relation to the loading force vectorin our models. This is different than what has been reported with geometric linear finite element analysis studies. The increased stress at the L5-S1 endplates seen in the Charité ADR models could play a role in the incidence of device subsidence.

326. Laminectomy for Cervical Spondylotic Myelopathy in Elderly Patients

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Introduction: As the population ages, medical professionals must increasingly take age into account during surgical decisionmaking. Unfortunately, significant attention has not been given to studying the effects of age on outcome for many neurosurgical procedures. In the present study we examine the functional outcome of cervical laminectomy in the elderly patient population.

Methods: We retrospectively reviewed the charts of patients over the age of 65 with cervical spondylotic myelopathy who underwent surgical decompression at our institution between 1997 and 2003. A total of 36 patients (17 male, 19 female) over the age of 65yrs (mean age=81yrs) underwent laminectomy for cervical spondylotic myelopathy. Information from charts and follow-up telephone interviews was used to determine functional state at 6 months following surgery. Functional outcome was measured using the Japanese Orthopaedic Association (JOA) scale, Cooper scale, and Nurick scale. Differences between pre-operative and post-operative function were compared and statistical significance determined using the two-tailed t-test for paired samples.

Results: Mean JOA scale scores improved significantly from 10.14 before surgery to 11.53 after laminectomy (P=0.015). Similar improvements were seen in the Cooper (3.72 to 1.47; P=0.004), and Nurick (2.61 to 2.30; P=0.13) scores. There were no serious complications and no surgical deaths.

Conclusions: Laminectomy for cervical myelopathy is a safe and effective procedure for elderly patients.

327. How to Predict Best Results from the Bypass Coaptation for Cervical Root Avulsion

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Introduction: The prognosis of cervical root avulsion is considered unfavorable for functional recovery. Based on bypass coaptation procedures, the authors retrospectively formulate the effective factors for restoring function of denervated muscles.

Methods: Twenty patients with cervical root avulsion accumulated over 22 years were divided into three groups: C5 and C6 roots avulsion (N=14); C8 and T1 avulsion (N=2 infants); and C5 through T1 avulsion (N= 4). In the first group, coaptation consisted of C3 and C4 anterior rami to the upper trunk of the brachial plexus (added by spinal accessory nerve in 3 patients); C3 or C4 ramus to the lower trunk in the second group; and C3 and C4 to the upper trunk and intercostal nerves to the median and ulnar nerves in the third group.

Results: 1) The first group had the best results to restore shoulder girdle muscles and biceps (4+/5 within 2.5 years). In a 17-years-old patient, same motor recovery occurred in 10 months. 2) The second group regained some finger movement but needs further follow-up. 3) The third group regained less motor recovery in the shoulder girdle muscles than the first group and only one infant restored significant finger movement. Pain relief was noted over 3-4 months after surgery.

Conclusions: The combination of abnormal EMG findings and normal sensory conduction confirms root avulsion proximal to the sensory ganglion. CT myelogram or MRI is for screening test. Bypass capitations are useful for motor restoration. Younger ages suggest good outcome.

328. Restoration and Maintenance of Coronal and Sagittal Lumbar Spinal Alignment with a Semi-Constrained Multi-level Lumbar Total Disc Arthroplasty (ProDisc-L)

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Introduction: The first prosthetic disc in the US was approved by the FDA for single-level disease. Unfortunately DDD frequently occurs in more than one level. The ProDisc-L artificial disc recently completed clinical trials for single and two-level DDD. Some patients have undergone disc replacements (DR) at 3 or more levels under "compassionate use" for multi-level DDD. Local asymmetric disc collapse and spinal deformity is common with multi-level DDD. There have been no reports on the effect of multi-level DR on spinal alignment.

Methods: This is a review of 80 patients with DDD who underwent 2 to 3-level DR with a semi-constrained prosthesis. Radiographic evaluation was performed to assess the restoration and/or maintenance of sagittal and coronal alignment. Patients with local spinal deformity due to significant asymmetric disc collapse were also evaluated separately.

Results: Multi-level DR with a semi-constrained prosthetic disc was successful in correcting local spinal deformity and maintaining alignment at up to 36 months of follow-up. Average preoperative lumbar lordosis on average was 40 degrees, and was measured at 42 degrees immediately postoperatively, 41 degrees at 24 months. Preoperative coronal asymmetric disc collapse causing local deformity up to 15 degrees was also successfully corrected and maintained.

Conclusions: Disc prostheses are dynamic devices that allow motion. However, with local deformity, semi-constrained DR successfully corrected asymmetry, implying that physiologic stabilizers in the back (muscles, ligaments, etc) can benefit from DR in maintaining alignment. Multi-level DR has shown the ability to maintain coronal and sagittal spinal alignment at up to 3 years of follow-up.

329. Motion-Preserving Dynamic Posterior Stabilization of the Lumbar Spine: Early Results from the US Clinical Trial with the Dynesys System

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Introduction: Lumbar fusion has long been the mainstay of surgical treatment for instability of the lumbar spine. Recently, a new concept of dynamic stabilization has been advocated to preserve motion and avoid the morbidity of spinal fusion. This is one of the first intermediate-term reports on the US FDA clinical trials for the Dynesys device.

Methods: 30 patients aged 49-77 (mean 65) with degenerative lumbar spondylosis at 1-2 levels were entered into the prospective randomized controlled US-IDE study of the Dynesys device. 23 patients completed at least 12 months of follow-up.

Results: Patients treated either with dynamic-stabilization or fusion had reduced pain and disability as measured by Oswestry and VAS scores. There was no significant difference between the two groups. Motion at the treated segment was slightly decreased for dynamic-stabilization patients while it was significantly decreased for fusion patients. Sagittal and coronal alignment were maintained by the Dynesys device. There were two instances where radiographs revealed mild radiolucent halos around Dynesys screws, both asymptomatic.

Conclusions: Both dynamic-stabilization and fusion-treated patients reported decreased disability and pain. Dynamic-stabilization decreases back and leg pain while avoiding the morbidity of fusion, maintaining sagittal alignment of the lumbar spine, and without eliminating motion. The short-term results from this study suggest that this may be a viable alternative to fusion.

330. Is Excessive Bone Formation Associated with the Use of rhBMP2 in Minimal Access PLIF/TLIF?

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Introduction: The use of rhBMP2 for interbody fusion is associated with excellent fusion rates. For posterior approaches, concerns regarding the formation of bone within the epidural space have been raised. The objective of this study was to assess the incidence and clinical sequelae of epidural bone formation after the use of rhBMP2 in minimal access interbody (PLIF and TLIF) fusions.

Methods: This study compared 2 groups (A - with BMP [n=23] / B - without BMP [n=10]) of patients who had undergone instrumented minimal access PLIF (n=10) or TLIF (n=23 [n= 4-bilateral]) with a minimum 6 month postoperative CT. In all cases local autograft and/or allograft was used. Clinical chart review and CT assessment for bone formation (intradiscal, annular/ALL/PLL, epidural [canal / foramen] and beyond the spine) was independently performed.

Results: Average clinical and CT follow up was 13.0 and 7.9 months respectively. From 33 patients, 36 levels (3 patients had 2 level procedures) were assessed. Bridging bone was seen in all but one level. Bone formation within the disc, to the outer rim of the annulus, canal, foramen, and beyond the spine was seen in 100%, 44.4% (n=10 group A, n=6 group B), 5.6% (n=1 group A, n=1 group B), 11% (n= 4 group A), and 0% of levels respectively. Foraminal bone formation was only seen in the BMP-TLIF group. No clinical sequelae were associated with epidural bone formation.

Conclusions: Although, the use of rhBMP2 is associated with a higher incidence of epidural bone formation, there were no associated clinical sequelae.

331. PEEK Interbody Spacers Filled with Allograft Chips in Anterior Cervical Discectomy and Fusion

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Introduction: Polyetheretherketone (PEEK) is a radiolucent, nonresorbable polymer successfully used as an interbody spacer for anterior cervical fusion when filled with iliac crest autograft and with recombinant BMP-2. The fusion rate with PEEK spacers has not been established when the device is filled with allograft chips.

Methods: We prospectively collected data on the surgeries using the PEEK spacer in 25 levels in 22 consecutive patients undergoing anterior cervical discetomy and fusion for cervical spondylotic myelopathy or radiculopathy. All patients had supplemental anterior instrumentation with semi-constrained plates. Patients with a history of diabetes or smoking within 6 months of surgery were instructed to use an external bone growth stimulator for 3 months. Serial x-rays were obtained in the course of routine office visits. Fusion was assessed using either flexion-extension x-rays or CT scans at a minimum of 6 months after surgery.

Results: The mean patient age was 56.3 years (42-78). Smokers were 9% while 32% had diabetes. Clinical follow up was obtained at a mean 14 months (9-31). Imaging assessment for fusion was performed at a mean 12 months after surgery (6-22). Fusion occurred in all patients. No graft-related complications were noted. One patient underwent additional cervical spine surgery for adjacent segment disease 7 months after the initial surgery. Fusion was appreciated in all patients with bone growth consistently seen both within the device center and periphery.

Conclusions: If confirmed by larger studies, PEEK interbody spacers filled with allograft appear to be a suitable substitute for structural allograft or autograft in anterior cervical fusion procedures.

332. A Long-Term Clinical Outcome Analysis of Minimally Invasive Cervical Foraminotomy

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Introduction: This study examines the 4-year long-term clinical outcomes of MICF over time to determine the incidence of recurrent symptoms and the percentage of patients requiring additional cervical spinal surgery.

Methods: We conducted a multicenter retrospective chart review of 73 patients who had a MICF. Patient histories and evaluations were reviewed and scored specifically for symptoms of neck pain, radiculopathy. In addition to these, findings of abnormal reflexes, decreased sensation, and decreased strength were also recorded. Static and dynamic plain cervical spine radiographs, MRI, and/or computed-tomographic myelogram (CTM) were obtained pre- and post-operatively.

Results: Whereas patients selected for MICF had minimal preop neck pain, significant neck pain was subsequently seen in 8 patients with symptoms in 2% at 1 year, 5% at 2 years, 9% at 3 years, and 11% at 40 months. Overall, 15 patients (20%) of these 23 symptomatic patients underwent an additional cervical surgery after MICF. 4% of patients underwent a repeat MICF at the same level as before at an average of 12 months postop with a positive response in all 3 cases. An additional 2 patients had MICF at a different level. 7 patients had an ACDF at the same level. An additional 2 patients were determined to have pain at a different level from preop and underwent ACDF at a different level with both having positive outcomes.

Conclusions: MICF continues to be our procedure of choice for properly selected patients with cervical radiculopathy.

333. Real-time CT-guided Percutaneous Thoracic Disc Decompression with Laser Assisted Spinal Endoscopy for Symptomatic Thoracic Disc Herniation

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Introduction: Computed tomography (CT) fluoroscopy, one of the most recent developments in interventional radiology, provides accurate spatial information and real-time information. The purpose of this study is to present percutaneous thoracic disc decompression (PTDD) with Laser Assisted Spinal Endoscopy (LASE) under CT fluoroscopy guidance for symptomatic thoracic disc herniation.

Methods: Between March to November 2003, eight consecutive patients, who have suffered from intractable thoracic axial and/or radicular pain due to soft disc herniation, underwent real-time CT-guided PTDD with LASE. By showing a live image, the ipsilateral or central portion of protruded disc is decompressed via the posterolateral approach using an automated nucleotome and microforceps through a small cannula. Then, disc tissue was more potentially shrunk and annuloplasty was performed using a Ho:YAG laser under endoscopic view. All patients were discharged from the hospital in less than 24 hours.

Results: The mean follow-up period was 23.8 months (range 20-28 months). According to the modified Macnab criteria, excellent was obtained in 6 patients (75.0%), good in 1 (12.5%), and fair in 1 (12.5%). Compared with preoperative values, there was a significant decrease in Visual Analog Scales (6.5 to 1.6; p=0.11) and Oswestry Disability Index (55.0 to 17.5; p=0.11) at the 3-month follow-up, and the improvements were well maintained throughout the follow-up period. There were no postoperative complications and no case required conversion to an open surgery.

Conclusions: PTDD with LASE under CT fluoroscopy guidance is an accurate, safe, and effective minimal invasive procedure for symptomatic thoracic disc herniation in selected patients.

334. Percutaneous Endoscopic Lumbar Discectomy for Upper Lumbar Disc Herniation

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Introduction: There have been few published studies on the outcomes of percutaneous endoscopic lumbar discectomy (PELD) for upper lumbar disc herniation. The purpose of this study was to evaluate the efficacy of PELD for upper lumbar herniation. We further describe the predictive factors and technical pitfalls unique for upper lumbar level.

Methods: We reviewed the clinical data of 47 consecutive patients treated with PELD at L1-2 or L2-3 level from Jan 2001 to Mar 2003 at our hospital and compared the clinical outcomes with those of patients treated with PELD at L3-4 level. Patients with soft disc herniation without segmental instability were included in our study.

Results: The mean follow-up period was 38.8 months and the mean age was 54.9 years. The success rate of L1-2 + L2-3 group was 74.5%, whereas that of L3-4 group was 88.1% ($P < 0.05$). The cases required further surgeries were more in L1-2 + L2-3 group than in L3-4 group (14.9% vs. 5.2%; $P < 0.06$). The clinical predictive factors for favorable outcome were younger age (less than 50 years; $P < 0.05$) and shorter symptom duration (less than 6 months; $P < 0.05$), while the radiological predictive factors were lateral disc herniation (subarticular or foraminal; $P < 0.05$) and low grade disc degeneration (grade 3 or less; $P < 0.05$).

Conclusions: The surgical outcomes of PELD for L1-2 and L2-3 herniation were less favorable than those for lower lumbar herniation. Therefore, more strict patient selection and specialized technical considerations are required.

335. Evaluation of the Misonix Ultrasound Osteotome Device in Sheep Laminectomies

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Introduction: Bone removal has traditionally been performed by hand instruments or cutting burrs. Ultrasonic osteotome devices offer the potential advantage of more controlled bone resection and reduced likelihood of soft-tissue injury. This study was designed to evaluate the safety and efficiency of bone removal in a sheep laminectomy model using the Misonix ultrasonic osteotome versus traditional use of high-speed drill and Kerrison punches.

Methods: The study was IACUC approved using twelve sheep undergoing complete 3 level, bilateral laminectomy. Eight surgeries were performed using the ultrasonic osteotome. Four control sheep surgeries used traditional means. Pre and post-op MRI's were done on one sheep from each group to evaluate for hematoma and/or inflammation. Somatosensory evoked potentials (SSEP) were done pre and post op on all sheep. Weekly clinical neurological and behavioral examinations evaluated gait, reflex, bowel/bladder function and pain withdrawal. After sacrifice, histological analyses assessing integrity of dura, nerve roots and bone was completed.

Results: Of the experimental and control group there were no weaknesses attributed directly to the surgery. Acquired post-op MRI's revealed no significant damage. All sheep remained healthy neurologically and behaviorally. Laminectomy times using the device averaged 7 minutes while time for the controls was 12.5 minutes.

Conclusions: The ultrasonic osteotome made a precise cut over a small distance in a controlled fashion, reduced surgery time in this model and was safe.

336. The Utility of MR Neurography in Brachial Plexus Imaging

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Introduction: Magnetic Resonance Neurography has shown promise for the image evaluation of the brachial plexus relative to routing MR imaging. However there has been no comprehensive assessment of initial progress in this field and no update of methodology. In the past artifacts and variable image quality have limited utility.

Methods: An updated standardized MR Neurography protocol was applied for the collection of brachial plexus image data in 500 patients and these were compared with image data on 200 patients imaged using an older MR Neurography brachial plexus protocol.

Results: The use of unilateral imaging with nerve perpendicular views and patient positioning to straighten the normal plexus resulted in significant increase in image reliability and clinical utility. This methodology equalized the efficacy for proximal and distal pathology including tumors, trauma and entrapment syndromes and greatly reduced the occurrence of image intensity artifacts.

Conclusions: Modification of brachial plexus MR Neurography protocols to correct problems observed with earlier protocols has greatly improved the efficacy, reliability, and clinical utility of this diagnostic technique.

337. Spontaneous Resolution of Syringomyelia Associated with Chiari Type 1 Malformation

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Introduction: Syringomyelia with Chiari malformation has been thought to rarely shrink spontaneously. To our knowledge, only several cases have been reported in English literature. We reported here additional nine pediatric cases whose syringomyelia shrank spontaneously, and assessed their neurological and neuroradiological features.

Methods: From 1988 to 2003, we conducted prospective MRI studies in pediatric patients with scoliosis and positive neurological signs or symptoms. Sixty-two scoliotic children showed syringomyelia associated with Chiari malformation, and nine of them revealed spontaneous resolution of syringomyelia following improvement of tonsillar ectopia.

Results: All nine patients showed only mild neurological deficits. Their scoliosis remained stable during follow-up periods. They were diagnosed as having syringomyelia at the age of 7.2 years, and the syringes disappeared or remarkably diminished in size at the age of 12.1 years. Basal angles have become narrower and clivo-axial angles wider during this period. Improvement of tonsillar displacement seems to be attributed to increased growth of the calvaria relative to the central nervous system, followed by spontaneous resolution of syringomyelia.

