**Oral Presentations**

**100. In Situ Placement of High-Dose rhBMP-2 within Spine Tumors Slows Tumor Growth and Decreases Onset to Paralysis in a Rat Model of Metastatic Breast Cancer**

Camilo A. Molina BA; Rachel Sarabia-Estrada DVM, PhD (Johns Hopkins University School of Medicine); Guergana Panayotova BS; Antonio Aguileria BA; Ziya L. Gokaslan MD (Johns Hopkins University); Jean-Paul Wolinsky MD; Ali Bydon MD (Johns Hopkins Hospital); Daniel M. Sciubba BS, MD (Johns Hopkins University)

*Introduction:* Recombinant human bone morphogenic proteins (rhBMPs) are FDA-approved for specific spinal fusion procedures, but use is contraindicated in spine tumor resection beds due to unclear interaction between tumor tissue and such growth factors. Interestingly, a number of studies suggest that BMPs may slow growth of adenocarcinomas in vitro, and adenocarcinomas represent the majority of histopathologies found in bony spine tumors. In this study, we hypothesized that high concentration rhBMP-2 placed in an intraosseous spine tumor rat model could show tumor suppression and prolong onset to paralysis in such animals.

*Methods:* 21 female nude athymic rats were randomized into three groups. Group 1 (n=7) underwent transperitoneal exposure and implantation of breast adenocarcinoma (CRL-1666) into the L6 lumbar spine segment, followed by implantation of 15 micrograms of rhBMP-2. Group 2 (n=7) underwent exposure and tumor implantation on the lumbar spine, but no local treatment with rhBMP-2. Group 3 (n=7) solely underwent exposure of the lumbar spine. The majority of histopathologies found in bony spine tumors. In this study, we hypothesized that high concentration rhBMP-2 placed in an intraosseous spine tumor rat model could show tumor suppression and prolong onset to paralysis in such animals.

*Results:* No animals in Group 1 were paretic by day 15 (median BBB score of 20, p<0.0027). All animals in Group 2 were paretic by day 15 (median BBB score of 0, p=0.0024) with a mean time to paresis (±SD) of 13.5±1.4 days. Time to paresis was significantly different between Group 1 and Group 2 (p<0.001). Group 3 (control) exhibited no neurological motor deficit. Gross and microscopic tumor volume was also significantly (p<0.048) different between Groups 1 and 2.

*Conclusion:* This study shows that high-dose administration of local rhBMP-2 in a rat spine tumor model of breast cancer not only fails to stimulate local tumor growth, but also decreases local tumor growth and onset of paresis in animals. This is the first preclinical experiment showing that local placement of rhBMP-2 in a spine tumor bed may slow tumor progression and delay associated neurological decline.

**101. The Effect of Surgery on Health Related Quality of Life and Functional Outcome in Patients with Metastatic Epidural Spinal Cord Compression: Initial Results of the AOSpine North America Prospective Multicenter Study**

Michael G. Fehlings MD, PhD, FRCSC, FACS (Toronto Western Hospital); Branko Kopjar MD; Alexander R. Vaccaro MD; Paul M. Arnold MD; Charles Fisher MD; Ziya L. Gokaslan MD (Johns Hopkins University); James M. Schuster MD; Mark B. Dekutoski MD (The Mayo Clinic); Joel Finkelstein MD (Sunnybrook Health Sciences Center); Laurence D. Rhines MD (UT-MD Anderson Cancer Center)

*Introduction:* Metastatic epidural spinal cord compression (MESCC) is common and recent studies have provided evidence that in selected patients combined surgery and radiotherapy provides the optimal neurological recovery. However, patients with MESCC have relatively short life-expectancy and face numerous challenges. Hence, the impact of surgery on improving quality of life outcomes in the setting of MESCC is less clear.

*Methods:* 72 surgical patients were enrolled in a prospective multi-center, cohort study involving 8 sites in North America. Outcomes were assessed using the pain assessments, ASIA scale, SF-36v2, and EQ-5D.

*Results:* Average age was 58 years (SD 11), 65% were males. Common primary sites were lungs (32%), prostate (15%), breast (11%), and kidney (11%). The baseline EQ5D was .38; SF36PCS 32; SF36MCS 39, VAS Pain 61.6; ASIA Impairment grade at baseline was 35% (E), 45% (D), 14% (C), 3% (B) and 3% (A). Median survival was 157 days; 93% survived one month; 62% survived 3 months, 41% survived 9 months, 32% survived 12 months. Among the surviving patients, the average improvement at 3 month was for EQ5D (P<.001), 26 for ODl (P<.001) , 2.6 for VAS Pain (P<.05). Also, there was a significant improvement in ASIA Impairment grade (P<.05). There was no significant change in SF36 PCS and MCS. The gains in EQ5D, ODl and VAS Pain were maintained in patients who survived 6 months.

*Conclusion:* Surgically treated patients with MESCC have poor survival. Among the surviving patients, the surgical treatment is associated with improvement in symptoms and functional outcomes. However, this does not translate into significant gains in overall health related quality of life. Individuals with less than three month life expectancy may be less than ideal candidates for surgical intervention. Further follow-up and a larger sample size in this ongoing study will help to identify subgroups of patients who may benefit from the surgical intervention.
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102. Survival of Patients with Malignant Primary Osseous Spinal Neoplasms from the Surveillance, Epidemiology, and End Results (SEER) Database from 1973-2005

Kaisorn L. Chaichana MD (Johns Hopkins Hospital); Scott Parker; Owoicho Adogwa BS, MPH; Debrah Mukherjee MD; Oran Aaronsom MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Ziya L. Gokaslan MD (Johns Hopkins University); Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Malignant primary osseous spinal neoplasms are aggressive tumors which remain associated with poor outcomes. To date, prognosis is based upon small single center series. In order to assess national trends in histology-specific survival, we reviewed survival data spanning 30 years from the surveillance, epidemiology, and end results (SEER) registry.