Conclusions: Spontaneous resolution of syringomyelia is not rare in growing children.

338. CT-SPECT Fusion Imaging for Diagnosing Painful Lumbar Facet Joint Arthropathy

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Introduction: Facet disease is believed to play a role in axial back pain. However, the lack of good diagnostic and imaging methods for diagnosing this condition have made this entity more obscure than discogenic pain. SPECT imaging is a highly sensitive and specific test, but the images have poor resolution. CT provides excellent resolution but lacks specificity.

Methods: Thirty-six patients with suspected back pain from facet disease underwent SPECT-CT fusion imaging of the lumbar spine. SPECT images were obtained using a dual head gamma camera equipped with VXGP high-resolution collimators using a 20% energy window centered at 140keV and a 360-degree rotation totaling 128 projections at 16 seconds each. Transaxial CT images were transferred in DICOM to provide proper image overlay in the axial, sagittal, and coronal planes. Scanning for both modalities was performed with standard patient positioning. Patients with concordant images and symptoms then underwent joint injection and/or rhizotomy by an independent physician.

Results: Successful image fusion was performed on all patients, and image quality allowed definitive localization of the "hot" lesion in all cases, in contrast to conventional high-resolution SPECT imaging which often led to problems differentiating L4/5 and L5/S1. In patients with solitary lesions, injection led to definitive pain resolution, even if temporary, in all cases with anesthetic blockade.

Conclusions: CT-SPECT fusion combines the virtues of functional and anatomic imaging, aiding the clinician in diagnosing painful facet arthropathy. In addition, the excellent anatomic detail allows for precisely targeted treatment of the offending joint, particularly in patients with abnormal lumbar segmentation.

339. Does Minimally Invasive Technique Limit The Ability to Prepare a Disc Space for Interbody Fusion?

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Introduction: The main determinant for obtaining arthrodesis with interbody fusion is adequate disc removal and endplate preparation. Controversy still exists as to whether this can be performed utilizing minimally invasive surgical (MIS) techniques. Herein, we compare discectomies obtained utlizing two different approaches (Open and MIS) to the lumbar spine in a human cadaveric model.

Methods: Standard Open and MIS Transforaminal Lumbar Interbody Fusions (TLIF) were performed in alternating segments of twelve lumbar disc spaces in four fresh human cadavers from L3-4 to L5-S1 (6 MIS, 6 open). Identical TLIF technique and instruments were utilized regardless of the approach taken. In each case, a unilateral facetectomy was followed by a radical discectomy; the only exception was that in the MIS levels, a fixed 22mm portal was used. Following discetomy in situ, the spines were removed from the body. The segments were then cut through the disc space and analyzed grossly and histologically by pathologists blinded to the approach, to quantify the extent of disc removal and bony end plate exposure.

Results: No clinically significant advantage was noted with either open or minimally invasive approaches. In both cases, the contralateral dorsal corner was the most consistently difficult region to reach. Quantative analysis showed that an adequate discectomy and disc space preparation could be obtained with both techniques.

Conclusions: For single level interbody fusion, with respect to disc space preparation for fusion, an open approach offers no significant advantage compared with an identical MIS technique. With either technique, an adequate disc space preparation can be obtained.

340. Treatment of Cervical Degenerative Disease: A Comparison of Arthrodesis Versus Laminoplasty

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Introduction: Cervical myelopathy due to spondylosis, disc herniation and OPLL may be treated by anterior cervical decompression and fusion (ACDF), cervical laminoplasty and laminectomy with fusion. We selected the operative approach according to a number of affected cervical levels. If the patient had lesions more than two without kyphosis and instability, we chose the laminoplasty. For one or two levels lesion, we selected the ACDF. A retrospective review of ACDF and laminoplasty patients was performed to compare preoperative/postoperative neurological scores and outcomes.

Methods: One hundred sixty-three patients with cervical degenerative disease were followed. Eighty-two patients underwent ACDF with cylindrical cage and 81 patients underwent mid-sagittal splitting laminoplasty. Patients were aged 20-79, (mean age 56 Cage fusion, 63 laminoplasty). Pre and postoperative neurological status were assessed using the Neurosurgical Cervical Spine Scale (NCSS, full score 14 points).

Results: Mean follow-up was 15 months for the ACDF group and 55 months for the laminoplasty group. NCSS score of ACDF were pre-op 10.0 and post-op 12.8. NCSS score of laminoplasty were 7.7 and 10.4. Recovery rates were 74.3% and 45.0% and recovery points were 2.8 and 2.7. Complications included 4 in Cage fusion (Transient motor weakness, CSF leakage and 2 Donor site problem) and 5 in laminoplasty (3 Transient C5 palsy, 2 intractable neck pain). There were no instrument failure and no required reoperation case.

Conclusions: Both procedures allowed for improvement in NCSS scores. Complications were comparable. Overall, ACDF using cage and laminoplasty provide similar results for the treatment of cervical disorders.

341. 360 Degrees Minimal Invasive Axial Percutaneous L5-S1 Fusion (Axialif). 2 Years Clinical and Radiological Follow-Up

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Introduction: The common approaches of the lumbosacral spine require muscular and ligament dissection, retraction of the neural and vascular structures when involve direct visualization to either the anterior or the posterior elements. A new minimally invasive presacral approach allowing longitudinal vertical spinal access for disc and vertebral body treatment was developed. The technique preserves the integrity of muscles, ligaments and annulus of the disc and provides biomechanical and physiological advantages. The purpose of this prospective study was to determine feasibility, safety and outcomes of the percutaneous axial interbody fusion.

Methods: 27 patients with radiculopathy resulting from non-sequestered simple disc herniation localized to the L5-S1, low back pain due to pseudoarthrosis, spondylo grade I and II. The surgery was performed using the AxiaLIF technique consisted of radial discectomy, disk packing with osteogenic material and stabilization by insertion of an axial interbody fusion rod. This construct was supplemented with posterior fixation. Radiographic and clinical outcomes were collected preoperatively, at 8 weeks, 3, 6, 9, 12,18 and 24 months postoperatively. ODI, VAS, Prolo and Sf-36 were used. All adverse outcomes related to the index procedure were noted.

Results: No intra-operative complications. Blood loss was less them 50 cc. Mean surgical time 122 minutes. All patients recovered uneventfully. Patients were discharged in the next 2 days.VAS, SF-36, ODI and Prolo scores improved. 86% rate of fusion after 1 year.

Conclusions: The current study demonstrates that AxiaLIF was feasible, there are numerous potential applications for this new approach and may be a new therapeutic option for minimally invasive spinal surgeons.

342. Safety and Feasibility of Percutaneous Lumbar Spine Pedicle Screw Fixation as an Outpatient Procedure

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Introduction: The standard technique for pedicle screw fixation usually involves extensive dissection for exposure of the spine. Percutaneous pedicle screw fixation (Sextant, Medtronic, Memphis, TN) is minimally invasive producing less tissue damage and blood loss. Overall recovery, therefore, is expected to be quicker.

Methods: A prospective analysis of 119 consecutive patients who underwent, on an outpatient basis, percutaneous lumbar pedicle screw fixation.

Results: 52.9 percent (63/119) of patients were smokers. 43.7 percent (52/119) were Workers Compensation cases and 22.7 percent (27/119) were No Fault cases. Preoperative symptoms were low back and leg pain in 71.4 percent (85/119), low back pain only in 28.6 percent (34/119). 90.8 percent (108/119) procedures were staged following an anterior lumbar interbody fusion after an average of 12 days from initial procedure. 9.2 percent (11/119) had previous standalone posterior lumbar interbody fusion with psuedoarthtrosis. 61.3 percent (73/119) were one level fixations, 38.7 percent (46/119) were two level fixations. The average blood loss was 15.9cc (10-300cc). The average operating time was 40.4 minutes (25-200 minutes). 94.1 percent (112/119) were discharged to home the same day of the procedure. 6 percent (7/119) were admitted and discharged within 1-4 days. There were two postoperative wound infections, and one patient required revision of a previously placed pedicle screw.

Conclusions: Blood loss, operative time, and complications for percutaneous pedicle screw placement in this study were the same or better than that reported in the literature for the standard open procedure. Nearly all patients were safely discharged the day of the procedure. Percutaneous pedicle screw placement on an outpatient basis is safe and effective.

343. MR and CT Characteristics of Materials Used for Artificial Cervical Disc Replacements

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Introduction: This study compares the MR and CT characteristics of five different materials commonly used for cervical artificial disc replacements.

Methods: We obtained MR and CT scans of 2 cadaveric spines with 5 different cylindrical implants approximating artificial cervical discs. We randomly placed the following: polyethylene (PE), titanium ceramic composite, (TiC), titanium alloy (Ti 6Al 4V), cobalt chrome (Co Cr), and 316 stainless steel (SS). These were analyzed by a radiologist and a spine surgeon independently and blindly. Each implant was graded for the amount of artifact, sharpness of the edge, ability to read the rest of the disc space, and the ability to read the adjacent disc space, and based on these, ranked from best to worst.

Results: For both CT and MR scans, the order was identical, and from best to worst was: PE, TiC, Ti 6Al 4V, CoCr, then SS. With CT, even the worst metal (SS) had minimal effect on readability. In contrast, the implants had a more profound effect on the MR scans. While PE had minimal to no effect, even the best metals, TiC, and Ti 6Al 4V imparted some artifact. SS made it impossible to see anything even at the adjacent disc space.

Conclusions: Our results indicate that PE imparts little to no artifact on MR or CT scans. In contrast to CT scans, MRs were profoundly affected. TiC and Ti 6Al 4V were judged to be nearly equal and the most readable and SS was felt to be the worst.

344. Fusion Rates in the Cervical Spine

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Introduction: Spine surgeons utilize anterior cervical discectomy (ACD), ACD with fusion (ADCF), ACDF with anterior plating (ACDFp), corpectomy (CORP), and corpectomy with plating (CORPp) to fuse the cervical spine. Surgeons should understand their respective fusion rates to discuss treatment options for cervical spondylosis.

Methods: Of 49 papers published since 1990 on anterior cervical fusion, 21 provided data on at least 25 patients, follow-up for more than 12 months, radiographic evidence of fusion, and delineation by number of levels fused. Chi-squared and Fisher exact tests were used for group and pairwise comparisons.

Results: Mean age was 46.7 years, 46.6% were female, and mean follow-up was 39.6 months. 2682 patients were included with an overall fusion rate of 89.5%. For single-disc level, fusion rates were 84.9 (ACD), 92.1 (ACDF) and 97.1% (ACDFp) (p0.002). For two-disc level disease, fusion rates for ACDF, ACDFp, CORP, and CORPp were 79.9 (ACDF), 94.6 (ACDFp), 95.9 (CORP), and 92.9% (CORPp) (p0.0001). For three-disc level disease, fusion rates were 65.0 (ACDF), 82.5 (ACDFp), 89.8 (CORP), and 96.2% (CORPp) (p0.0001). Utilizing anterior plates significantly improved fusion for 1-level (p0.0001), 2-level (p0.0001), and 3-level (p0.05) ACDF. There was no significant difference in fusion rates for 2-level ACDF and CORPp. By one-tailed Fisher exact testing, CORPp had a significantly higher fusion rate than ACDFp for 3-level disease (p0.03).

Conclusions: Anterior approaches to cervical disc disease and spondylosis can achieve high fusion rates. Utilization of an anterior plating system significantly improves fusion rates. For two-level disease, ACDF and corpectomy are comparable procedures in achieving postoperative fusion.

345. Vertebral Artery Injury Diagnosed with Computed Tomographic Angiography in Patients Harboring Blunt Cervical Spine Trauma

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Introduction: Vertebral artery injury is a well-documented complication of blunt cervical spine trauma. Its clinically silent and often delayed presentation may lead to under-diagnosis of this severe clinical entity. In our current communication, we report on our experience with the use of computed tomographic angiography (CTA) in the early evaluation of vertebral artery affection in patients sustaining blunt cervical spine trauma.

Methods: This is a prospective clinical study including 27 consecutive patients (18 male, 9 female) who presented to our institution with a diagnosis of blunt cervical injury and associated subluxation or fracture of the posterior cervical elements. The mean age of the patients was 39.2 years (range 17-85). Imaging studies including C-spine x-rays, computed tomography (CT) and CTA were performed in all patients.

Results: Traumatic vertebral artery occlusion was evident on CTA in 2/27 patients (7.4%). In one case, both vertebral arteries were affected in a patient with complete C2-C3 dislocation. The other patient sustained occlusion of the proximal right vertebral artery associated with locked facets at the level of C5-C6.

Conclusions: Injury of the vertebral artery secondary to blunt cervical spine trauma can be safely and accurately detected by CTA. Large multi-institutional prospective clinical trials should be conducted in order to evaluate the role and cost to risk ratio of CTA as a screening modality in patients harboring blunt cervical spine injury.

346. Use of Continous Intraoperative Electromyographic Potential Nerve Root Monitoring During Decompression of Patients with Symptomatic Lumbar Radiculopathy

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Introduction: This study examines the utility of continous intraoperative monitoring of EMG nerve root potentials during decompression of lumbar radiculopathy using a proprietary neurophysiological EMG monitoring system.

Methods: Of the 43 patients, 8 had spondylolisthesis, 13 had classical lumbar central and recess stenosis with minimal disc herniation, 6 had purely recess or foraminal stenosis without herniation, and 16 had recess/foraminal stenosis with significant disc herniation. Neurological strength examination; EMG amplitudes, VAS scores for radiculopathy were recorded (pre and post op).

Results: Only 39 of the 43 patients demonstrated measurable asymmetric EMG amplitudes. 30 patients had clinical strength improvements. Intraoperative EMG improvements were seen in 21 of these 30 patients. Of the 9 patients who did not improve in strength after decompression, 8 demonstrated worsening on EMG. In the early recovery group, EMG was 88% sensitive as compared to 50% sensitive for late improvements in strength after 3 months postop. Overall, EMG nerve root monitoring had a positive predictive value of 95.5% and a negative predictive value of 47.1% with regards strength improvement. There were 3 cases with worsened transient postop weakness resolved within 3 months. In detecting such motor injury, EMG was 100% sensitive, 97% specific with a positive predictive value of 75% and a negative predictive value of 98%.

Conclusions: Use of intraoperative EMG nerve root surveillance may provide an useful adjunct in determining the adequacy of decompression during surgical treatment of compressive lumbar radiculopathy and may help to predict the degree of motor improvement to be expected after surgery.

347. Potential for Radiation Dose Reduction by Performing Percutaneous Kyphoplasty Under Intraoperative Fluoro-based CT Guidance

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Introduction: Fluoroscopic guidance has contributed to the safety of various spine surgery procedures, at the same time the concern is raised on increased radiation exposure. Percutaneous kyphoplasty is usually performed under biplanar fluoroscopic image guidance. The purpose of this study was to compare radiation time when using isocentric (Iso-C) fluoroscopy-based navigation vs. biplanar fluoroscopy for the pedicle cannulation during kyphoplasty procedure.

Methods: A prospective clinical study was performed. Total operative time and intraoperative fluoroscopy time in the Iso-C fluoroscopy patients group was compared to a historical cohort of patients that underwent the procedure under biplanar fluoroscopy guidance. There were 35 patients in the Iso-C fluoroscopy assisted group and 12 patients in the retrospectively analyzed biplanar fluoroscopy assisted patients group.

Results: The mean duration of the surgery was shorter in the isocentric fluoroscopy guidance patients group compared with the biplanar fluoroscopy-assisted procedures, 58.6 min (range 36 - 89 min) versus 69.2 min (range 44 - 113 min) for single-level cases, respectively. This difference was not statistically significant (P - 0.3). The mean fluoroscopy exposure time was 57.4 sec (range, 20 - 83 sec) for the isocentric fluoroscopy assisted cases with additional 40 seconds fluoroscopy time utilized for the 3-D fluoroscopy "spin", compared to 266.6 sec (range, 144 - 400 sec) for the biplanar fluoroscopy assisted cases. The difference was statistically significant (P - 0.0001).

Conclusions: The use of intraoperative fluoro-based CT guidance for the pedicle cannulation during percutaneous kyphoplasty potentially increases safety and significantly reduces radiation exposure for the patient and surgical staff.

348. Comparison of Motion at Treated and Untreated Adjacent Segments After Single to Three-Level Disc Replacement Versus Fusion in the Cervical Spine

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Introduction: Large-scale clinical trials have shown the ability of lumbar disc replacement (DR) to restoring and maintain range of motion (ROM). However, detailed comparison of ROM across disc replacements (individual segments in multi-level arthroplasty) and untreated adjacent levels, versus fusion, has not been reported.

Methods: This is a prospective randomized controlled study comparing single-level cervical DR to ACDF. Two and three-level DR were performed in eligible patients after receiving special permission from the FDA. Preoperative and postoperative radiographic ROM measurements were performed across treated and adjacent untreated levels, and compared between single and multi-level DR, and ACDF.

Results: 41 patients were included in the study, consisting of 26 DR and 15 ACDF patients. There were 18 1-level DRs and 15 1-level ACDFs. Follow-up ranged from 1 to 2 (mean 1.5) years. There were also 6 3-level and 2 2-level DRs. DR increased segmental motion. In multi-level DR, at each individual DR segment, the ROM was maintained and approximated that of physiologic ROM (as measured at unaffected segments). Adjacent segment motion above a fusion was increased significantly compared to DR. Adjacent segment motion below the treated level was also significantly different between fusion and DR.

Conclusions: Cervical DR not only retains mobility, but is able to do so while imparting normal physiologic ROM, both at the treated and untreated segments; versus ACDF which imparts hypermobility to adjacent segments. Moreover, multi-level cervical DR is able to maintain physiologic range of motion at each of the treated segments.

349. Stand-alone PLIF with Ray TFC in 103 Cases: Perioperative Complications and 5-Year Follow-up

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Introduction: Cylindrical titanium cages have been extensively used as a device in posterior lumbar interbody fusion (PLIF). However, many complication cases were reported when using cages without supplemental posterior fixation. I report perioperative complications and 5-year follow-up outcome in those who underwent PLIF in which a Ray TFC was implanted.

Methods: A total of 125 patients underwent PLIF with Ray TFC without supplemental fixation (stand-alone PLIF) between September 1997 and July 2000. Seven died of other diseases, seven were under medical treatment for other disease, six were lost and two needed additional PLIF with pedicle screws for migration of cages before five years have passed. A total of 103 patients remained in a stand-alone PLIF group at 5-year follow-up. These patients included 59 males and 44 females with mean age of 52.8 yrs (17-81 yrs). Fifty-two patients were implanted at 1-level, 44 at 2-level, and 7 at 3-level. Pre- and post-operative functions were evaluated by the Japanese Orthopedic Association (JOA) score. Normal score is 29 points.

Results: Perioperative complications occurred in 10 cases (8%). However, device-related complications needed additional operation or suffered from permanent symptom occurred only in 3 cases (2.4%). The JOA Score improved from 9.7 before operation to 28.3 points at 5-year follow-up.

Conclusions: A larger cage should be used to avoid retropulsion and migration of cages. Exact after treatment with a hard corset is required for 3 to 6 months after surgery. Under these conditions, stand-alone PLIF will achieve good outcome for degenerative lumbar spine disease.

350. Prevalence of Obesity in Elective Thoracolumbar Fusions and Relation to Complication Incidence

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Introduction: Many patients undergoing elective thoracolumbar procedures are obese, although prevalence within this community is unclear. Contribution of obesity to complications in spine surgery is unclear. We assessed the prevalence of obesity in a thoracolumbar fusion cohort and correlate degree of obesity with operative complications.

Methods: A retrospective review of all patients treated by the senior author was completed. 332 elective thoracolumbar cases, exempting cases of trauma and tumor, were found. Restricting our assessment to fusion cases, 97 cases were found; 91 had adequate follow-up. Body mass index was calculated for all patients, following the equation BMI= weight in kilograms / (height in meters) squared.

Results: Average BMI for the cohort was 29.3. Seventy two percent of patients were overweight or obese, with 41% of patients having a BMI greater than 30, and 9% greater than 40. Overall complication rate was 44 complications in 32 patients, yielding a rate of 35%. We found 19 significant complications in 17 patients (18.7%). A standard cohort of complications occurred: wound infection (n=3), CSF leak (n=8, 1 requiring reoperation), DVT (2), cardiac (4), symptomatic pseudoarthrosis (1), pneumonia (3), prolonged intubation (2), urologic issues (10), positioning palsy (2), neuropathic pain (2), and other (7). Concentrating on significant complications, we found correlation between weight and complication incidence. Positioning palsies only occurred in the extremely obese.

Conclusions: Obesity is prevalent in elective fusion cases. Extreme obesity may increase perioperative complications. Specific care should be taken to limit risk of perioperative positioning palsies in obese patients.

351. An Economic Analysis of Lumbar Total Disc Replacement vs. Fusion

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Introduction: New treatments, particularly those that include the use of new implants, may lead to increased costs to both hospitals and payers. The potential costs associated with lumbar total disc replacement (TDR) were examined and compared to fusion.

Methods: An economic model examining hospital and payer cost perspectives was developed to compare costs of TDR to three spinal fusion procedures: ALIF with ICBG; ALIF with BMP and cages, and instrumented IPLIF with ICBG. Parameter estimates for the model were collected from the IDE trial of the Charité Artificial Disc, peer-reviewed literature, clinical expert opinion, and a multi-year medical claims analysis.

Results: The estimated cost for the index hospitalization for each procedure is $15,368 for TDR, $17,407 for ALIF with ICBG, $21,498 for ALIF with BMP, and $21,495 for IPLIF. The key cost drivers for each of the procedures were medical supplies and hospital facility costs. Over a two-year time horizon the cost to a payer for each procedure is estimated at $25,329 for TDR, $24,225 for ALIF with ICBG, $29,508 for ALIF with BMP, and $32,226 for IPLIF. The key cost driver across all procedures from the payer perspective is the cost for the index hospitalization. Success rate for each procedure and costs of revision (when necessary) were also a contributors to overall cost.

Conclusions: The model demonstrates that the overall economic effect of TDR procedures on hospitals and payers is likely to be equivalent or less than lumbar fusion procedures.

352. Anterior Lumbar Interbody Fusion followed by Percutaneous Pedicle Screw Fixation for the Revision Surgery in the Lumbar Spine

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Introduction: In the past decade, anterior lumbar interbody fusion (ALIF) was a common procedure for various pathologic conditions including trauma, deformity correction, infection, degenerative disc disease, and revision of the previous back surgeries. The aim of this study was to determine the efficacy of ALIF augmented by percutaneous pedicle screw fixation (PPF) for revision surgery in the lumbar spine.

Methods: Radiographs and medical records for 32 patients who underwent ALIF with PPF were reviewed retrospectively. The preoperative diagnosis was instability (n=11), DDD (n=9), recurrent disc herniation (n=7), and pseudarthrosis (n=5). The patients were 13 men and 19 women with a mean age of 59 years (range; 29 ~ 78), the mean follow-up was 25 months (range; 13 ~ 46). An average of 1.5 previous procedures were performed. The postoperative changes of back and leg pain were graded by the visual analog scale (VAS), and the functional outcome was measured by Oswestry Disability Index (ODI).

Results: The mean VAS for back and leg pain were decreased from 8.2 and 7.9 to 3.5 and 3.1, respectively ($P < 0.01$). The mean ODI was improved from 83% to 28%. Solid fusion was achieved for 31 of 32 patients. Complications included one case of small iliac vein tear, repaired with intraoperative suturing, and one case of painful pedicle screw instrumentation requiring removal.

Conclusions: Based on these results, the ALIF with PPF is an effective surgical option in the revision of the lumbar spine in selected cases. A prospective controlled study is required to confirm these results.

353. Feasibility Study of Percutaneous Axial Lumbar Fusion: Interim Results

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Introduction: A clinical pilot study was conducted to presacral percutaneous access to the anterior sacrum with insertion of an axially oriented stabilization construct for immobilization and fusion of the lumbosacral spine.

Methods: 18 patients needing L5-S1 fusion resulting from degenerative disc disease were examined and evaluated with radiographic tools, VAS, SF-36 and Oswetry scores preoperatively. Fixation of the lumbosacral junction was performed through a 14 mm access cannula using an axial presacral approach. Treatment of the patients was facilitated by means of insertion of an axial interbody fusion construct for stabilization of the lumbosacral junction coupled with osteogenic material and posterior pedicle screw instrumentation.

Results: There was minimal postoperative pain. There were no cases of bowel, vascular or nerve damage. One postoperative complication was noted (Septicemia 2-weeks postoperative due to an infection of the bone graft harvest site. Patient has since recovered). Improvements were observed in VAS, Oswestry and SF-36 values. Radiographic analysis concluded there is no evidence of implant backout, loosening or damage, bone resorption, fractures, or sacral abnormalities. To date the patients clinical progress is acceptable and no additional intervention has been required. Four patients have passed the 12-month data point. CT demonstration of fusion at 12 months has been observed.

Conclusions: The clinical data to date indicate that the subjects being treated with the study device and procedure have on average improved since their pre-treatment condition and that the fusion implant can be safely delivered utilizing the presacral access technique.

354. Incidence of the Piriformis Syndrome in Patients with Sacroiliac Dysfunction

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Introduction: Sacroiliac dysfunction accounts for about 15% of low back pain patients. The pain is usually posterior, in the area of the sacroiliac joint. A subset of patients also presents with sciatica-like pain which, to date, has remained unexplained. The piriformis syndrome can be diagnosed electrophysiologically by measuring the H-reflex delay when the leg is placed in a flexed-adducted-internally rotated position.

Methods: A series of patients with sacroiliac dysfunction diagnosed by a fluoroscopically controlled sacroiliac block were also assessed for piriformis syndrome using the H-reflex delay method.

Results: The presence of piriformis syndrome was noted in about one third of patients diagnosed with sacroiliac dysfunction (detailed numbers to be presented).

Conclusions: The piriformis syndrome is frequenltly associated with sacroiliac dysfunction, explaining the presence of sciatica like symptoms in a subset of patients.

355. Comparison of Microsurgical Versus Minimally invasive Approaches in Bilateral Decompression of Lumbar Spinal Stenosis

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Introduction: Minimally invasive procedures for decompression of spondylitic spinal stenosis have been advocated in order to minimize surgical complications, and improve outcome. This study compares the results of the Open Microsurgical approach (OMS) for bilateral laminotomies and partial facetectomies with that of Minimally Invasive Surgery (MIS). We hypothesized that since MIS requires less surgical manipulation and retraction of the soft tissues, as well as better preservation of the spinous ligaments, it should carry less surgical risk than OMS. Patient functional outcome and satisfaction should be higher with MIS than OMS.

Methods: A retrospective chart review of 100 surgical cases performed by a single surgeon was undertaken. 50 consecutive cases utilizing the OMS approach were compared to 50 consecutive MIS. Both types of procedures were performed through a unilateral inicion. We compared immediate, 3- month, and greater than 1 year outcomes.

Results: Surgical complications and postoperative complications rates were decreased in the MIS as compared to the OMS group. Immediate, short-term (3 month) and long-term (greater than 1 year) outcomes of functional capacity and patient satisfaction were also better in the MIS than in the OMS group. Delayed spinal instability was not encountered during the study period.

Conclusions: This study answers our hypothesis affirmatively. Decreasing surgical trauma and limiting decompression to the regions essential for nerve decompression decrease the incidence of immediate and delayed complications. Postoperative recovery is faster and functional capacity improved. While MIS is technically more complex than OMS, there is significantly added benefit to the patient, well worth the effort.

356. Cadaveric Morphometric Study of S2 Alar Screws

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Introduction: Robust posterior fixation to the sacrum can be a challenging task. In the presence of osteoporotic bone, long segment fusions, and high-grade spondylolistheses, standard S1 pedicle screws may be predisposed to failure. However, the routine application of iliac fixation carries excessive morbidity. S2 alar screws give the spinal surgeon an intermediate option for supplementing sacral fixation without the need to fuse across the sacroiliac joint.

Methods: This cadaveric study was undertaken using 80 adult non-diseased human sacral specimens. Cadaveric linear measurements were performed directly on the specimens using electronic calipers to ascertain morphometric data most useful for optimal screw placement starting superior to the S2 foramen and directed superiorly and laterally towards the sacroiliac joint.

Results: The mean sagittal distance between the S1 and S2 foramina was 14.7 $\pm$ 2.7 mm; the mean sagittal distance between the sacral ala and the S2 foramina was 28.8 $\pm$ 4.4 mm. The average lateral offset between the midline and the medial S2 pedicle wall was 14.2 $\pm$ 1.4 mm. The shortest bicortical screw trajectory (parallel to the S2 pedicle) was 25.2 $\pm$ 2.5 mm, while the longest and idealized screw trajectory was 43.3 $\pm$ 3.9 mm.

Conclusions: The placement of S2 screws is highly dependent on intraoperative landmarks, with intraoperative radiographs being of limited use. Furthermore, determining screw trajectories and lengths based on preoperative imaging can be difficult on two-dimensional images. This data may assist surgeons in the safe placement of alar screws with the maximal bony purchase.

357. Radiographic Outcome Following Anterior Alone Stabilization for Thoracolumbar Burst Fractures

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Introduction: The surgical management of thoracolumbar burst fractures may be via an anterior, posterior, or a combined approach. The fear of doing an anterior alone stabilization is continued progression of deformity with the possibility of chronic pain and/or neurologic deficit.

Methods: We reviewed our last 11 cases of anterior alone stabilization of thoracolumbar burst fractures to determine the stability of the construct over time. A minimum follow-up of 6 months was required. The preoperative, postoperative, and latest follow-up radiographs were reviewed for sagittal alignment (one level above and below), fusion status, and hardware failure. The patients neurologic status, comorbidities, and smoking status were also recorded.

Results: All patients underwent anterior alone decompression and stabilization of L1, L2 or T12 burst fractures with allograft femur and anterolateral plate stabilization. Seven were at L1, three at L2, and one at T12, all but two were neurologically intact before surgery. The average preop sag angle was 18° (sd 7.1, range 9-30°). Postoperatively the sag angle averaged 14° (sd 4.1, range 5-19) and 14° (sd 4.9, range 6-22°) at latest follow-up. All patients demonstrated evidence of fusion. Ten were neurologically intact, with one demonstrating neurologic improvement.

Conclusions: Anterior alone decompression and stabilization is an established treatment for unstable thoracolumbar burst fractures. Some fear progression of deformity without a concominant dorsal fixation, especially in the face of posterior column injury. Our data indicate, that an anterior alone strategy is effective at correcting kyphois and more importantly maintaining the correction in long term follow-up.

358. Pain outcome and vertebral body height restoration in patients undergoing kyphoplasty.

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Introduction: Osteoporotic vertebral compression fractures (VCFs) are a significant cause of disability for the elderly. In the last few years, kyphoplasty, a minimally invasive technique, has been developed in order to provide immediate pain relief and return patients to premorbid level of activity.

Methods: We retrospectively reviewed 24 patients (16 female, 8 male) treated with balloon kyphoplasty for osteoporotic VCFs. The average age of the patients was 72.6 years (range 48-87 years). A total of 37 vertebral levels (25 thoracic and 12 lumbar) were intervened upon. Kyphoplasty was performed in all cases within 9 weeks from the onset of pain. VAS scores were documented in the immediate pre- and post-operative period, as well as 4, 12, and 72 weeks after the procedure. Vertebral body height restoration was assessed on post-operative x-rays.

Results: Mean pre-operative VAS score was 9.3 and improved to 5.4 in the immediate post-operative period. At 4, 12 and 72 week post-operative, mean VAS scores were 5.1, 5.9, and 6.1 respectively. All patients were discharged from the hospital within 24 hours and were able to return to their daily activities. However, no significant restoration of vertebral body height was observed. No severe complications were associated with the procedure.

Conclusions: Kyphoplasty is a safe and effective treatment modality for osteoporotic VCFs when undertaken early after the onset of pain, even when no significant restoration of vertebral body height is achieved.

359. Prevertebral Soft Tissue Thickness Safety Guidelines for Discharge After Anterior Cervical Discectomy

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Introduction: Shorter postoperative hospitalization for anterior cervical discectomy (ACD) requires the early identification of postoperative complications for safe discharge.

Methods: In this retrospective chart and X-ray review, the postoperative day 1 (POD 1) prevertebral soft tissue thickness (PVSTT) anterior to the third cervical vertebral body (C-3) on lateral cervical spine X-ray was scrutinized to find signs of increased retropharyngeal edema and airway stenosis in ACD patients being prepared for discharge on POD 1 or POD 2. Comparisons of POD 1 PVSTT between patients discharged on the planned discharge day and those with prolonged hospitalizations were made.

Results: Six of the ninety ACD patients reviewed had signs of increased PVSTT and airway anterior-posterior diameter less than 5 millimeters. Four of these six patients had symptomatic retropharyngeal edema requiring prolonged hospitalization. On average, these six patients had a 1.1 day longer length of stay (p less than .001). Six other ACD patients had increased length of stay for various reasons. The mean POD 1 PVSTT among all ACD patients with increased length of stay was 11.0 millimeters while the mean for patients with normal discharge date was 8.1 millimeters (p equals .027).

Conclusions: ACD patients with POD 1 PVSTT anterior to C-3 greater than 10 millimeters on lateral cervical spine X-ray should be assessed for symptomatic airway stenosis prior to discharge. ACD patients with prolonged postoperative hospitalization have increased PVSTT anterior to C-3 on POD 1 lateral cervical spine X-rays.

360. Instrumented Posterior Lumbar Interbody Fusion with Mineralized Collagen Matrix and Bone Marrow Aspirate as a Bone Graft Substitute

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Introduction: The use of iliac crest bone graft for lumbar interbody fusion can lead to significant postoperative donor site pain and morbidity. A commercially available Type I bovine collagen fibrous matrix is combined with bone marrow aspirate to create an osteogenic and osteoconductive bone graft substitute.