Methods: The SEER registry (1973-2003) was queried to identify primary spinal chordoma, chondrosarcoma, osteosarcoma, or Ewing’s sarcoma via ICD-O-2 coding. Survival was assessed via Cox proportional-hazards regression analysis.

Results: 1,892 patients were identified with primary osseous spinal neoplasms (414 chordoma, 579 chondrosarcoma, 430 osteosarcoma, 469 Ewing’s sarcoma). Chordomas presented in older (59±17, p<0.01) and Ewing’s Sarcoma in younger (19±11, p<0.01) patients versus other tumors. The incidence of each tumor type remained similar per decade. African Americans comprised a significantly greater proportion of osteosarcoma than other tumors (9.6 vs. 3.5%, p<0.01). Mobile spine versus sacrum was more often location for chordomas than other tumors (47% vs. 23%, p<0.05). Osteosarcoma and Ewing’s Sarcoma were 3-fold more likely to present with metastasis (31% vs. 8%), Surgical resection was performed more frequently for chordoma (88%) and chondrosarcoma (88%) than osteosarcoma (61%) and Ewing’s (53%). Median survival was histology specific (Osteosarcoma: 11mo, Ewing’s: 26mo, chondrosarcoma: 37mo; chordoma: 50mo) Survival was worse in patients with metastasis at presentation, Figure1, but unaffected by site (mobile spine versus sacrum/pelvis)Figure2. More recent year of diagnosis was associated with greater utilization of surgery (OR1.23, p<0.001) and improved survival for isolated spinal Ewing’s sarcoma (HR, 0.95, p=0.001), chondrosarcoma (HR, 0.98, p=0.009), and chordoma (HR, 0.98, p=0.10) but was not associated with increased utilization of surgery (OR1.10, p=0.43) or survival for osteosarcoma, Figure3.

Conclusion: In our analysis of a 30-year U.S. population based cancer registry (SEER), we provide nationally representative prognostic and survival data for malignant primary spinal osseous neoplasm. Use of surgery and overall survival has improved for isolated spine tumors with advancements in care over the past four decades. These results may be helpful in providing historical controls for understanding the efficacy of new treatment paradigms patient education and guiding level of aggressiveness in treatment strategies.

103. Electrical Stimulation Enhances Axon and Nerve Regeneration

Rajiv Midha MD (University of Calgary); Bhagat Singh; Qing Gui Xu; Colin Franz; Colin Dalton; Tessa Gordon; Doug Zochodne

Introduction: Axon regeneration after peripheral nerve injury is delayed and incomplete. Brief low frequency electrical stimulation (ES) applied immediately after injury is known to improve axonal regeneration. With these findings, we aimed to explore several new features of this interesting property.

Methods: We examined early axon and Schwann cell (SC) outgrowth beyond transaction sciotic nerve injuries in mice comparing sham ES to brief ES (3V, 20Hz, and pulse width 0.1 ms for 1 hr) delivered only at the time of injury. In a second approach to examine early axon outgrowth, an identical protocol was examined using harvested adult rat sensory neurons in vitro stimulated over a novel microelectrode array construct.

Results: We identified accelerated outgrowth beyond the repair site of both axons and SCs following ES. These early benefits translated into an ongoing impact of ES on regeneration. There was enhanced myelinated axon repopulation by 21 days across transaction sites, with higher numbers of retrogradely labelled motor neurons regenerating their axons. In thy-1 GFP mice with fluorescent peripheral axons, we confirmed the early impact on outgrowth and identified earlier arrival of GFP cutaneous axons in peripheral sensory targets. This was strongly correlated with more rapid recovery of mechanical and thermal sensation in the foot and of compound muscle action potentials beyond the injury site. The in vitro paradigm identified robust immediate rises in neurite initiation of the stimulated neurons and improved outgrowth as compared to control conditions.

Conclusion: These data support the robust role of brief ES following peripheral nerve trunk injuries in promoting axon initiation and outgrowth after transection, in axon maturation and in repopulation of targets. This is a wider repertoire of impact than previously known and its replication in vitro supports the hypothesis that a neuron specific reprogrammed injury response is recruited by the ES protocol.

104. Efficacy and Active Ingredients in an Epidural Analgesic Paste after Lumbar Decompression: A Prospective Randomized Double-Blind Controlled Trial

Roberto Jose Diaz MD, BSc (Foothills Medical Centre); S. Terence Myles (Alberta Childrens Hospital); R. John Hurlbert MD, PhD, FACS, FRCS(C) (Department of Clinical Neurosciences, Foothills Hospital)

Introduction: The purpose of this study was to evaluate the efficacy and active ingredients of a previously described epidural analgesic paste in controlling post-operative pain and facilitating early discharge from hospital after lumbar decompressive surgery.

Methods: A prospective randomized double-blind controlled trial was conducted. Two-hundred and one patients were randomized to one of four epidural analgesic pastes at the time of lumbar spinal surgery: combo paste (morphine + methylprednisolone), steroid paste (methylprednisolone alone), morphine paste (morphine alone), and placebo. The primary outcome measures used were narcotic and non-narcotic use and McGill Pain Questionnaire (MPQ). Secondary outcome measures included modified ASIA score, SF-36, time to ambulation and discharge from hospital.