Methods: A retrospective review was performed of 86 consecutive patients having had one- or two-level lumbar fusion. Three were lost to follow-up leaving 83 for review. There were 38 smokers, 11 diabetics, and 64 patients admitting to regular alcohol use. Forty-three (43) were working prior to surgery, and 14 were on worker's compensation. All patients had PLIF with transpedicular fixation. No iliac crest bone graft was used, but local bone and PRP were added in some cases. No graft was placed in the lateral gutters. There were 68 one-level and 15 two-level fusions. Clinical outcome was measured with a Visual Analog Scale. Plain 4-view lumbar radiographs and CT scans (in 72 patients) were performed and evaluated using a modified Lenke scale.

Results: Mean follow-up was 12 months with a range of 10-21 months. Pain decreased 72.7% at latest follow-up compared to baseline. Postoperatively, 54 patients were working and 4 were on worker's compensation. Radiographically, 76 (91.6%) patients were rated as "definitely solid" and 6 (7.2%) were rated as "possibly solid" There were no graft-related complications.

Conclusions: The combination of mineralized collagen and bone marrow aspirate may be a viable bone graft substitute in an interbody fusion model. Further follow-up to 2 years is warranted.

361. Three-Dimensional Fluoro-Based CT Guidance for Complex Spinal Surgery

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Introduction: The purpose of this study was to prospectively evaluate the clinical utility and accuracy of intraoperative 3-D fluoro-based CT as an adjunct for the placement of a complex spinal instrumentation.

Methods: The Iso-C 3-D fluoroscopy unit (Siemens, Malvern, PA) and the Stealth Treon computer volumetric navigational system were used. A total of 322 spinal instrumentation screws or transpedicular cannulations were performed in 82 patients. Accuracy, operative time and the amount of fluoroscopy utilization time were assessed for TLIF and kyphoplasty cases.

Results: Only 4 percutaneous transpedicular lumbar screws out of 265 total (1.5 %) were malpositioned. Average operative time for TLIF cases was 185 minutes (range, 114 to 311 minutes) for one-level and 292.6 minutes (range, 173 to 390 minutes) for two-level procedures. Biplanar fluoroscopy utilization time was 93 seconds (range, 27 to 280 seconds) for one-level procedures and 216 seconds (range, 80 to 388 seconds) for two-level procedures. Average surgery duration for kyphoplasty was 58.6 minutes (range, 36 to 89 minutes) for one-level procedures and 68.5 minutes (range, 65 to 75 minutes) for two-level cases. Biplanar fluoroscopy utilization time was 57.4 seconds per case (range, 20 to 83 seconds).

Conclusions: Use of intraoperative 3-D fluoroscopy for image guidance in minimally invasive complex spinal instrumentation procedures is feasible and safe. This technique provides excellent visualization of three-dimensional relationships. This potentially results in improved accuracy of screw positioning and the ability to detect misplaced screws prior to wound closure. This technique also potentially results in a significant reduction in radiation exposure for patients and staff.

362. Predictive Factors for Subsequent Vertebral Fracture After Percutaneous Vertebroplasty

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Introduction: The purpose of this study was to evaluate the predictive factors for subsequent vertebral fracture after percutaneous vertebroplasty (PVP) at the neighboring levels (adjacent vs. non-adjacent levels).

Methods: The medical records of 508 consecutive patients treated with PVP, between Jan 2000 and Dec 2002, were retrospectively reviewed. A total of 43 patients with 49 painful subsequent vertebral fractures after PVP were identified on the basis of clinical and radiological findings. New vertebral fractures, occurring at any of the 3 consecutive vertebral bodies from the previously treated level, were included in the study. Study groups were divided into 3 groups; adjacent fracture group, non-adjacent fracture group and control group composed of 50 randomly selected patients with no evidence of a new fracture. The clinical factors, radiological factors and intervention-related factors were statistically analyzed.

Results: Of the 49 new vertebral fractures, 35 (71.4%) were developed at the adjacent level. The mean time to subsequent fracture was 7.9 months. For the adjacent fracture, intradiscal cement leakage ($P < 0.01$) and low body mass index ($P < 0.05$) were the significant predictive factors. In contrast, segmental mobility (difference in range of motion) was related to the non-adjacent fracture ($P < 0.05$).

Conclusions: According to our results, the mechanisms of subsequent fracture at adjacent and non-adjacent vertebrae are quite different. A direct pillar effect (difference in strength caused by cement augmentation) may provoke the adjacent fracture, whereas a dynamic hammer effect (difference in segmental mobility) may be related to the non-adjacent fracture.

363. Percutaneous Ventral Decompression for Degenerative Lumbar Spondylolisthesis in Medically Compromised Geriatric Patients

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Introduction: The purpose of this study is to present the surgical technique of percutaneous ventral decompression for degenerative lumbar spondylolisthesis (DLS) and the clinical outcomes in medically compromised geriatric patients.

Methods: Between November 2001 and February 2004, 11 consecutive patients underwent percutaneous ventral decompression without violation of the posterior bony structure was performed under local anesthesia. We decompressed the ventral portion of thecal sac through posterolateral approach using endoscopic tools. All patients had significant limitation in ambulatory ability because of buttock pain, leg, and back pain.

Results: The mean follow-up period was 25.1 (range, 11-38) months. There were 11 patients suffered from diabetes (n=4), cardiac disease (n=5) cerebrovascular accident (n=2) or malignancy (n=2). Among them two patients had both diseases simultaneously, and the levels of two malignancies were same on the treated levels. The affected levels were L3-4 in two, and L4-5 in nine patients. The mean age of the patients was 67±9.1 (range, 51 to 85) years. The mean operation time was 72±16.9 (range, 50 to 100) minutes. The mean score of ODI improved from 72.2% preoperatively to 27.4% at the final follow-up. All patients could walk without any difficulty after surgery. There was one complication that was quadriceps weakness in one patient but it was transient. There were no postoperative complications and no progression of spondylolisthesis during the follow-up period.

Conclusions: Percutaneous ventral decompression is a safe and effective minimally invasive alternative method of treating DLS in medically compromised geriatric patients, especially when general anesthesia is not recommended.

364. Initial Clinical Outcomes of a Minimally Invasive Lumbar Interbody Fusion (MiLIF) Multi-Center Study

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Introduction: Transforaminal lumbar interbody fusion (TLIF) requires extensive exposure and prolonged retraction times resulting in ischemia and denervation of paraspinal musculature. Minimally invasive lumbar interbody fusion (MiLIF) affords the advantages of TLIF while minimizing muscle/soft tissue dissection.

Methods: Patients with degenerative disc disease or spondylolisthesis were enrolled prospectively in a multicenter study. MiLIF was performed through two one-inch paraspinal incisions with placement of structural allograft or synthetic interbody fusion device and local or iliac crest bone graft and pedicle screws. Oswestry Disability Index (ODI), SF-36, Numeric Rating Scale (pain), and Modified Prolo Scale were measured.

Results: Forty-three patients (25 male, 18 female), average age 43 years (22-75) underwent single level MiLIF. Mean blood loss was 187.1 cc, mean operative time was 231 minutes, and mean length of hospitalization was 2.7 days. There were no intraoperative complications or blood transfusions. Mean percent ODI decreased significantly from 45.5 pre-operatively to 35, 27.4, 22.3, and 21 at 6 weeks, 3, 6, and 12 months respectively. Average pain score of 6.0 improved to 4.5 at 2 weeks post-op (p-value less than 0.0009). SF-36 summary scores significantly improved by 6 months. Average return to work was 39.6 days. Based on Modified Prolo Scale, 100 percent had successful return to work/activity at 3 months.

Conclusions: MiLIF is a safe and effective treatment for degenerative disc disease and spondylolisthesis and compares favorably to published retrospective open TLIF case series. Prospective studies directly comparing open versus minimally invasive fusion are required to validate benefits of minimally invasive techniques.

365. One Year Follow-up on the First 40 Patients Using Cortoss for Treating Vertebral Compression Fractures in Vertebroplasty and Kyphoplasty

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Introduction: 40 patients were enrolled in 2 FDA approved pilot IDE studies using Cortoss for the treatment of VCFs using vertebroplasty technique at 3 centers (20 patients) and kyphoplasty technique at 5 centers (20 patients). Treatment was limited to one or 2 levels from T6 to L5.

Methods: 8 males and 12 females (mean age 72) were treated using the Vertebroplasty technique. 26 vertebrae were treated averaging 1.9cc injected per vertebra. 6 males and 14 females (mean age 79) were treated using the Kyphoplasty technique. 25 vertebrae were treated averaging 4.1cc injected per vertebra.

Results: Vertebroplasty patients VAS improved from 74.1 pre-op to 24.1 at 3 months, 28 at 6 months and 32 at 12 months. Similarly, ODI decreased from 52% pre-op to 30% at 3 months and 23% at 12 months. Kyphoplasty patients VAS improved from 78 pre-op to 22 at 3 months and 20 at 6 months. Similarly, ODI decreased from 60% pre-op to 33% at 3 months and 35% at 6 months. Leakages were analyzed on post-op CT scans and found to be similar in both groups. All extravasations were asymptomatic with no cardiac irregularities or pulmonary emboli.

Conclusions: The results obtained in these 2 pilot IDE studies are consistent with those of the European prospective study which indicate that Cortoss is safe and effective in the treatment of osteoporotic VCF. These studies suggest a smaller volume of Cortoss appears to successfully reinforce the vertebrae and achieve symptomatic relief, as compared to volumes reported in the literature for PMMA.

366. Management of Deep Spine Infections with Vacuum-Assisted Closure; a Retrospective Study of 15 Patients

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Introduction: Deep infections of the spine are a significant cause of morbidity and mortality. Deep tissue infections complicate anywhere from 0.7-11.9% of spinal surgeries. Management of spine infections includes non-surgical management with IV antibiotics, irrigation and debridement with primary closure, drains, inflow/outflow irrigation systems, or open- healing through secondary intention with wound packing and dressing changes. Vacuum assisted closure (VAC) is a new alternative in treating this problem. We present a retrospective review of 15 patients presenting with complex spine infections treated with I&D and placement of VAC dressings.

Methods: We reviewed the charts of 15 patients dating back to 2003 who presented with deep infections of the spine and who were treated with placement of VAC dressings. We reviewed operative notes, discharge summaries, and follow-up visits. We assessed outcome based on review of follow-up visits.

Results: Management of deep wound infections with VAC placement resulted in good wound closure in 13 out of 15 patients. 1 patient has had the VAC removed but has an open wound with healthy granulation tissue and no signs of infection. 1 patient, a Jehovah's Witness, died as a result of intra-op blood loss 2 days following placement of the VAC dressing. 1 patient did experience a bleeding complication related to the continuous negative pressure of the VAC.

Conclusion: We have had consistently good results obtaining wound debridement and closure in patients with complex and deep spine infections. We believe VAC offers a good alternative in the management of these infections.

367. Lumbar Total Disc Replacement from a Direct Lateral Approach

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Introduction: Most lumbar TDR devices require an anterior abdominal approach, which can be technically demanding at L4-5 because of the need for mobilization of the great vessels. Limited anterior access can result in less than ideal device placement and resulting functional limitations or complications. TDR placement from an anterior approach also requires removal of the anterior longitudinal ligament, which can result in hyperextension and possible dislodgement of the device. Lateral placement of a TDR device may allow for easier access to the disc space and preservation of stabilizing ligamentous structures.

Methods: A lateral TDR device (NuVasive, Inc., San Diego, CA) was implanted at an L4-5 level via an XLIF approach through a 2-inch lateral incision using a MaXcess retractor and EMG guidance (NuVasive). The device has a large footprint and is positioned over the bilateral periphery of the ring apophysis, with the axis of motion positioned posteriorly.

Results: Implantation of the lateral TDR device took approximately 50 minutes, with minimal blood loss and no complications. Immediate post-op x-rays showed good placement of the device, and restoration of disc height, foraminal volume, and sagittal balance. The patient was up and walking the same day of surgery and discharged the next day, with complete resolution of symptoms.

Conclusions: A lateral TDR device can be successfully implanted using an XLIF approach. This approach appears to be safer and less disruptive than an anterior placement approach. Preliminary review of motion and symptom relief is positive. A larger patient series with longer-term evaluation is forthcoming.

368. Subjective and Objective Variability in Assessing Lumbar Spinal Stenosis on Magnetic Resonance Imaging

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Introduction: Magnetic resonance image (MRI) is a frequent investigation used in assessing lumbar spinal stenosis. The availability of digital imaging tools may allow for more objective reporting of these investigations.

Methods: Seven spine surgeons were asked to generate a subjective (normal, mild, moderate, severe impression) and objective (canal cross-sectional area) score at L34, L45 and L5S1 for six lumbar spine MRIs. Each score was generated twice by each observer at different sittings. Spearman or Pearson correlation coefficients were determined to compare inter- and intra-observer variability as well as the correlation between the two scores.

Results: The intra-observer correlation coefficient for the subjective score was 0.785 and 0.936 for the objective score. The mean inter-observer correlation for the subjective score was 0.759 and 0.895 for the objective score. The overall correlation between the subjective and objective methods was 0.506. However, this was not uniform at all levels (0.524 at L34, 0.834 at L45 and 0.328 at L5S1). The median subjective scores at these levels were mild, moderate and normal respectively while the mean objective scores were 131.7, 99.4, and 170.5 mm^2.

Conclusions: Objective measurements of canal diameter on MR images of the lumbar spine improved both intra- and inter-observer variability over often used subjective assessments. The correlation between the subjective and objective scores was poor, particularly in the presence of mild disease. This suggests that while canal diameter is considered during radiological assessment of spinal stenosis, other variables greatly influence the spine surgeon's conclusions.

369. Management of Atlantoaxial Degenerative Pannus of the Elderly with Tranoral Odontoidectomy and Posterior C1-C2 Fusion

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Introduction: Degenerative pannus of the eldery (atlantodental synovial cyst degeneration) can occur at the atlantodental articulation to cause myelopathy or cervical pain conditions. In the setting of myelopathy, these lesions often require anterior transoral decompression followed by posterior C1-C2 arthrodesis.

Methods: A retrospective chart review was performed on all patients receiving transoral odontoidectomy and posterior C1-C2 fusion to identify patients treated for (non-rheumatoid) degenerative pannus at the antlantoaxial joint. Patient age, sex, clinical presentation, operation performed, pathology findings, fusion status, clinical outcome, and complications were retrospectively evaluated.

Results: Nine patients (5 male and 4 female; mean age 75.4, range 49-89) with degenerative panni were treated with transoral decompression. Seven of nine patients presented with myelopathy, one presented with cervicalgia, and one presented with dysphagia. All patients were treated with transoral odontoidectomy and resection of pannus followed by a C1-2 posterior fusion procedure. Pathology was sent on all nine patients confirming the diagnosis of non-rheumatoid degenerative synovial cyst. A majority of patients had significant improvement in neurological function following surgery. Of the patients with adequate long-term follow-up, all demonstrated radiographic fusion of the C1-C2 posterior arthrodesis. Complications were limited to two post-operative wound infections with one requiring debridement.

Conclusions: Degenerative atlantoaxial pannus due to synovial cyst formation occurs most commonly in elderly patients and most frequently presents with myelopathy. In the setting of significant anterior spinal cord compression, this condition is best treated with anterior decompression with resection of pannus followed by posterior C1-C2 stabilization. A large percentage of patients with myelopathy will have neurological improvement after surgical intervention.

370. A New Approach for Kyphoplasty and/or Vertebroplasty of Sacral Insufficiency Fractures

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Introduction: Thoracolumbar kyphoplasty and vertebroplasty is a safe, reproducible technique now widely utilized for the treatment of osteoporotic compression fractures and osseous tumors of the spine. Its role for the treatment of sacral lesions and sacral insufficiency fractures is less well defined. The authors describe a novel approach to the treatment of sacral insufficiency fractures.

Methods: Seven patients underwent vertebroplasty and/or kyphoplasty with a new, to our knowledge, previously unreported technique. Sacral insuffiency fractures generally occur through the sacral ala, rather than the S1 pedicle, and can result in subluxation and angulation of the S1 or S2 segment into the pelvic inlet. A standard approach through the S1 pedicle, therefore, fails to fill the majority of the fracture line. The authors took a caudal approach with an entry site at the S3 segment in a medial to lateral trajectory through the fracture line ending at the rostal cortical margin of the sacral wing. Kyphoplasty of the fracture line was performed in some patients. Filling with PMMA then was accomplished from a cephalic to rostral course as the cannula was withdrawn.

Results: The procedures were all considered technically successful without major complication. Early clinical results were promising.

Conclusions: This new technique directly addresses the pathologic fracture line bridging the gap from the sacral foramina to the sacraliliac joint. Our initial clinical results indicate that this is the preferred approach and may offer relief to this population of patients.

371. Asymetric Pedicle Subtraction Osteotomy with Partial Vertebrectomy for Correction of Fixed Combined Coronal and Sagittal Imbalance: A New Twist on an Old Technique

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Introduction: Fixed coronal plane deformity typically requires a 2-stage anterior release and/or vertebral resection and posterior release with instrumented fusion to correct these challenging problems. We present a variation of the pedicle subtraction osteotomy procedure (PSO) as a one-stage posterior procedure for the treatment of fixed coronal and sagittal imbalance.

Methods: We treated two patients who had multiple previous spine surgeries for idiopathic scoliosis. They presented with inability to stand erect with fatigue-related pain. Full length standing PA, lateral, and bending scoliosis x-rays were obtained. Patient#1 had pre-operative curves measuring 33 and 53 degrees with 6cm of right coronal imbalance and 5cm of anterior sagittal imbalance. Patient#2 had curves measuring 43 and 59 degrees with 6.5cm of right coronal imbalance and 7.5cm of anterior sagittal imbalance. Imaging studies revealed signs of solid fusion. Both patients underwent single-stage posterior lumbar asymmetric PSO with extensive transpedicular partial vertebral resection. Correction was maintained and stabilized with pedicle screw fixation.

Results: Patients had correction of their coronal and sagittal imbalance. Patient#1 had imbalance corrected to within 0.9 and 1.6cm respectively, and patient#2 corrected to within 0.7cm and 1.0cm, respectively. Average blood loss was 2600cc. Average surgical time was 558 minutes.

Conclusions: Fixed combined deformity presents unique challenges that are distinctly different from pure sagittal plane deformities. Fixed sagittal plane deformities are usually well treated with a single-stage PSO. We believe that our modification of the PSO procedure involves extensive asymmetric partial vertebral body resection and closing wedge osteotomy as a one-stage posterior procedure is effective in achieving simultaneous correction in both planes.

372. Anterior Rod Placement in Thoracolumbar Corpectomy: A Biomechanical Study

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Introduction: Thoracolumbar vertebrectomy is a common treatment with traumatic and oncologic indications. Anterior reconstruction with a struct graft and posterior placement of pedicle screws is a common treatment strategy. It has been suggested that a single rod anteriorly augments stability, particularly in torson, although this has not been formally explored.

Methods: Fourteen fresh frozen cadavers were divided into two groups with similar ages and bone mineral densities (BMD). Both groups underwent a standard anterolateral vertebrectomy of T12 with preservation of the contralateral cortex. Reconstruction was performed with a titanium cage and posteriorly placed pedicle screws from T11 to L1. In one group screws were placed bicortically accross the bodies of T11 and L1 and connected with a single rod. Specimens were potted at T10 and L2. Force displacement curves were generated with an MTS piston and extensiometers to measure displacement.

Results: The anterior rod afforded increased stability with respect to all movements examined, namely flexion, rotation, and lateral bending. None of the differences, however, were statistically significant. In an analysis of covariance it was found that BMD was much more closely associated with stifness than construct design in the motions of torsion ($p=0.0006$) and flexion ($p=0.0525$).

Conclusions: Anterior rods offer little in the way of additional stability when added to a construct of anterior cage and posterior short segment pedicle screw constructs.

373. 360° Lumbar Fusion with Minimally Invasive Surgical Technique: Results in 100 Cases

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Introduction: Simultaneous stabilization of both the anterior column and the posterior elements yields the highest rate of fusion in the lumbar spine. This may be done with a combination of anterior lumbar interbody fusion (ALIF) and posterior segmental fixation (PSF), however, this involves two separate surgical approaches. Another method allows for a single surgical approach by combining posterior interbody fusion (PLIF) and PSF. This latter method has been criticized for excessive muscle dissection and neural retraction. Posterior lumbar decompression and PLIF are now readily performed without significant paraspinal muscle dissection through tubular retractors via one inch paraspinal incisions. PSF can be achieved in an essentially percutaneous manner via the same incision. By combining these latter two techniques one might achieve 360 degree lumbar fusion via two small paraspinal incisions with all the benefits of minimally invasive surgery. Minimally invasive spine surgery results in less blood loss, shorter hospital stay, less postoperative pain, and eventually shorter operative time. This study analyzes the clinical and radiographic results in 100 cases of 360 degree lumbar fusion done with minimally invasive surgical techniques.

Methods: Cases were analyzed retrospectively. Clinical outcome was measured using a modified Prolo scale and fusion rate by plain x-ray or CT scan.

Results: Good to excellent clinical results were seen in 80% and radiographic fusion was noted in all patients within 6-12 months. There were no neurologic complications or wound infections and no construct or alignment changes.

Conclusions: Circumferential lumbar fusion with PLIF/PSF can be achieved safely and effectively with minimally invasive surgery.

374. Comparison of FluoroNav and ISO-C 3-D Image-Guidance Navigation for Thoracic Pedicle Screw Placement

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Introduction: Pedicle screws are typically the best means to stabilize the thoracic spine, however, their placement can be challenging due to the variable size, shape, and location of the pedicles in this region. Image-guided techniques for facilitating screw placement have been described, however, their accuracy and safety, especially in the thoracic region, have been questioned. A retrospective series of screws placed safely with 2-D FluoroNav and the newer 3-D ISO-C technology is presented.

Methods: 37 patients had 277 thoracic pedicle screws placed. 183 (25 patients) were placed with FluoroNav (Medtronic, Memphis, TN), and 94 (12 patients) were placed with ISO-C 3-D (Siemens, Malvern, PA) linked to StealthStation (Medtronic, Memphis, TN). All patients underwent post-operative CT scanning. Scans were used to measure pedicle diameter, and to quantify screw perforations when present. Perforations were described qualitatively (location), and quantitatively using previously published grading criteria.

Results: Screws placed with FluoroNav had an unintended perforation rate of 8.7%, and a mean grade of 1.75. Screws placed with ISO-C had a perforation rate of 5.3%, and a mean grade of 1.40. There were no neurovascular complications, and no revisions were deemed necessary.

Conclusions: The rate and degree of perforation were slightly lower in the ISO-C group. For both groups, the perforations encountered were not clinically significant, and lower than many rates of perforation previously published for both image-guided and non-image-guided techniques. Thus, both techniques were found to be useful adjuncts facilitating the safe placement of thoracic pedicle screws.

375. Value of the Maximum Canal Compromise and Spinal Cord Compression for Evaluation of Neurological Status and Prediction of Neurological Outcome After Acute Traumatic Spinal Cord Injury

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Introduction: This study examines the value of maximum canal comprise (MCC) and maximum spinal cord compression (MSCC) for assessing neurological status and predicting of neurological outcomes in individuals with acute spinal cord injury (SCI).

Methods: All consecutive individuals with acute spine trauma who underwent MRI and CT scan at admission from 1998-2000 were included. Using ASIA score/grade, neurological status was assessed at admission and after discharge from outpatient clinic. Data were analyzed using ANOVA and linear regression.

Results: There were 22 individuals (6F, 16M; ages 17-82 years; mean of 53) who were surgically (50%) or conservatively treated. Most individuals had ASIA C (n=7), D (n=8) or E (n=4), but 3 individuals had complete motor impairment (ASIA A1, B2) at admission. Significant correlation with baseline ASIA scores was observed for the CT-MCC (p=0.044), MRI-MCC (p=0.004), and MRI-MSCC (p=0.021). Individuals with more severe SCI had larger MRI-MCC (p=0.01) and there was a trend for a similar association with MRI-MSCC (p=0.064). There were no significant differences for CT-MCC measurements among individuals with different ASIA grades (p=0.392). After a mean followup of 10.2 months, 10 of 18 individuals showed improving ASIA grade and two subjects had improving neurological functions with no change in ASIA grade. Neurological outcome was correlated with MRI-MCC (p=0.003) and MRI-MSCC (p=0.011), but not CT-MCC measurement (p=0.848).

Conclusions: Although all three radiologic parameters were correlated with ASIA score at admission, only MRI-MCC and MRI-MSCC demonstrated larger measurements associated with more severe SCI. Moreover, MRI-MCC and MRI-MSCC measurements at admission are potential predictors for neurological outcomes.

376. Percutaneous Endoscopic Cervical Discectomy with WSH Working Channel Scope for Noncontained Cervical Disc Herniation: Minimum 2 Years Follow-up

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Introduction: The conventional percutaneous endoscopic cervical discectomy (PECD) technique has the risk of spinal cord injury because of the relatively blind approach and straight-firing laser and the difficulty of removal of remnants. The aim of this study is to present the surgical technique and clinical outcome of PECD using a working channel scope (WSH endoscopy set, Storz, Germany) and a side-firing laser for noncontained cervical disc herniation.

Methods: Between March 2002 and September 2003, 136 patients underwent PECD using a WSH endoscopy set. Under the conscious sedation, the patient was placed in supine position with neck extension. After the tract was dilated using a serial dilators, and the working channel scope was inserted into disc space. Under the direct visualization, ruptured disc fragment was removed by a microforceps and vaporized by a side-firing Ho:YAG laser through the working channel.

Results: The mean follow-up period was 33.3 (range, 24-42) months. There were 52 males (38.2%) and 84 females with a mean age of 46.1 (range 24-69) years. According to the Macnab criteria, excellent was obtained in 73 patients (53.7%), good in 46 (33.8%), fair in 5 (3.7%), and poor in 12 (8.8%). During the follow-up period, 12 (8.8%) patients required conversion to open surgery.

Conclusions: PECD using a WSH working channel scope provided a safer and effective alternative for the treatment of noncontained cervical disc herniation. The WSH working channel scope had several advantages, such as a high quality of optics, a bigger working channel, and a side-firing laser.

377. Class II Cervical Outcomes

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Introduction: Prospective cohort outcomes were measured in our clinical practice (4 NS and 3 Ortho) of cervical spine operations 2002-2003. 165 patients were divided by operative procedure (7 DRG's) and had one-year follow-ups.

Methods: Patients on admission had a touch-screen data entry on demographics and pain/disability scores. At 6 months an independent nurse contacted the patients to access resolution of 10 different scaled results. Complete or mostly complete resolutions of problems were considered good/excellent results. Cases were divided into anterior (ACDF), posterior (decompression alone), posterior with fusion, combined anterior-posterior – all with or without comorbidities – complications (wCC).

Results: Relief of preop weakness, pain, numbness ACDF 65%, ACDF (wCC) 60%, C. Lam 60%, C. Lam (wCC) 69%, C. Lam and Fusion 75%,<br / Ant. - Post. 50%. Resumption of work ACDF 79%, ACDF (wCC) 69%, C. Lam. 60%, C. Lam. (wCC) 70%, C. Lam. and Fusion 76%, <bAnt. - Post. 82%. But demographics had the biggest influence on outcome. Healthy BMI nonsmokers getting complete relief 79%, overweight 65%, obese 60%, WC/litigation 25%. Return to work 93% for healthy BMI nonsmokers, smokers 84%, overweight 66%, obese 78%, WC/lit. 31%. Rating of outcome healthy BMI nonsmokers 89%, smokers 81%, overweight 76%, obese 80%, and WC/lit. 44%.

Conclusions: This study is Class II data that measures "effectiveness" on a broad mix of patients. Clearly, demographic influences the results, and litigation has a profound effect more so than in general spine work.

378. The Tops Lumbar Facet Replacement System. Biomechanical Evaluation, Operative Data, and Preliminary Clinical Results

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Introduction: The purpose of this study is to report preliminary surgical data and clinical outcomes in patients treated with the TOPS Lumbar TFR system.

Methods: Ten patients had spinal stenosis and/or spondylolisthesis at L4-5 due to facet arthropathy. Radiographs and outcome measures including Visual Analogue Scale for pain, Oswestry Disability index, SF-36 and Zurich Claudication Questionnaire were prospectively recorded before surgery and at 1, 3 and 6 months postoperatively. Prior to instrumentation, a bilateral total facetectomy and laminectomy and, in some cases, discectomy at the L4-L5 level was accomplished through a standard midline posterior approach. After decompression, the TOPS screws were inserted into the L4 and L5 pedicles to achieve maximal purchase via triangulating bicortical trajectories. An appropriately-sized TOPS arthroplasty implant was then applied.

Results: Mean surgical time was 160 minutes. Patients experienced a degree of postoperative pain similar to that of standard fusion patients and were discharged at an average of 2.5 days postoperatively. VAS, SF-36, ODI, and Zurich claudication questionnaire scores improved postoperatively with all patients being overall satisfied with the procedure at early assessment. Flexion-extension films in early follow-up demonstrated preservation of motion at L4-5 in all cases with no evidence of screw loosening or device malfunction.

Conclusions: Preliminary surgical data demonstrates that it can be safely applied through a traditional approach with low surgical morbidity and excellent early functional and radiographic outcomes in patients with back pain and posterior disease. Long-term, randomized studies will be needed before conclusive statements can be made regarding the efficacy of the TOPS system.

379. The Results of Minimal Invasive Optimesh Graft Technique for Stand-Alone Lumbar Interbody Fusion in Spondylolisthesis

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Introduction: Optimesh (Spineology, Stillwater, Minnesota) is a novel deployable interbody device used here for lumbar interbody fusion in spondylolisthesis by a minimally invasive access technique. This study characterizes the preliminary experience with Optimesh for in situ interbody fusion for lumbar spondylolisthesis.

Methods: 18 patients from 33 to 76 years of age (average 58 years), 10 female and 8 male, with spondylolisthesis at L3-4, L4-5, or L5-S1 were treated with minimally invasive decompression and interbody fusion with Optimesh. Postoperative follow-up ranged from 8 to 24 months (average 13 months). Data was collected through personal interview, clinical examination, radiographic analysis, and medical record review.

Results: Operative times ranged from 110 to 240 minutes (mean 177 minutes). Blood loss was uniformly less than 100 cc. There were no durotomies, neural injuries, transient or permanent paresthesias, or blood transfusions. Two superficial wound infections resolved with antibiotic therapy, and irrigation and debridement without removal of instrumentation. The average preoperative Visual Analog Scale (VAS) of the patients was 8.7, and it decreased to 2.7 after 49 days (range 10 to 240 days) clinical follow-up. Radiographic follow-up with X-ray, CT, and MRI showed the Optimesh engaged in between vertebral body endplates in a lock-and-key type configuration, no increase in spondylolisthesis, and no instability on lumbar flexion/extension X-rays at 3 to 12 months.

Conclusions: Preliminary 18 month results of the Optimesh system used in lumbar interbody fusion for spondylolisthesis demonstrate it to be a viable interbody fusion device with minimal risk for intraoperative complications characteristically associated with fixed-sized grafts and cages.

380. Development of a Thoracoscopic Implantation Technique for Spinal Reconstruction after Vertebrectomy Using the Synex Cage

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Introduction: The goals of anterior and middle column reconstruction of the thoracic and lumbar spine are to correct deformity, decompress the spinal cord, and immediately stabilize and restore the weight-bearing capacity of the involved vertebral segments. We report our experience with the Synex expandable interbody cage system to achieve these goals.

Methods: A prospective database has been established for patients who have undergone implantation of the Synex cage system. Demographic data, including surgical approach, level of disease, etiology of instability, and other spinal surgeries were recorded. Our primary outcome was hardware and surgical perioperative complications.

Results: Since July 2002, we have implanted the Synex cage in 30 patients. Most patients were male (n=24) and the average age was 48. The cause of instability was predominantly neoplastic (n=15) or acute trauma (n=13). Eighteen patients had neurologic changes at admission. The most commonly affected levels were T10, T12, and L1. Initially, traditional open procedures to the thoracic and lumbar spines were used (n=24). However, endoscopic techniques have been performed recently with good success. Supplemental anterior (n=12) and posterior (n=10) approaches were used in select patients. Of the four complications, all were pulmonary issues; two of these required an additional thoracic surgery to address the complication. No hardware-related complications were observed.

Conclusions: The Synex expandable cage is a useful tool for rebuilding the vertebral body in the thoracic and lumbar spines. It is safe and can be used as a minimally invasive thoracoscopic implant.

381. Posterior Lumber Interbody Fusion: Comparative Analysis of a Minimally Invasive Versus an Open Approach

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Introduction: We compared clinical and radiographic outcomes in patients who underwent minimally invasive versus a traditional open single level lumbar fusion with pedicle screw instrumentation and posterior interbody arthrodesis.

Methods: We retrospectively compared blood loss, length of hospitalization and pre- and post-operative Oswestry Pain Index scores. Additionally, computed tomography (CT) scans were obtained on all patients postoperatively to determine accuracy of screw placement and presence of successful interbody fusion.

Results: Average follow-up was 33.9 months for open patients and 13.3 months for minimally invasive patients. Blood loss during surgery was significantly less for minimally invasive patients compared to open patients [299cc vs. 561cc (P=0.0058)]. Hospitalization was shorter for minimally invasive patients (4 versus 4.7 days), but was not statistically significant. The open fusion group had a slightly greater, but not significant, improvement in Oswestry scores after surgery. Fourteen of 28 patients (50%) who underwent the minimally invasive procedure had CT proven interbody fusion versus 14 of 18 (78%) in the open fusion group; this difference was not significant. In the minimally invasive group, 6/112 screws (5%) breeched the pedicle compared with 8/72 (11%) in the open procedure; this data was not significant.