Results: Administration of combo and steroid paste, but not morphine paste resulted in a statistically significant reduction in mean PRI and PPI components of the MPQ in the first 3 days after surgery. Narcotic analgesic consumption was reduced on post-operative day 1 in the combo paste and steroid paste groups. No difference in time to ambulation or discharge, general health perception, ABPI scores, or neurological recovery was observed.

Conclusion: We have demonstrated the efficacy of epidural analgesic paste containing methylprednisolone acetate to produce a robust post-operative analgesic effect. This paste should be considered for use in patients undergoing routine lumbar decompressive surgery.

105. Radiographic Same-Level Recurrent Disc Herniation After Lumbar Discectomy: Prospective Longitudinal Study With Two-Year Follow-Up

Scott Parker; Richard L. Lebow MD (Vanderbilt University Medical Center); Owoicho Adogwa BS, MPH; Scott Parker; Adrijna Sharma PhD (Vanderbilt University); Oran Aaronsom MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: To date, the incidence of radiographic same-level
recurrent disc herniation has not been studied prospectively with sequential imaging. Furthermore, the clinical relevance of radiographic recurrent disc herniation on MRI after discectomy remains unknown, particularly in patients without symptoms or with poorly localized pain after surgery. We previously reported factors associated with asymptomatic same-level recurrent disc herniation from this cohort. In a post-hoc analysis, we set out to determine the incidence of asymptomatic same-level recurrent disc herniation and assess their effect on two-year outcome.

Methods: One hundred and eight patients undergoing lumbar discectomy for a single-level herniated disc at five institutions were prospectively followed for two years. CT and MRI of the lumbar spine were obtained every three months to assess re-herniation and disc height loss. Leg and back pain visual analogue scale (VAS), Oswestry Disability Index (ODI), and quality of life (SF-36 physical component) were assessed 3, 6, 12, and 24 months after surgery.

Results: No patients demonstrated residual disc on post-operative MRI. By two years after discectomy, 25 (23.1%) patients had demonstrated radiographic evidence of recurrent disc herniation at the level of prior discectomy (mean 11.8 ± 8.3 months after surgery), the majority of which were asymptomatic [14 (13%) patients]. The occurrence of asymptomatic re-herniation was not associated with disc height loss or any outcome measure (VAS, ODI, SF-36) by two years.

Conclusion: In a prospective cohort study with serial imaging, nearly one-fourth of patients undergoing lumbar discectomy demonstrated radiographic abnormality suggestive of recurrent disc herniation at the level of prior surgery, the majority of which were asymptomatic. Asymptomatic disc herniation was not associated with clinical consequences by two years. Clinically silent recurrent disc herniation is not uncommon after lumbar discectomy. When obtaining MRI evaluation within the first two years of discectomy, providers should expect that radiographic evidence of re-herniation may be encountered and that treatment should only be considered when correlating radicular symptoms exist.

106. Cost Effectiveness of Multilevel Hemilaminectomy for Lumbar Stenosis Associated Radiculopathy

Erin Fulchiero BS; Brandon J. Davis MD, PhD (Vanderbilt University Hospital); Owoicho Adogwa BS, MPH; Onan Aaronson MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Clint Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Laminectomy for lumbar stenosis associated radiculopathy is associated with improvement in pain, disability, and quality of life. However, given rising healthcare costs, attention has been turned to question the cost-effectiveness of lumbar decompressive procedures. The cost-effectiveness of multilevel hemi-laminectomy for radiculopathy remains unclear. We set out to assess the comprehensive medical and societal costs of multi-level laminectomy at our institution and determine its cost-effectiveness in the treatment of degenerative lumbar stenosis.

Methods: Fifty-four consecutive patients undergoing multilevel hemi-laminectomy for lumbar stenosis associated radiculopathy after 6 months of conservative therapy were included. Over a two-year period, total back-related medical resource utilization, missed work, and improvement in pain (VAS-LP), disability (Oswestry Disability Index (ODI), quality of life (SF-12), and health-state values [quality adjusted life years (QALYs)], calculated from EQ-5D with U.S. valuation) were assessed. Two-year resource use was multiplied by unit costs based on Medicare national allowable payment amounts (direct cost) and patient and care-giver work-day losses were multiplied by the self-reported gross-of-tax wage rate (indirect cost). Mean total two-year cost per QALY gained after TLIF was assessed.

Results: Compared to pre-operative health states reported after at least 6 months of medical management, a significant improvement in VAS-BP, ODI, and SF-12 (physical and mental components) was observed two years after laminectomy, with a mean two-year gain of 0.72 QALYs. Figure 1. Mean ±SD total two-year cost of multilevel hemilaminectomy was $23,477 ±9,912 (Surgery cost: $10,220 ±100; Outpatient resource utilization cost: $2,805 ±1,958; Indirect cost: $10,452 ±9,364). Multilevel hemilaminectomy was associated with a mean two-year cost per QALY gained of $32,606.

Conclusion: Multilevel hemilaminectomy improved pain, disability, and quality of life in patients with lumbar stenosis-associated radiculopathy. Total cost per QALY gained with multi-level laminectomy was $32,606 when evaluated two years after surgery with Medicare fees, suggesting that multilevel hemilaminectomy is a cost effective treatment of lumbar radiculopathy.
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109. Effect of Patient Pain Expectations and Preoperative SF-36 Mental Component Summary Scores on Clinical Outcomes Following Anterior Cervical Discectomy and Fusion

Frances A. Carr BA; Theresa Hernandez; Kyle M. Healy; Ewell Lee Nelson MD; Alexander Mason MD; Sigita Burneikiene MD; Alan T. Villavicencio MD

Introduction: The primary purpose of this study was to analyze if preoperative patient expectations and SF-36 MCS scores have any effect on clinical outcomes.

Methods: A prospective clinical study was performed. This study included 79 (38 males, 41 females) patients who underwent one- to three-level ACDF surgery. Preoperatively, patients were asked to rate their expected pain after surgery and complete VAS neck/arm (0-10), NDI and SF-36 PCS/MCS scales. Patients were divided into two groups for the expectation analyses: complete resolution of pain (n=44) and some pain expected (n=35) postoperatively. The above clinical parameters and patient satisfaction with results scores were measured postoperatively. The mean follow up was 38.8 months (range, 7-59).

Results: Overall, all postoperative measures depicted significant improvement (Table 1). Patient demographics and clinical parameters were comparable preoperatively between the expectation groups (Table 2, 3). Controlling for respective preoperative scores, patients who expected no pain reported lower postoperative neck/arm pain (p<0.02), higher SF-36 MCS (p=0.04) and higher satisfaction with results (p=0.007) scores, although no significant differences were detected in postoperative NDI or SF-36 PCS scores compared with patients that expected some pain. Furthermore, controlling for respective preoperative scores, higher preoperative SF-36 MCS scores significantly predicted lower postoperative neck pain (p=0.003) and NDI (p=0.004) scores, and higher postoperative SF-36 PCS (p=0.002), SF-36 MCS (p=0.001) and satisfaction (p=0.033) scores.

Conclusion: Patients who expected no pain postoperatively reported better postoperative scores on the more subjective outcome measures (VAS arm and neck, satisfaction with results), as well as the SF-36 mental component score. Patients with higher preoperative mental component scores had better clinical outcomes (VAS neck, NDI, SF-36 PCS/MCS, satisfaction with results). The results suggest that optimism in patients’ expectations as well as other potential psychological factors predict improved clinical outcomes and patient satisfaction.

110. Factors Associated with the Occurrence of Perioperative Complications in the Treatment of Cervical Spondylotic Myelopathy Based on 302 Patients from the AOSpine North America Cervical Spondylotic Myelopathy Study

Justen S. Smith MD, PhD (University of Virginia Health System); Christopher L. Shaffrey MD, FACS (University of Virginia); Brankot Kopjar MD; Paul M. Arnold MD; Sangwook Yoon MD (Emory Orthopedic); Alexander R. Vaccaro MD; Darrel S. Bordke MD; Michael Janssen MD; Jens Chapman MD; Rick Sasso MD; Eric J. Woodard MD (New England Baptist Hospital); Robert J. Banco MD; Eric M. Massicotte (Toronto Western Hospital); Mark Dekotowski; Ziya L. Gokaslan MD (Johns Hopkins University); Christopher Bono MD; Michael G. Fehlings MD, PhD, FRCS, FACS (Toronto Western Hospital)

Introduction: Surgery is often warranted for cervical spondylotic myelopathy (CSM). Our objective was to assess for clinical and surgical factors associated with the occurrence of complications in the surgical treatment of CSM based on a prospective multicenter study.

Methods: The AOspine North America CSM study is a recently completed prospective multicenter study of patients surgically treated for CSM. Rates of perioperative complications (within 30 days of surgery) were assessed and stratified based on clinical and surgical factors.

Results: 302 patients were enrolled (mean age: 57 years, range: 29-86). Of 332 reported adverse events, 73 were adjudicated to be complications, including 25 major (8%) and 48 minor (16%). Of patients treated with anterior-only (n=176), posterior-only (n=107), and combined anterior-posterior procedures (n=19), 11%, 19%, and 37%, respectively, had one or more complications (p=0.008). Procedures including a posterior approach had a significantly higher rate of infection (6.3% vs 0.6%, p=0.005). Dysphagia was significantly more common with anterior-only (2.3%) or combined anterior-posterior (21.1%) procedures, compared with posterior-only procedures (0.9%, p<0.001). C5 radiculopathy/palsy was not significantly associated with surgical approach (p=0.8). Occurrence of complications was significantly associated with increased operative time (p<0.001), increased blood loss (p<0.001), and inclusion of a fusion (p=0.01), but not with age (p=0.9), body-mass index (BMI, p=0.7), smoking (p=0.3), prior surgery (p=0.09), or number of operated vertebrae (p=0.9).

Conclusion: For the surgical treatment of CSM, operative factors, including surgical approach, operative time and blood loss, have stronger associations with the occurrence of perioperative complications than do patient factors, such as age, BMI, and smoking.

111. Comparative Economic Analysis of Ventral versus Dorsal Surgery for Cervical Spondylotic Myelopathy

Andrew Becker; Robert Gray Whitmore MD (Hospital of the University of Pennsylvania); Susan Christopher RN; Jill Curran MS; Benjamin Baskin; Zohar Ghogawala MD (Greenville Neurosurgery)

Introduction: The objective of this study was to determine the optimal surgical approach (ventral versus dorsal) for patients with 3-4 levels of stenosis resulting in cervical spondylotic myelopathy (CSM).

Methods: A prospective, non-randomized, 8-center trial was conducted. Patients aged 40-79 years with 3-4 levels of degenerative cervical spondylotic spondylosis resulting in CSM were enrolled. Four outcome assessments (SF-36, Oswesty Neck Disability Index (NDI), mJOA, EuroQol-5D) were obtained pre-operatively and post-operatively at 6 months and 1 year. A hospital-based economic analysis used costs derived from total hospital charges and year-specific cost-to-charge ratios.