Conclusions: Compared with traditional open instrumented lumbar fusion, a minimally invasive approach resulted in lower blood loss. Hospital stay, interbody fusion rates and accuracy of screw placement were not significantly different. Both groups demonstrated significant improvement in post-operative Oswestry scores but there was no difference in functional improvement comparing open and minimally invasive techniques.

382. Stand-Alone Anterior Lumbar Discectomy and Fusion (ALDF) with Plate: Initial Experience

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Introduction: The stability of the lumbar spine following anterior lumbar interbody fusion (ALIF) with lateral plate fixation and/or posterior fixation has previously been investigated. However, stand-alone anterior lumbar discectomy and fusion (ALDF) with plate has not. We review our initial experience with stand alone ALDF for degenerative disease of the lumbar spine.

Methods: Ten patients treated between 2004 and 2005 were included in this analysis. All patients presented with discogram positive back pain and 3 with radiculopathy. All patients had placement of a midline anterior plate. Patients underwent flexion/ extension imaging at 6 weeks, 3 months, 6 months, and 1 year post-operatively.

Results: Seven patients underwent 1-level ALDF with plate, 2 underwent 2-level ALDF with plate, and 1 underwent a corpectomy with placement of anterior graft and plate. None had supplemental posterior instrumentation. Average follow-up was 9.5 months. All patients demonstrated radiographic evidence of fusion at last follow-up. None developed instability at the fusion level and none developed hardware failure (plate back-out, screw lucency, etc.). Average subsidence at 6 months post-operatively was 2.2mm (+/- 0.4mm).

Conclusions: Preliminary results of stand-alone ALDF with plate suggest it is safe and effective for the surgical treatment of patients with degenerative disease of the lumbar spine. Long-term follow-up is clearly needed. Subsidence is diminished with ALDF and anterior plating compared to ALIF with posterior instrumentation. It is unclear at this time which subset of patients may ultimately require posterior hardware supplementation.

383. Maverick Artificial Disc Removal Due to Metal Allergy

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Introduction: A common concern involving spinal arthroplasty is the ability for safe revision. The Maverick (Medtronic Sofamor Danek, Memphis, TN) artificial disc has a large central keel that allows for improved fixation when initially implanted. However, there have been concerns that this would make it more difficult and potentially dangerous if the implant needed to be revised or removed. There are currently no reports describing the removal of a Maverick lumbar artificial disc.

Methods: A 43-year-old female underwent Maverick artificial disc replacement for intractable pain that had failed extensive conservative management. Over 3 months following surgery she developed worsening intractable lumbar pain despite good positioning of the device and no evidence of infection or other problems. She was suspected to be developing an allergic reaction to the metal based on imaging studies and an allergy skin patch test.

Results: The patient underwent removal of the device with an anterior lumbar interbody fusion (ALIF) with PEEK (poly-ether-ether-ketone) interbody fusion cages and a resorbable Lactosorb® plate and screws without complications. Her symptoms subsided almost immediately following removal of the device.

Conclusions: Artificial disc removal surgery can be safely performed for at least some devices with large midline keels. There were no intraoperative complications and there was minimal intraoperative blood loss from the vertebral body. A subsequent fusion still remains another option for the patients after an unsuccessful arthroplasty procedure.

384. Biomechanics of Asymmetric Lumbar Pedicle Screw Combinations

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Introduction: We sought to compare the biomechanics of posterior lumbar fixation in treating an unstable two-level unilateral lesion. Using pedicle screws and rods, we compared asymmetric fixation (more levels included ipsilateral to the lesion), short versus long fixation, and fixation with and without connection to the involved vertebra.

Methods: Seven human cadaveric specimens (T12-S1) were studied (1) intact, (2) after simulated unilateral lesion at L2-3 and L3-4, (3) L2-L4 unilateral fixation (L3 excluded), (4) L2-L4 bilateral fixation (L3 included contralaterally), (5) L1-L5 unilateral fixation (L3 excluded), (6) L1-L5 fixation ipsilateral (L3 excluded) and L2-L4 fixation contralateral (L3 included), (7) L1-L5 bilateral fixation (L3 included contralaterally), (8) L1-L5 bilateral fixation (L3 excluded both sides). Testing order varied among specimens. Angular range of motion was recorded optically while loading to 6.0 Nm using nonconstraining pure moments.

Results: Unilateral short fixation provided significantly worse stabilization than bilateral (p less than 0.05, RM ANOVA). There was an average of 50 percent reduction in range of motion across the lesion when adding one additional level rostrally and caudally. Asymmetrical long/short stabilization provided similar stability to symmetrical long stabilization. Very little additional stability was gained by including L3 in the fixation.

Conclusions: Unilateral fixation was inadequate for stabilizing a two-level unilateral lesion. Bilateral fixation, whether symmetrical or asymmetrical, provides good stabilization for this injury. It is not important for stability to include the level of the lesion within the construct contralaterally.

385. Biomechanical Benefits of Nonsurgical Exogenous Crosslink Therapy (NEXT)

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Introduction: Extracellular matrix revitalization may have advantages over new tissue fabrication in the biologically harsh environment of degenerated intervertebral discs. Recent investigations demonstrated the ability of injectable crosslink augmentation to improve annulus fibrosus fatigue resistance, increase elasticity, stabilize the joint, and improve nutritional transport. In this study, multi-directional material properties of crosslinked and normal bovine lumbar annulus specimens were measured in vitro.

Methods: Four types of annulus fibrosus specimens were dissected from bovine lumbar discs in 24 symmetrical pairs, including circumferential tension (CT), radial compression (RC), axial tension (AT), and axial compression (AC). One specimen from each pair was soaked in PBS for 2 days at room temperature while the other was soaked in a 0.33% genipin solution. Cross-sectional areas were measured using a custom non-contact rotating laser measurement system. Compressive test parameters included low stiffness region modulus, and elastic region modulus. Tensile tests parameters included low stiffness modulus, elastic region modulus, 0.5% yield strength, ultimate tensile strength (UTS), and toughness.

Results: AC modulus in the low stiffness region was 126% higher with crosslink augmentation (p=0.031). CT yield strength was 78% higher with crosslinking (p=0.024), and UTS increased 79% (p=0.033). CT elastic modulus showed a 59% increase with crosslinking (p=0.045) while toughness increased 83% (p=0.05). AT yield strength increased 45% with crosslinking (p=0.008) while UTS increased 21% (p=0.036).

Conclusions: These results suggest some additional beneficial effects of crosslink augmentation on the mechanical properties of the annulus fibrosus: increase in strength, toughness, and modulus in the principle stress directions.

386. Addition of a Cross-link to the C-1 Lateral Mass/C2 Pedicle Screw Fixation construct: A Biomechanical Study

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Introduction: Atlantoaxial stabilization is required in various conditions such as trauma, malignancy, and inflammatory diseases. Screw fixation of the lateral mass of C1 and the C2 pedicle (CLM/C2) is a viable fusion option. The addition of a cross-link may provide added stability and increase fusion rates. The study's objective is to assess the rigidity of CLM/C2 pedicle screw fixation construct, with and without a cross-link, in an odontoidectomy instability model.

Methods: Seven cadaver specimens were tested in the following order: intact specimen, destabilized C1-C2, instrumented CLM/C2 without a cross-link, instrumented CLM/C2 with cross-link. Test mode series included flexion/extension, lateral bending, and torsion. Range of motion (ROM) and stiffness were calculated for the last three cycles of each test. An analysis of variance assessed significant differences in ROM and stiffness between test conditions.

Results: CLM/C2 alone and CLM/C2 with cross-links exhibited significantly increased stiffness (Nm/degree) in flexion/extension, lateral bending and torsion than the intact specimen and the destabilized C1-C2 specimen. Stiffness during torsion of the instrumented CLM/C2 with cross-links (2.757+/-0.52) was significantly increased (P less than .001) compared to the instrumented CLM/C2 alone (1.96+/-0.51). There was a trend towards decreased ROM in CLM/C2 with cross-links when compared to instrumented CLM/C2 alone in flexion/extension (0.32+/-0.01 vs 0.33+/-0.02, respectively) and lateral bending (0.55+/-0.2 vs 0.59+/-0.17, respectively).

Conclusions: Cross-links statistically significantly increased the stiffness in the CLM/C2 in torsion when compared with instrumented CLM/C2 alone. A trend was noted for increased stiffness in lateral bending when cross-links were added. Cross-links increase stability of the CLM/C2 thereby potentially increasing the fusion rate in vivo.

387. Electrical Stimulation DC of Posterior Lumbar Interbody Fusion

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Introduction: DC electrical stimulation has been shown to promote bony fusion. There is no well accepted method for utilizing DC electrical stimulation to augment fusion rates in a PLIF construct.

Methods: Over six months we offered patients undergoing PLIF at high risk for pseudoarthrosis the placement of a DC bone stimulator in the interspace. Five patients accepted. PLIF interspace preparation was performed in the standard fashion. Free bone was place anteriorly in the interspace followed by the bone stimulator electodes followed in turn by the carbon fiber cage. CT scan were obtained at six months. In one case a two level fusion was performed with the stimulator used at only one level and one level was unstimulated as an internal control.

Results: All patients experienced fusion at six months as demonstrated on sagittal CT scan with bone growing across the interspace. Flexion-extension xrays showed no movement as well. The proximity of the traversing root to the stimulator leads was not a factor due to the use of an approach corridor that is further lateral than a traditional PLIF and the availability of the pedicle screw construct to suture the lead to and thereby keep in very lateral in the field. No patient experienced a complication due to the insertion of the bone stimulator into the interspace.

Conclusions: The use of a DC bone stimulator is safe in a PLIF or TLIF construct and should be considered in cases at high risk for a pseudoarthrosis.

388. Comparative Analysis of Lumbar Lordosis after Lumbar Spinal Fusion Using the Wilson Frame and Jackson Table

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Object: The aim of this study was to document changes in total lumbar lordosis, unisegmental lordosis, and sacral tilting between preoperation, intraoperation, and postoperation using two different spinal frames (the Jackson table and Wilson frame).

Method: Thirty-two patients were reviewed retrospectively, having undergone pedicle screw fixation due to lumbar spinal stenosis. The patients were divided into two groups, one using the Wilson frame (group 1) and the other using the Jackson table (group 2). In group 1, 34 patients (16 men, 18 women; age range 45-75) were reviewed. In group 2, 38 patients (20 men, 18 women; age range 42-70) were reviewed. And according to surgery levels (L4-5, L5-S1, L4-5-S1), the two group were compared with total lumbar lordosis, segmental lordosis, in preoperation, intraoperation, and postoperation.

Results: In group 1, the intraoperative total lumbar lordosis decreased with compared to preoperative lordosis ($p < 0.05$). In group 2, there was no marked reduction between preoperation and intraoperation ($p < 0.05$). But, in group 1 in patient who underwent L4-5-S1 fusion, postoperative total lumbar lordosis was not restored to preoperative lordotic condition while in group 2, There was no marked changes between preoperation and intraoperation, postoperation ($p < 0.05$). In group 1, intraoperative segmental lordosis decraesed with compared to preoperative segment lordosis at all levels, whereas in group 2, intraoperative segmental lordosis showed no change at all levels with compared preoperative segmental lordosis ($p < 0.05$).

Conclusions: The Wilson frame induces iatrogenic decreased lumbar lordosis, segmental lordosis, sacral tilting which creates an iatrogenic sagittal imbalance.

389. Posterior Lumbar Interbody Fusion Combined with Instrumented Postero-lateral Fusion- A Series of 75 Patients

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Introduction: Posterior lumbar interbody fusion (PLIF) allows decompression of the spinal canal and interbody fusion using cages can be performed through a single posterior incision. Additional instrumented postero-lateral fusion (IPLF) using a pedicle screw system can also be achieved using the same incision. We wanted to assess retrospectively the clinical and radiological outcome of this technique performed in our unit by the senior author.

Methods: Between July 1999 and April 2004, 75 patients underwent PLIF using cage and IPLF using pedicle instrumentation. Clinical outcome was measured with physical examination in the outpatient setting and assessment of pain and function. Radiological outcome was assessed with serial radiographs/flexion-extension radiographs/computed tomography at follow-up visits.

Results: The mean age was 48.7 years (range 30-75 years). The average follow-up was 29.17 months (12 months to 67 months). The outcome was considered to be good or excellent in 88% of these patients. 64% of patients returned back to their original work. Radiographic evidence of stable fixation was seen in all but one patient, and radiological bony fusion was seen in all the cases at the time of the most recent follow-up. One patient had pullout of a pedicle screw, and one patient had a fracture of the titanium cage (both asymptomatic). Three patients sustained a neurological complication, two of which resolved completely.

Conclusions: The results are comparable with similar studies published in the literature. Therefore we recommend the continuous use of PLIF + IPLF in painful lumbar degenerative spinal disease where conservative management has failed.

390. Uniplate for Anterior Cervical Discectomy and Fusion Instrumentation

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Introduction: The Uniplate anterior cervical plate system is a novel device that involves a thin titanium plate and a single screw at each vertebral level. This report describes an initial case series of 21 patients who underwent one or two level fusions using this new hardware system. The Uniplate system involves less retraction for instrumentation placement as well as the use of fewer screws compared to traditional cervical plates.

Methods: 21 patients underwent either one (13 patients) or two level (8 patients) anterior cervical discectomies and fusions using the Depuy Acromed Uniplate system. All surgeries were performed by the same surgeon and used similar techniques. Patients undergoing surgery included degenerative or traumatic conditions. All patients received one month and three month followup cervical xrays to evaluate hardware and allograft positions.

Results: There were no hardware related complications during this study. There was one case of transient dysphagia. All 21 patients have demonstrated no hardware failures (plate or screw breakage) or migration on followup xrays. All 21 patients demonstrate evidence of bony fusion proceeding. None of the 21 patients required reoperation for any reason.

Conclusions: This is the initial report of the use of the Uniplate in a series of patients undergoing anterior cervical discectomy and fusion. There were no device related complications or any evidence of hardware failure over a 3 month post-operative followup period. This study demonstrates the feasability of the device and long-term studies will be used to evaluate fusion outcomes for further comparison in the future.

391. RhBMP-2 Retention in a Vertebral Body Fracture Stabilization Device (OptiMesh)

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Introduction: The OptiMesh (Spineology, MN) is currently FDA-approved for stabilization of vertebral compression fractures. Outside the US, it is also used for interbody fusion. This is a Dacron woven-sleeve inserted through a cannula. For interbody fusion, the sleeve is backfilled with allograft chips providing disc-space expansion and stabilization. BMP's have revolutionized interbody fusion procedures. This study investigates rhBMP-2 retention characteristics of OptiMesh.

Methods: Eleven OptiMesh devices were tested. Nine were prepared with 500 ul of 0.032mg/ml rhBMP2, allowed to soak for 20, 60, or 120 minutes (n=3 devices/soak time), and placed in vials of 40 ml 0.9% Sodium Chloride solution at 37°C water bath with 5ml of air to inflate nine balloons. Two deflated devices with 1 hour absorb time with 500 ul of 0.032mg/ml rhBMP2 were placed in saline at 37°C water bath. Same rhBMP-2 solution was control. 150ul samples were withdrawn from each vial at 1, 20 minutes and 1, 6, 12, 24, and 48 hours. ELISA was applied to samplings to assess the concentration of rhBMP-2.

Results: The OptiMesh (Spineology, MN) Dacron woven sleeve device was able to retain approximately 90% of the original concentration of rhBMP2 diluted in 500ul of solution and expanded with a balloon to mimic clinical expansion with a soak time of at least 20 minutes. The longer the preparation soak time, the less rhBMP2 in solution.

Conclusions: The Optimesh device retained approximately 90% of the original concentration of rhBMP2. Further investigation is needed to determine the devices' ability to produce reliable rhBMP-2 mediated osteoinduction in-vivo.

392. The Efficacy of Percutaneous Endoscopic Interlaminar Discectomy (PEID) on L5-S1 Disc Herniation

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Introduction: Because of the high lying iliac crest, we have encountered difficulty in obtaining adequate access when performing posterolateral transforaminal endoscopic discectomies on L5-S1 disc herniation. Therefore, we have performed PEID as a minimally invasive procedure in these cases.

Methods: This is a retrospective clinical review of 17 patients who underwent PEID on L5-S1 during the period of February 2004 to August 2004. All procedures were performed under epidural anesthesia. Under fluoroscopic guidance, we inserted an endoscopy (6mm diameter, YESS) into epidural space through interlaminar route, and we removed the herniated disc. The wound was closed with simple skin suture. The outcomes were analyzed using a visual analog scale (VAS) and Modified MacNab criteria.

Results: The study involved 9 males and 8 females with a mean age of 32 years (range, 21 to 43). The mean hospital stay was 2.3 day. All patients returned to work within 8 weeks (range, 1 to 8) after the procedure. The mean follow-up period was 13.5 months (range, 12 to 18). VAS decreased from a preoperative mean of 7.9 to 1.8 at the final follow-up. Upon analysis using Modified MacNab criteria, excellent results in 9 subjects (53%), good results in 7 (41.2%), a fair result in 1 (5.8%), and poor results in 0 (0%) cases were obtained. There were no complications.