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Results: This study enrolled fifty-six patients (mean age – 62 years; gender – 57% male). Ventral decompression and fusion (VF) was performed on twenty-five patients, dorsal laminectomy with fusion (DF) on twenty-four, and dorsal laminectomy without fusion (L) on nine. One-year follow-up data was available on 73% of the cohort. Baseline demographics and outcome assessments were comparable at baseline. DF patients had significantly longer lengths of stay than VF (4.4 days versus 3.1 days, P=0.03). VF patients showed significant 1-year improvements for each of the four outcome measures and DF patients showed significant improvement in the mJOA. VF patients showed larger 1-year improvements than DF in 3 of the 4 assessments (Figure 1). Thirteen VF, seventeen DF, and five L patients were included in the cost analysis (Figure 2). VF was clearly cost-effective when compared to DF.

Conclusion: Of the 3 surgical strategies, ventral decompression with fusion resulted in the most significant 1-year functional improvement when treating 3-4 levels of spondylosis. In addition, ventral decompression with fusion is a cost-effective treatment option for CSM when compared to dorsal laminectomy both with and without fusion.

112. Functional and Quality of Life Outcomes in Geriatric Patients with Type II Odontoid Fracture: One-Year Results from the AOSpine North America Multi-Center GOF Prospective Study

Michael G. Fehlings MD, PhD, FRCSC, FACS (Toronto Western Hospital); Alexander R. Vaccaro MD; Branko Kopjar MD; Jens Chapman MD; Christopher I. Shaffrey MD, FACS (University of Virginia); Paul M. Arnold MD; Ziya L. Gokaslan MD (Johns Hopkins University); Roger Hartl MD (NY Hospital/Cornell Medical Center); Darrel S. Brodke MD; John France MD; Sangwook Yoon MD (Emory Orthopedic); Mark B. Dekutoski MD (The Mayo Clinic); Rick Sasso MD; Christopher Bono MD

Introduction: Odontoid fractures commonly occur in the elderly and represent a management challenge. It is unclear whether surgery or conservative management is the best treatment option. Moreover, there is a paucity of information regarding treatment outcomes.

Methods: We conducted a prospective multi-center cohort study of subjects > 65 years old with a Type II odontoid fracture at 13 sites in North America. Patients received nonoperative or surgical treatment at the discretion of the surgical team and were followed for 12 months. Outcomes assessments included the SF36, Neck Disability Index (NDI) and rates of mortality and complications.

Results: A total of 166 subjects were recruited (average age: 80.7 (SD 7.6); 59.6% females of whom 65.6% were treated operatively (15.2% anterior odontoid screw; 76.2% posterior C1- C2 screw fixation; 6.7% posterior transarticular screw fixation and 1.9% other). A total of 26 (15.7%) subjects expired and 5 subjects withdrew from the study. Follow-up was available for 100 (74%) of 135 eligible, surviving subjects. The baseline NDI was 21.9 (SD 17.0) and SF36v2 PCS was 41.0 (SD 10.5). At 12 months, the NDI worsened by 7.5 (SD 18.1) points (P < .001) and SF36v2 PCS declined by 2.3 (SD 10.4) points (P = .03). There was a significant difference in NDI outcomes between the surgically and the conservatively treated group. The decline in NDI among the surgical cases was 4.7 points compared to 13.0 points in the conservatively treated group (P = .017). There were no differences in the SF36v2 PCS outcomes between the treatment groups.

Conclusion: In spite of treatment, elderly patients with type II odontoid fracture experience significant mortality and decline in functional outcomes at one year follow-up. Our results do suggest that NDI outcomes may be better in the surgical group, though the possibility of selection bias needs to be carefully considered.

113. Prospective, Randomized, Multicenter Study of Cervical Arthroplasty: 269 Patients from the Kineflex/C Metal-on-Metal Artificial Disc IDE Study with Minimum Two Year Follow-Up

Domagoj Coric MD (Carolina Neurosurgery & Spine); Richard D. Guyer MD; Pierce D. Nunley MD; Charley Gordon MD; Thomas Dimmig MD; Cameron Carmody MD; Donna D. Ohmneiss Dr.Med.; Margaret Boltes

Introduction: This prospective, randomized, multicenter study evaluates the safety and efficacy of a new metal-on-metal cTDR implant (Kineflex/C) by comparing it to ACDF.

Methods: The study was a prospective, randomized FDA IDE pivotal trial conducted at 21 centers across the US. The primary clinical outcome measures included the Neck Disability Index (NDI), visual analog scales (VAS), and a composite measure of clinical success. Patients were evaluated clinically and radiographically preoperatively and at 1.5, 3, 6, 12, and 24 months after surgery.

Results: A total of 269 patients were enrolled and randomly assigned to either cTDR (n=136) or to ACDF (n=133). The overall success rate was significantly greater in the cTDR group (74%) compared to the ACDF group (62%) (p=0.05). In both the cTDR and ACDF groups, the mean NDI and VAS scores improved significantly by 6 weeks after surgery and remained significantly improved throughout the 24-month follow-up (p<0.001). The range of motion (ROM) in the cTDR group was significantly greater than the pre-op at 12- and 24-month follow-up. Adjacent level degeneration was also evaluated in both groups from pre-op to 2 year follow-up and classified as: none, mild, moderate or severe. Pre-op, there were no significant differences between groups when evaluating the different levels of adjacent level degeneration. However, at 2 year follow-up, there were significantly more patients in the ACDF group with severe adjacent level radiographic changes (p<0.01).

Conclusion: Kineflex/C was associated with a significantly greater overall success rate compared to fusion while maintaining motion at the index level. Furthermore, there were a significantly fewer Kineflex/C patients showing severe adjacent level radiographic changes at two year follow-up. These results from a prospective, randomized study support that Kineflex/C cTDR is a viable alternative to ACDF in select patients with cervical radiculopathy.

114. Cervical Disc Replacement: Interim Five-Year Follow-Up Results from the United States Prospective Randomized Bryan Clinical Trial

Richard G. Fessler MD (Northwestern University); Rick Sasso MD; Paul Anderson MD; John Hellier MD

Introduction: The purpose of this study is to evaluate the currently available data at half of a decade to determine their consistency over time and to assess complications and revision surgeries.

Methods: 463 patients were enrolled and received the study surgical treatments in a prospective, randomized, controlled, multicenter study with a 1:1 randomization scheme. No statistical differences were seen between the groups for demographics and preoperative measures. As of May 28, 2010, 5-year follow-up data were available for 193/242 (79.8%) of the arthroplasty patients and 159/221 (71.9%) of the control patients. The study’s primary outcome measure, overall success, as well as secondary functional outcome measures (NDI, SF-36, arm and neck pain scores), were collected at pre-defined time points out to 60 months postoperatively.

Results: At 60 months: Overall success rate: 160/193 (82.9%) for the arthroplasty group, 119/159 (74.8%) for the control group, p=0.043; NDI score: 15.9 arthroplasty, 19.1 control, p=0.020 (Change from preop: -35.6 arthroplasty, -30.2 control, p=0.020); Neck pain score: 23.8 arthroplasty, 28.8 control, p=0.031 (Change from preop: -51.3 arthroplasty, -45.2 control, p=0.031); and SF-36 PCS: 47.3 arthroplasty, 44.0 control, p=0.006 (Change from preop: 14.4 arthroplasty, 11.8 control, p=0.006); Cumulatively up to 60 months: Second surgery at index level: 11 (4.5%) arthroplasty, 11 (5.0%) control; Possibly device-related AEs: 9 (3.7%) arthroplasty, 14 (6.3%) control; Possibly device-related and serious (grade 3 or 4) AEs: 4 (1.7%) arthroplasty, 9 (4.1%) control.

Conclusion: Excellent results continue out to 5 years in both the arthroplasty and ACDF groups. Statistically significant differences
are present for overall success that favor the arthroplasty cohort. The NDI, SF-36 PCS and neck pain scores also showed improvement in the arthroplasty group that was statistically significant at 60 months compared to the control group. Second surgery and adverse events were very low in both groups with no statistically significant differences between groups at half a decade postoperatively.

115. Are Closed Suction Drains in Posterior Spinal Surgery “The Devil’s Highway” for Infection?

James S. Harrop MD; Srinivas K. Prasad MD (Thomas Jefferson University Hospital); John Kevin Ratliff (Thomas Jefferson University); Mitchell Gil Maltenfort PhD (Thomas Jefferson University, Department of Neurological Surgery); Phyllis Flomenberg; Ashwini Dayal Sharan MD; Alex Vaccaro; Shilpa Rao

Introduction: Surgeons advocate placement of extra-axial subfascial drains after posterior spine surgery to reduce post-operative collections (ie: hematomas). This may potentially decrease neurologic complications and possibly decrease infectious rates. However, the potential adverse consequences of increased infection rate due to foreign body placement have not been determined.

Methods: A retrospective analysis of an infection control prospective database of a single tertiary care surgery population was performed over a one-year period. Posterior instrumented spinal fusion procedures were assessed for surgical site infections (SSIs) and analyzed against case-controls (1:3 ratio). Specifically, the placement of subfascial drains and their duration of placement and how this correlated was explored.

Results: 1587 fusion procedures were performed during this one-year period of which 42 posterior instrumented fusions developed wound site infections (2.6%). Infections were diagnosed a mean of 14.6 ± 4.9 days post-procedure and skin flora (Staphylococcus aureus) was the most common pathogen (65%). Infected instrumented posterior spinal fusion procedures had a longer duration of subfascial drains than controls (median 5 days vs. 3 days, respectively [p<0.0001; log-rank test]). At a breakpoint of drain duration > 5 days, the OR of infection was 14.2 (95% CI = 5.6-35.9; p < 0.0001). Multivariate logistic regression indicated that likelihood of infection increased with drain duration (Odds Ratio, 1.5 per day drain present [95% CI, 1.2 - 2.0; p < 0.0001]) and was higher for males (OR 2.8; 95% CI 1.2-6.6; p = 0.01). Proportional hazards test determined that the probability of drains being removed on any given day was lower (hazard ratio 0.9, 95% CI 0.8-1.01; p=0.08). The increase in the thoracic or lumbar spine between June 2002-June 2009. Vascular encroachment was determined by review of routine post-operative CT scans.

Conclusion: The increased duration of time after the placement of posterior subfascial closed suction drains after instrumented spinal fusions appears to correlate with an increased incidence of surgical site infection. Therefore, shorter durations of time (specifically less than four days) or elimination of these drainage catheters may decrease the overall infection rates in this subpopulation of spine surgery patients.