Conclusions: PEID may be an efficacious, safe, and minimally invasive procedure for an endoscopic discectomy on L5-S1 disc herniaton.

393. Interspinous Locker Fixation with Ligamentoplasty for Lumbar Stenosis or Degenerative Spondylolisthesis.

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Introduction: Dynamic stabilization device can treat degenerative disc disease without fusion of the vertebrae, preserving motion and flexibility. The purpose of this study is to present interspinous locker fixation (ILF) with ligamentoplasty (LP) for lumbar stenosis or degenerative spondylolisthesis.

Methods: Between January 2004 and June 2005, 17 consecutive patients underwent ILF with LP after decompression. The indications included spondylolisthesis grade I with central stenosis and bilateral foraminal stenosis. Supraspinous and interspinous ligaments were removed without violation of the spinous processes. The lower half of the upper lamina and buckled yellow ligament were removed. After decompression, a locker was located between the spinous process. Both spinous processes were surrounded with an artificial ligament as a figure-of-eight.

Results: Mean follow-up was 11.7 (range 3-21) months. There were 12 males and 5 females with a mean age of 62.3 (range 41-81) years. There were 13 cases of single-level and 4 of two-levels. The operated levels were L3-4 in 7, L4-5 in 12, and L5-S1 in 2 patients. After surgery, lumbar lordosis was well preserved. The average score of Oswestry Disability Index was improved from 66.0 % to 31.1 %. Complications are superficial wound infection in 2 patients and transient dysesthesia in 2. There was no reoperation.

Conclusions: Interspinous locker fixation with ligamentoplasty has the characteristics of both distraction and compression. ILF with LP seems to be the best option for soft stabilization in treating degenerative pathology. Long-term comparative studies are needed to establish the standard therapeutic role of ILF with LP.

394. Neural Prosthetic Implants in Spinal Cord: Direct Activation of Muscles with Multishank Single Unit Stimulation Electrodes

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Introduction: Focal pools of neurons that control a single muscle (spinal motor units) have been characterized and stimulated successfully with single unit electrodes. We present the use of a multishank electrode system to activate different muscles with stimulation of individual electrodes within the system.

Methods: We created an electrode with 30 stimulating electrodes in a three-dimensional array, and implanted these into the lumbar motor units of spinal cords of 10 Sprague-Dawly rats. EMG and accelerometers were used to record the output of the muscles activated.

Results: Using stimulations of 0.0-0.2mA, 0.1-0.3ms, we were able to reproducibly activate several different muscles depending on which electrode was stimulated. This muscle response, as graded by the rate of movement of the joint as recorded by the accelerometers attached to the limbs, was dependent on the size of the muscle and the stimulus intensity.

Conclusions: The use of a large array of electrodes implanted in the spinal cord of a rat can produce specific, stereotypic contraction of various individual muscles in a way the investigator can control. This has significant implications for the treatment of chronic spinal cord injured patients with intact spinal cords below a level of injury.

395. Kyphoplasty for Treatment of Traumatic Anterior Column Compression Fractures

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Introduction: Vertebroplasty and kyphoplasty are accepted procedures for correction of pathological thoracolumbar compression fractures caused by osteoporosis, multiple myeloma, and hemangioma. Unstable traumatic compression fractures have traditionally been treated with open, surgical stabilization. Treatment for stable vertebral compression fractures conventionally focuses on the alleviation of acute pain with bracing, medication, and activity modification. We will present the results from a series of 12 patients with stable, traumatic, thoracolumbar compression fractures, successfully treated with kyphoplasty.

Methods: Twelve patients with painful, traumatic anterior column thoracolumbar compression fractures underwent percutaneous balloon kyphoplasty at our institution from 2004 to 2005. These patients participated in a broader study examining the safety and efficacy of kyphoplasty. We evaluated pain, use of pain medications, function and quality of life pre-procedure and three to six weeks post-procedure. All major and minor complications were recorded. The 12 patient charts and radiographs were reviewed retrospectively.

Results: All 12 patients experienced prompt improvement in pain and were able to resume weight-bearing activities. There was further improvement in pain, quality of life, and function over three to six weeks. No serious complications occurred, and hospitalization was generally brief. Postoperative radiographs showed preserved alignment or improvement of the kyphotic angle and no significant cement leakage.

Conclusions: Kyphoplasty is a safe and effective treatment for patients with painful, traumatic compression fractures of the anterior vertebral column.

396. Biomechanical Comparison of Isolated Occipitoatlantal Posterior Fixation Techniques

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Introduction: Transarticular screws can be used to immobilize C0-C1 after occipitoatlantal dislocation. Alternately, rods can connect screws from the C1 lateral masses to keel screws in the skull base. These screw techniques were compared biomechanically to a contoured wired Steinmann pin across C0-C1.

Methods: Fourteen human cadaveric specimens (occiput-C2) were tested (1) normal, (2) destabilized, (3) after screw fixation, (4) after adding a dorsal graft wired from occiput-C1, (5) after fatiguing for 10,000 cycles (no graft), (6) after wiring a contoured rod across occiput-C1, (7) after wiring a dorsal graft, (8) after fatiguing (no graft). Pure moments were applied to induce flexion, extension, lateral bending, and axial rotation while recording 3-D angular motion. Range of motion (ROM) and increase in ROM due to fatigue were compared statistically using analysis of variance followed by Holm-Sidak test.

Results: With and without a graft, transarticular screws allowed the smallest ROM, followed by the keel-lateral mass screws-rods followed by wired contoured rod. Transarticular screws and wired contoured rod benefited more from a dorsal graft than the keel-lateral mass screw technique. Fatigue caused significantly greater ROM increase in the wired contoured rod construct (mean 0.83-degree increase) than in the transarticular screw construct (mean 0.06-degree increase) or keel-lateral mass screw construct (mean 0.08-degree increase).

Conclusion: The transarticular screw technique allowed less motion at C0-C1 than the keel-lateral mass screw technique, especially when a wired structural graft was present dorsally. Both screw techniques limited motion better than the wired contoured rod construct and were less susceptible to loosening by fatigue.

397. Value of Magnetic Resonance Imaging in Mouse Models of Spinal Cord Injury

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Introduction: The feasibility of performing high-resolution in vivo MRI on injured mouse spinal cord at 9.4 T magnetic field strength was evaluated with wild type and transgenic mice.

Methods: The MR properties of normal murine SC tissue were measured. The characteristics of the water diffusion were quantified as normative measurements. Data indicate that the differences in the proton density, and transverse relaxation time between grey and white matter dominate the contrast seen on normal SC images at 9.4 T. On heavily T2-weighted images, these differences result in the reversal of contrast. The diffusion of water in normal mouse SC is anisotropic; the WM exhibits greater anisotropy and principal diffusivity than the GM. This data should establish a standard for comparing similar measurements obtained from SCs of genetically engineered mouse models of SCI.

Results: Using established moderate compression model SCI at T12 level, we performed additional MRI and behavioural studies on C57Bl/6 wild type, comparing results with human protease nexin I overexpressing transgenic male. MRI were conducted on postinjury days 1, 7 and 14 to monitor injury progression longitudinally and to quantify changes in lesion volume. The neurobehavioral recovery of each animal was assessed using modified BBB scores on PI days 1, 3, 7, 10 and 14. On PI day 14, mice were euthanized for histological analysis of injured SCs.

Conclusions: The MRI-based measurements on the lesion volume appear to reflect improvements in neurobehavioral, as well as neurohistological,

recovery patterns and may offer significant value in assessing similar recoveries to establish mechanisms in genetically-manipulated mice.

398. Extrapedicular Unilateral Vertebroplasty

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Introduction: Vertebroplasty has been demonstrated to be an effective treatment for osteoporotic vertebral compression fractures. Standard techniques involve transpedicular delivery of methyl methacrylate bilaterally. Small pedicles require small 2-3-mm OD needles and delivery of low viscous cement with a possible risk of embolization. Bilateral pedicle cannulation is often required to achieve an effective vertebral body fill.

Methods: A modification of the standard vertebroplasty technique involves placement of a larger cannula through a lateral extrapedicular trajectory. The trajectory allows for a medial needle placement and excellent vertebral body fill through a unilateral pass. The larger cannula allows for more viscous cement delivery with less risk for cement embolization. Five to 8cc of methy methacrylate was delivered. Biplanar fluoroscopy was used for localization.

Results: A unilateral extrapedicular vertebroplasty was performed in 20 patients (average age=75.3). Pain improved in 16/20 (80%) of patients. Average VAS pain scores improved from 8.2 to 4.0 ($P<0.05$). No procedure related complications were noted. With 6 month average follow-up, 2 patients demonstrated vertebral fractures at other levels.

Conclusions: A unilateral extrapedicular vertebroplasty technique allows for excellent vertebral body fill with a single needle placement. The larger needle allows for a safer more viscous methy methacrylate delivery. Overall clinical results are similar to previously described vertebroplasty series.

399. Bone Scan Imaging for Selective Percutaneous Vertebroplasty in Osteoporotic Vertebral fractures

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Introduction: Percutanous polymethylmethacrylate (PMMA) vertebroplasty is an effective treatment of osteoperotic compression fractures. Many patients have multiple vertebral body compression fractures or vertebral body wedging. Some patients have therefore undergone multiple level vertebroplasty. The goal of this study was to determine if a positive bone scan targeted vertebroplasty would eliminate the need for multilevel vertebroplasties.

Methods: Twelve patients presented with acute back pain and radiographs demonstrating multiple thoracic and lumbar compression fractures (average number of levels 2.8). No previous films were available for comparison. Each patient underwent a bone scan. In ten patients, a positive bone scan test was obtained demonstrating increased uptake at one level. Percutaeous vertebroplasty was performed at the level of increased uptake only.

Results: All ten patients had improvement in their back pain. The average VAS improved from 8.1 to 4.5 ($p<0.05$). There were no procedure related complications. In two patients, a level not clearly identified as fractured initially was noted to have increased uptake and subsequent x-ray review indicated vertebral body "wedging."

Conclusions: A bone scan is an effective test to predict outcome with vertebroplasty and to specifically target the symptomatic vertebral level in patients with osteoperotic compression fractures.

2006 MAYFIELD BASIC SCIENCE AWARD RECIPIENT

208. Development of an Animal Model of Post-Traumatic Syringomyelia Associated with Adhesive Arachnoiditis: Implications for an Enhanced Understanding of the Pathobiology and for the Development of Novel Therapeutic Approaches

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Introduction: We have sought to develop a animal model of post-traumatic syringomyelia (PTS) to facilitate the understanding of this disorder so that improved therapeutic approaches can be developed.

Methods: Injured Wistar rats received 35g clip injury was applied to the spinal cord to simulate a moderate spinal cord injury (SCI) at T6 level. (1)Rat PTS model (n=48); The animals were divided into 4 groups. G1 was animals received SCI only, G2 was received SCI and injected kaolin into the subarachnoid space (SAS), G3 was injected kaolin into the SAS only, and G4 was sham group. The survival time was 1, 2, and 6 weeks. (2)Neuroprotective drugs (n=4-5/treatment); Experimental rats were randomly divided into 1 of 5 treatment groups. Beginning 1h after injury, the animals were given either an intraperitoneal injection of saline, vehicle, MPSS, minocycline, or riluzole for 6 days after SCI. All treatment rats were examined by using the BBB for 4 weeks. Quantitative histological and immunohistochemical assessments were undertaken using fluorescence microscopy and image analysis.

Results: (1)Both groups G3 and G4 did not develop syringomyelia. PTS was observed in both groups G1 and G2 at 6 weeks. Especially, G2 was observed larger syrinx compared with G1. (2)Gradual improvement in hind limb function was observed for each group in BBB, although the statistical analysis revealed no significant difference. However the lesion was significantly decreased in the neuroprotective drug groups compared with control groups.

Conclusions: Both compressive injury and adhesive arachnoiditis are required to develop extensive PTS. By understanding the molecular pathogenesis of PTS, improved treatment approaches may be developed.

2006 MAYFIELD CLINICAL SCIENCE AWARD RECIPIENT

310. Clinical and Radiographic Outcomes of Thoracic and Lumbar Pedicle Subtraction Osteotomy for Fixed Sagittal Imbalance

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Introduction: Few reports for complications and outcomes after pedicle subtraction osteotomy (PSO) exist in the literature. There are no reports pertaining to thoracic PSOs specifically. We evaluate the radiographic and functional outcomes of pedicle subtraction osteotomy (PSO) in general. Furthermore, we compare and contrast these measures between thoracic and lumbar PSO subgroups.

Methods: Thirty-five consecutive patients with sagittal imbalance treated with PSO by a single surgeon with minimum 2-year follow-up were analyzed. Perioperative course and complications were noted. Measurements of standing long-film radiographs of the spine were taken preoperatively, immediately post-operatively, and at most recent follow-up. The Modified Prolo and SRS-22 outcomes instruments were administered.

Results: Early complications after PSO included neurologic injury, wound-related problems, and nosocomial infections. Late complications were limited to pseudoarthrosis and attendant instrumentation failure. Lumbar PSOs were associated with improvements in local, segmental, and global measures of sagittal balance while thoracic PSOs were only associated with local improvement. Most patients rated their functional status as 'fair' to 'good' according to the Modified Prolo scale and reported that they were satisfied with the overall management of their back condition according the SRS-22 questionnaire.

Conclusions: The ability to perform a PSO at both lumbar and thoracic levels is a powerful asset for the spinal deformity surgeon. Radiographic and clinical outcomes were superior with lumbar PSOs secondary to several anatomical and technical obstacles hindering the thoracic procedure. Nevertheless, the thoracic PSO proves to be a useful addition for regional improvement in sagittal balance for patients with a fixed thoracic kyphosis.

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SPECIAL COURSE I – INTERVENTIONAL SPINE SURGERY

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to :					
Describe basic spinal injections	A	B	C	D	E
Review the indications for spine interventional procedures	A	B	C	D	E
Recognize patients with vertebral compression fractures	A	B	C	D	E
2. John C. Oakley, MD communicated clearly and effectively	A	B	C	D	E
Ray M. Baker, MD communicated clearly and effectively	A	B	C	D	E
Isador Lieberman, MD communicated clearly and effectively	A	B	C	D	E
Kevin E. Macadaeg, MD communicated clearly and effectively	A	B	C	D	E
Richard M. Spiro, MD, MPH communicated clearly and effectively	A	B	C	D	E
3. The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this special course that you will apply to your practice?

8. Overall, how could this special course be improved (i.e. topics covered, speakers, audiovisual)?

9. Did you perceive any type of commercial bias during this program? Yes No
   If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SPECIAL COURSE II – CODING UPDATE AND REVIEW

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to:					
Recognize the newest changes in CPT coding	A	B	C	D	E
Review the methodology for correct spine coding	A	B	C	D	E
Identify specific coding scenarios that can be difficult to code and bring clarity to the relevant scenarios	A	B	C	D	E
2. Gregory J Przybylski, MD communicated clearly and effectively	A	B	C	D	E
Robert R. Johnson, II, MD, FACS communicated clearly and effectively	A	B	C	D	E
3. The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this special course that you will apply to your practice?

8. Overall, how could this special course be improved (i.e. topics covered, speakers, audiovisual)?

9. Did you perceive any type of commercial bias during this program? Yes No
   If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SPECIAL COURSE III – MOVING YOUR PRACTICE TO THE DIGITAL AGE/OFFICE AUTOMATION

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to:					
Describe the criteria by which to evaluate utilization and effectiveness of electronic medical records	A	B	C	D	E
Discuss negotiating contracts with vendors and pricing protection	A	B	C	D	E
Discuss market trends and vendor performance	A	B	C	D	E
2. Joel D. MacDonald, MD communicated clearly and effectively	A	B	C	D	E
Brian R. Greer communicated clearly and effectively	A	B	C	D	E
David W. Polly, Jr., MD communicated clearly and effectively	A	B	C	D	E
Ashwini D. Sharan, MD communicated clearly and effectively	A	B	C	D	E
3. The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this special course that you will apply to your practice?

8. Overall, how could this special course be improved (i.e. topics covered, speakers, audiovisual)?

9. Did you perceive any type of commercial bias during this program? Yes No
   If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SPECIAL COURSE IV– MOTION MAINTENANCE AND DISC REGENERATION

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to:					
Recognize indications and pitfalls of arthroplasty	A	B	C	D	E
Identify the advantages of motion preservation	A	B	C	D	E
Recognize indications for less invasive treatments of spinal disorders	A	B	C	D	E
2. Christopher I. Shaffrey, MD communicated clearly and effectively	A	B	C	D	E
Stephen Badylak, DVM, PhD, MD communicated clearly and effectively	A	B	C	D	E
Vadim N. Bikmullin, MD, PhD communicated clearly and effectively	A	B	C	D	E
Rick Delamarter, MD, communicated clearly and effectively	A	B	C	D	E
Fred H. Geisler, MD, PhD communicated clearly and effectively	A	B	C	D	E
Brian R. Subach, MD communicated clearly and effectively	A	B	C	D	E
Charles S. Theofilos, MD communicated clearly and effectively	A	B	C	D	E
Jeffrey C. Wang, MD communicated clearly and effectively	A	B	C	D	E
3 The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this special course that you will apply to your practice?