116. Clinical and Radiographic Factors Driving the Transition from Nonoperative to Operative Treatment in Elderly Adults with Degenerative Scoliosis

Kai-Ming G. Fu MD, PhD (University of Virginia Hospital); Justin S. Smith MD, PhD (University of Virginia Health System); Christopher I. Shaffrey MD, FACS (University of Virginia)

Introduction: Few studies report the long-term outcomes of elderly adult degenerative scoliosis patients treated nonoperatively. In addition, the rate of crossover of nonoperatively managed patients and the factors influencing this crossover has not been demonstrated. In order to address these questions, we prospectively followed a cohort of such patients presenting to a surgical clinic for evaluation.

Methods: 92 consecutive adult degenerative scoliosis patients (age >60, mean 69) were followed prospectively upon presentation to the surgical clinic. All were initially managed nonoperatively. Quantitative measures of health status (SF-12 and ODI), VAS pain scores, and radiographic parameters were recorded. Patient follow-up was recorded at specified biennial time points or when a patient was treated operatively. Statistical analysis was performed via T-Test with a P<0.05 considered significant.

Results: 73 patients (79%) were followed for a minimum of 2 years (mean 2.64 years) or became operative patients. Of these 18 (25%) went on to have surgery in the follow-up period with a mean time to surgery of 1.6 years. There were no differences at presentation in age, health status (SF-12, ODI), leg pain, back pain, or sagittal balance between those that crossed over and those that were “successfully” treated conservatively. At last follow-up or pre-surgical follow-up, crossover patients had lower SF-12 scores (P=0.033), higher disability scores (p=0.04), and worse back (6.8 vs. 4.8 (p=0.002)) and leg (5.4 vs. 3.0 (p=0.002)) pain. There were no differences in radiographic parameters. Of note there was no significant overall progression of sagittal balance or maximum coronal curve. Patients continuing conservative therapy did not demonstrate significant changes in SF-12 and ODI scores.

Conclusion: There is a significant rate of crossover in nonoperatively managed elderly scoliosis patients. Those crossing over reported higher disability and worse pain and health. Patients continuing nonoperative therapy report stable, but not improved, outcome measures.


Scott L. Parker BS (The Johns Hopkins Hospital); Anubhav Amin; Ali Bydon MD (Johns Hopkins Hospital); Daniel M. Scibuca BS, MD (Johns Hopkins University); Jean-Paul Wolinsky MD (Johns Hopkins University); Ziya L. Gokaslan MD (Johns Hopkins University); Timothy F. Witham MD, BS (Johns Hopkins Hospital)

Introduction: Iatrogenic major vascular injuries during anterior instrumentation procedures have been reported by several authors, but there is a paucity of data regarding major vascular injuries during posterior instrumentation procedures. The purpose of this study is to evaluate the incidence and clinical significance of vascular encroachment resulting from free-hand placement of pedicle screws in the thoracic and lumbar spine.

Methods: We retrospectively reviewed records of all patients undergoing free-hand pedicle screw placement without image guidance in the thoracic or lumbar spine between June 2002-June 2009. Incidence and extent of vascular encroachment by a pedicle screw was determined by review of routine post-operative CT scans obtained within 24 hours of all surgeries. Vascular encroachment was defined as a screw touching or deforming the wall of a major vessel.

Results: Nine-hundred sixty-four patients received 6,816 free-hand pedicle screws in the thoracic or lumbar spine. Fifteen (0.22%) screws were identified to encroach upon a major vascular structure. Ten (67%) thoracic screws encroached on the aorta, 4 (27%) lumbar screws on the common iliac vein, and 1 (6%) S1 screw on the internal iliac vein. Figure 1. The spinal level of involvement is depicted in Figure 2. Consultation with vascular surgery was utilized to determine if revision surgery was recommended and the technique/approach for the revision procedure. Two (11.7%) patients required revision surgery to remove the encroaching pedicle screw (T5 and T8) due to concern for vascular injury. Both patients requiring revision were asymptomatic and recovered without further complications after revision surgery.

Conclusion: Vascular encroachment of major vessels occurs rarely in the setting of free-hand pedicle screw placement in the thoracic and lumbar spine. Although rare, delayed vascular injury from errant pedicle screw placement has been reported in the literature. Aorta is the vessel at highest risk of injury. Routine intra-operative and post-operative
CT scanning allows for early identification of screws encroaching on vascular structures thereby facilitating early revision surgery.

118. Evidence of Descending Supraspinal Control of Nociception and Pain Behavior in Experimental Disc-Herniation Radiculopathy

Mohammed F. Shamji MD, PhD (University of Ottawa Hospital -Civic Campus); Priscilla Hwang; Kyle D Allen; Mosfata Gabr; J. Chen; Lufang Jing; William J. Richardson MD; Lori A. Setton PhD

Introduction: Disc-herniation induced radiculopathy involves both mechanical compression and biochemical inflammation of apposed neural elements.(1-3) Recent evidence suggests heterotopic disc placement induces early and persistent allodynia alongside transient pathological gait asymmetry.(1) This suggests divergent molecular effects at spinal and supraspinal levels. This study evaluated the inflammatory and analgesic molecular profile observed at the dorsal root ganglion (DRG) and midbrain periaqueductal grey and red nucleus in an animal disc-herniation disease model.

Methods: Sprague-Dawley rats underwent surgical procedure including harvesting autologous nucleus pulposus (NP) from a tail intervertebral disc and exposure of the L5 dorsal root ganglion (DRG). Control animals (n=12) underwent exposure only and experimental animals received NP placement onto the DRG (n=12). Animals were evaluated for mechanical allodynia and for stance and gait symmetry. Following sacrifice (1 or 4 weeks), the DRG and midbrain were evaluated by immunohistochemistry for inflammatory activation and neurotransmitter receptors respectively.