8. Overall, how could this special course be improved (i.e. topics covered, speakers, audiovisua)l?

9. Did you perceive any type of commercial bias during this program? Yes No
   If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SCIENTIFIC SESSION I – THE EVOLUTION OF CERVICAL SPINE SURGERY

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Recognize the newest technologies for cervical fusion	A	B	C	D	E
Recognize the biological and biomechanical aspects of cervical arthroplasty	A	B	C	D	E
Review the current experiences of senior surgeons that have experience with this technology	A	B	C	D	E
2. Vincent C. Traynelis, MD communicated clearly and effectively	A	B	C	D	E
Regis W. Haid, Jr., MD communicated clearly and effectively	A	B	C	D	E
Praveen V. Mummaneni, MD, communicated clearly and effectively	A	B	C	D	E
Gregory R. Trost, MD communicated clearly and effectively	A	B	C	D	E
Robert F. Heary, MD communicated clearly and effectively	A	B	C	D	E
Oral Abstract Presenters communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The quality of the written material provided was:	A	B	C	D	E
6. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this general session that you will apply to your practice?

9. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SCIENTIFIC SESSION II – THE EVOLUTION OF LUMBAR SPINE SURGERY ANTERIOR/POSTERIOR

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Explain the various options in treating lumbar spine disease from an anterior approach	A	B	C	D	E
Identify patients that may have better outcomes with posterior approaches	A	B	C	D	E
Recognize the rationale for approaching the spine either anteriorlyor posteriorly	A	B	C	D	E
2. Joseph T. Alexander, MD communicated clearly and effectively	A	B	C	D	E
Ray M. Baker, MD communicated clearly and effectively	A	B	C	D	E
Charles L. Branch, Jr., MD communicated clearly and effectively	A	B	C	D	E
Paul McAfee, MD communicated clearly and effectively	A	B	C	D	E
Richard G. Fessler, MD communicated clearly and effectively	A	B	C	D	E
Fred H. Geisler, MD communicated clearly and effectively	A	B	C	D	E
André Van Ooij, MD communicated clearly and effectively	A	B	C	D	E
William C. Welch, MD communicated clearly and effectively	A	B	C	D	E
Oral Point Abstract Presenters communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The quality of the written material provided was:	A	B	C	D	E
6. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this general session that you will apply to your practice?

9. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SCIENTIFIC SESSION III – SPECIAL TECHNOLOGY SESSION

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Recognize available radiological guidance systems that can be implemented in the OR	A	B	C	D	E
Summarize the newest diagnostic imaging techniques	A	B	C	D	E
Explain the benefits and pitfalls of frameless stereotactic guidance	A	B	C	D	E
Discuss how telemedicine can be incorporated into spine practices to increase efficiency	A	B	C	D	E
2. Gerald E. Rodts, Jr., MD communicated clearly and effectively	A	B	C	D	E
Deborah L. Benzel, MD communicated clearly and effectively	A	B	C	D	E
Christopher H. Comey, MD communicated clearly and effectively	A	B	C	D	E
Richard G. Fessler, MD, communicated clearly and effectively	A	B	C	D	E
Kevin T. Foley, MD communicated clearly and effectively	A	B	C	D	E
Brian R. Greer communicated clearly and effectively	A	B	C	D	E
Iain H. Kalfas, MD communicated clearly and effectively	A	B	C	D	E
Isador Lieberman, MD communicated clearly and effectively	A	B	C	D	E
Najeeb Thomas, MD communicated clearly and effectively	A	B	C	D	E
Oral Abstract Presenters communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The quality of the written material provided was:	A	B	C	D	E
6. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this general session that you will apply to your practice?

9. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SPECIAL COURSE V – ABC'S OF PERIPHERAL NERVE SURGERY

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to:					
Convey basic information on diagnosis and management of common nerve injuries, nerve entrapments and nerve disorders	A	B	C	D	E
Prepare the residents for the written board examinations and the young neurosurgeons for the oral board examinations on nerve topics and questions	A	B	C	D	E
Review the diagnosis and differential diagnoses of nerve conditions, particularly those that have overlap to medical and spinal conditions	A	B	C	D	E
Distinguish those nerve conditions needing emergent and urgent management versus those that can be managed in a more delayed fashion	A	B	C	D	E
Recognize common peripheral nerve conditions and distinguishing these from the unusual conditions, which should be referred to subspecialists	A	B	C	D	E
2. Robert J. Spinner, MD communicated clearly and effectively	A	B	C	D	E
Eric L. Zager, MD communicated clearly and effectively	A	B	C	D	E
Allan J. Belzberg, MD communicated clearly and effectively	A	B	C	D	E
Aaron G. Filler, MD, PhD communicated clearly and effectively	A	B	C	D	E
Holly S. Gilmer-Hill, MD communicated clearly and effectively	A	B	C	D	E
Line Jacques, MD communicated clearly and effectively	A	B	C	D	E
Allen H. Maniker, MD communicated clearly and effectively	A	B	C	D	E
John E. McGillicuddy, MD communicated clearly and effectively	A	B	C	D	E
Robert L. Tiel, MD communicated clearly and effectively	A	B	C	D	E
3. The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The quality of the written material provided was:	A	B	C	D	E
6. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this special course that you will apply to your practice?

9. Overall, how could this special course by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

MEETING THE CHALLENGES OF CARING FOR THE PATIENT WITH A SPINAL TUMOR – A SPECIAL SYMPOSIUM FOR NURSES, NURSE PRACTITIONERS AND PHYSICIAN ASSISTANTS

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this symposium I am able to:					
Discuss the significance of spinal tumors and the neurosurgical decision making for patients with a spinal tumor	A	B	C	D	E
Analyze perioperative care considerations, adjunctive treatment options and when neurosurgical treatment is no longer indicated	A	B	C	D	E
2. Shannon Hagy, BSN, CNRN communicated clearly and effectively	A	B	C	D	E
Andrea L. Strayer, NP, CNRN communicated clearly and effectively	A	B	C	D	E
Edward C. Benzel, MD communicated clearly and effectively	A	B	C	D	E
Robert D. Hager, MMSC, PAC communicated clearly and effectively	A	B	C	D	E
Michael P. Steinmetz, MD communicated clearly and effectively	A	B	C	D	E
Christina M. Stewart-Amidei, MSN, RN, APN, CNRN, CCRN communicated clearly and effectively	A	B	C	D	E
3. The level to which this symposium met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The quality of the written material provided was:	A	B	C	D	E
6. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this symposium was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this symposium that you will apply to your job responsibilities?

9. Overall, how could this symposium by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

DAVID CAHILL MEMORIAL CONTROVERSIES SESSION

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Discuss the indications for surgery in the management of asymptomatic spinal cord compression	A	B	C	D	E
2. R. John Hurlbert, MD, PhD communicated clearly and effectively	A	B	C	D	E
Christopher I. Shaffrey, MD communicated clearly and effectively	A	B	C	D	E
Ronald I. Apfelbaum, MD communicated clearly and effectively	A	B	C	D	E
Ray M. Baker, MD communicated clearly and effectively	A	B	C	D	E
Edward C. Benzel, MD communicated clearly and effectively	A	B	C	D	E
Anthony K. Frempong-Boadu, MD communicated clearly and effectively	A	B	C	D	E
Richard G. Fessler, MD communicated clearly and effectively	A	B	C	D	E
Larry T. Khoo, MD communicated clearly and effectively	A	B	C	D	E
Stephen M. Papadopoulos, MD communicated clearly and effectively	A	B	C	D	E
Fred H. Geisler, MD communicated clearly and effectively	A	B	C	D	E
André Van Ooji, MD communicated clearly and effectively	A	B	C	D	E
William C. Welch, MD communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this general session that you will apply to your practice?

8. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

9. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SCIENTIFIC SESSION IV – PAIN AND THE SPINE SURGEON

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Review appropriate narcotic weaning regimens for patients undergoing spinal surgery	A	B	C	D	E
Describe the current pharmacological options available for caring for these patients	A	B	C	D	E
Recognize indications for surgical pain management with neural augmentations and stimulation	A	B	C	D	E
2. John C. Oakley, MD communicated clearly and effectively	A	B	C	D	E
Giancarlo Barolat, MD communicated clearly and effectively	A	B	C	D	E
Richard K. Osenbach, MD communicated clearly and effectively	A	B	C	D	E
David S. Sinclair, MD communicated clearly and effectively	A	B	C	D	E
John J. Moossy, MD communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

7. What did you learn in this general session that you will apply to your practice?

8. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

9. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

10. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SCIENTIFIC SESSION V – YOUR ENVIRONMENT: THE SPINE PLAYING FIELD

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this general session I am able to:					
Outline the current infrastructure that exists with regards to Medical politics	A	B	C	D	E
Recognize the competing factors and compelling reasons to implement a concerted effort to unify and align our society's interests with other spine lobby organizations	A	B	C	D	E
2. Mark R. McLaughlin, MD communicated clearly and effectively	A	B	C	D	E
Christopher I. Shaffrey, MD communicated clearly and effectively	A	B	C	D	E
James Bean, MD communicated clearly and effectively	A	B	C	D	E
Paul B. Nelson, MD communicated clearly and effectively	A	B	C	D	E
Katie Orrico, JD communicated clearly and effectively	A	B	C	D	E
Troy M. Tippett, MD communicated clearly and effectively	A	B	C	D	E
Paul Starr, PhD communicated clearly and effectively	A	B	C	D	E
3. The level to which this general session met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
7. The overall rating of this general session was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this general session that you will apply to your practice?

9. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

SPECIAL COURSE VI– BOARD REVIEW FOR SPINE SURGERY AND PERIPHERAL NERVE

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

	RATING SCALE				
	Excellent		Average		Poor
	A	B	C	D	E
1. Because of this special course I am able to:					
Summarize the most common peripheral nerve cases that might be presented on an oral board examination	A	B	C	D	E
Review common spine case scenarios that might be presented	A	B	C	D	E
Discuss incorporating an alga rhythm format in creating a systematic approach to the answering oral examination questions	A	B	C	D	E
2. Ehud Mendel, MD, FACS communicated clearly and effectively	A	B	C	D	E
Daniel K. Resnick, MD communicated clearly and effectively	A	B	C	D	E
Allen H. Maniker, MD communicated clearly and effectively	A	B	C	D	E
Alan Levi, MD, PhD, FRCS communicated clearly and effectively	A	B	C	D	E
3. The level to which this special course met my expectations was:	A	B	C	D	E
4. The opportunity for questions and discussion was:	A	B	C	D	E
5. The applicability of the information presented to my practice was:	A	B	C	D	E
6. The overall rating of this special course was:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

8. What did you learn in this general session that you will apply to your practice?

9. Overall, how could this general session by improved (i.e. topics covered, speakers, audio/visual)?

10. Did you perceive any type of commercial bias during this program? Yes No
If yes, please explain:

11. What other topics and/or speakers would you like to see presented at future Annual Meetings?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

OVERALL MEETING EVALUATION

Name _____ Member ID _____

Your comments to the following questions are needed to assist the Annual Meeting Committee in developing future programs. Your time and effort in completing this evaluation form is appreciated.

RATING SCALE: Excellent A B Average C D Poor E

ABSTRACT PRESENTATIONS

1.	Balanced selection of papers:	A	B	C	D	E
2.	Originality of the papers presented:	A	B	C	D	E
3.	Content relevant to my practice:	A	B	C	D	E
4.	Opportunity for questions/discussion:	A	B	C	D	E

OVERALL PROGRAM

5.	Overall impression of the meeting:	A	B	C	D	E
6.	Level to which the Annual Meeting met my expectations was:	A	B	C	D	E
7.	The duration of the meeting is: A. Just Right B. Too Long C. Too Short	A	B	C		
8.	Quality of the audiovisual:	A	B	C	D	E
9.	Meeting location:	A	B	C	D	E
10.	Hotel accommodations and service staff met my expectations:	A	B	C	D	E
11.	Pricing of hotel/resort accommodations:	A	B	C	D	E
12.	The overall cost to attend the meeting is: A. Reasonable B. Moderate C. Too Expensive	A	B	C		
13.	Did you perceive any commercial bias during this program? A. Yes B. No	A	B			

If yes, please explain:

EXHIBIT AND E-POSTERS

14.	The organization and content of the poster session was:	A	B	C	D	E
15.	How many hours have you spent in the exhibit hall so far? A. Less than 1 hour B. 1–2 Hours C. 2–3 Hours D. More than 4 Hours E. None	A	B	C	D	E
16.	The quality of the exhibit program is:	A	B	C	D	E

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION

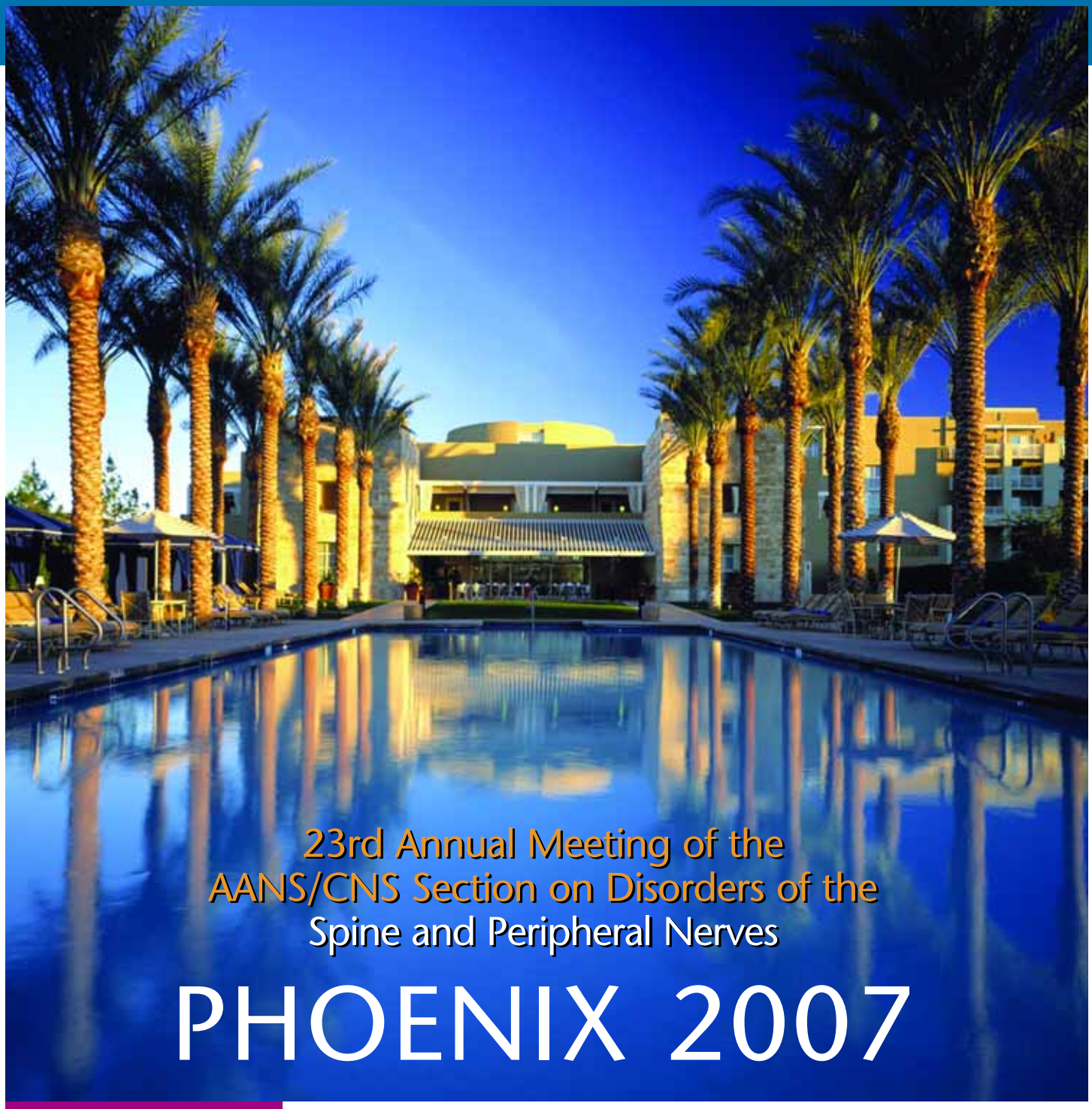
17. What suggestions do you have for improving this meeting?

18. What suggestions do you have for improving the exhibit hall?

19. What other topics and/or speakers would you like to see presented at future Annual Meetings?

20. Is there a city or location you would like to see the AANS/CNS Section on Disorders of the Spine and Peripheral Nerves host a future Annual Meeting?

PLEASE TURN IN EVALUATION FORMS AT REGISTRATION



23rd Annual Meeting of the
AANS/CNS Section on Disorders of the
Spine and Peripheral Nerves

PHOENIX 2007

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