Results: Persistent mechanical allodynia occurred in rats subjected to NP stimulation at 1 and 4 weeks, although this heightened sensitivity had the functional consequence of early gait asymmetry (1 week) with late normalization (4 weeks) (Figure 1). Injured animals revealed early and persistent inflammatory glial cell activation at the DRG, paralleling the allodynia phenotype. Conversely, midbrain studies revealed persistently high glutamate receptor expression, high serotonin receptor expression at 1 week with late normalization, and early normal opioid receptor expression with late escalation at 4 weeks (Figure 2).

Conclusion: Persistent mechanical allodynia with only transient gait abnormality in this model of non-compressive disc herniation suggests deficits to be mediated by both spinal and supraspinal mechanisms. Inflammatory DRG activation may generate persistent allodynia and promote gait asymmetry. Early midbrain nucleus serotonin and glutamate receptor expression may aggravate this deficit while late opioid receptor expression may permit adaptive response to normalize behavior.

119. Perioperative Use of Dexamethasone in Multilevel Anterior Cervical Spine Surgery: Preliminary Results of a Prospective, Randomized, Double-Blinded Trial

Tyler J. Kenning MD; Karen Petronis; John W. German MD; Doniel Drazin MD, MA; Darryl J. Dirisio MD (Albany Medical College)

Introduction: Anterior approaches to the cervical spine involve some retraction affecting the midline structures of the anterior neck. Steroids given intraoperatively may reduce the incidence of adverse outcomes, such as dysphagia and airway compromise. Their use has historically been controversial during spinal arthrodesis procedures due to concern that anti-inflammatory agents could reduce bony fusion rates.

Methods: A prospective, randomized, double-blinded study in patients undergoing multilevel anterior cervical spine surgery is being conducted at Albany Medical Center. Our hypothesis is that perioperative steroids decrease postoperative swallowing and airway complications and don’t impact long-term fusion rates. The target enrollment is 200 subjects with 2-year follow-up. This preliminary data reflects an interim analysis of the first 53 patients. We studied patients undergoing multilevel (>2 motion segments) anterior cervical spine procedures. Patients were randomized to receive intraoperative doses of either intravenous dexamethasone (0.2 mg/kg IV; n=28) or an equivalent volume infusion of saline (n=25). Four postoperative doses of 0.06mg/kg of steroid or placebo were administered every 6 hours for the first 24 hours. Preoperative parameters, including baseline demographics, smoking history, pain and functional status (mJOA, NDI, SF-12, VAS), swallowing function (functional outcome swallowing scale, FOSS) and diagnosis were reviewed. Postoperative data included length of inpatient stay, FOSS, mJOA, VAS, SF-12, and fusion status, assessed by CT, at 6 months. Any postoperative complications were noted.

Results: There were no statistical differences in preoperative parameters of age, gender, diagnosis, smoking history, number of operative levels, mJOA, FOSS, NDI, SF-12, or VAS between the 2 groups. FOSS, when assessed in the immediate postoperative period, was significantly lower in the steroid(S) group when compared to the placebo(P) group (S:0.59±0.80, P:1.23±0.92, p=0.01). This significance was lost at the 1, 3, and 6-month follow-up. There were no significant differences in any of the other postoperative measures, including 6 month fusion status. One patient in the placebo group required postoperative re-intubation, and one patient in the steroid group required PEG tube placement secondary to prolonged dysphagia.

Conclusion: Our preliminary data suggests that perioperative steroids decrease postoperative swallowing complications without negatively impacting long-term fusion rates.

120. Analysis of the Three United States FDA-IDE Cervical Arthroplasty Trials

Cheerag Upadhyaya MD; Jau-Ching Wu (Department of Neurosurgery, Taipei Veterans General Hospital); Regis W. Haid MD (Atlanta Brain and Spine Care); Vincent C. Traynelis MD (Rush University Medical Center); Bobby Tay MD; Domagoj Coric MD (Carolina Neurosurgery & Spine); Gregory R. Tost MD (University of Wisconsin-Madison); Scott A. Meyer MD (University of California, San Francisco); Praveen V. Mummaneni MD (UCSF Spine Center, Department of Neurosurgery)

Introduction: There are three randomized, multicenter, United States FDA IDE, industry sponsored studies comparing arthroplasty with anterior cervical discectomy and fusion (ACDF) for single level cervical disease with complete 2-years of follow-up. The studies evaluated the PRESTIGE ST, BRYAN, and ProDisc-C artificial discs and analyzed the combined results of these three trials.

Methods: A total of 1,213 patients with symptomatic, single-level cervical disc disease were randomized into two treatment arms in the 3 randomized trials. 621 patients received an artificial cervical disc and 592 patients were treated with ACDF. 94% of the arthroplasty group and 87% of the ACDF group have completed two years of follow-up. We analyzed the 2-year data from these three trials including previously unpublished source data. Statistical analysis was performed with both fixed and random effects models.

Results: Analysis demonstrated preserved segmental sagittal motion with arthroplasty (preoperatively 7.26 degrees and postoperatively 8.14 degrees) at the two-year timepoint. The fusion rate for ACDF at two years was 95%. The NDI, SF-36 MCS, SF-36 PCS, VAS neck pain, and VAS arm pain scores were not statistically different between groups at 24-months follow-up. The arthroplasty group demonstrated superior results at 24-months in neurological success (RR 0.595, F=0.006). The arthroplasty group had a lower rate of secondary surgeries (RR 0.508, I²=0%, p=0.018). The reoperation rate for adjacent level disease was lower for the arthroplasty group when we analyzed the combined data set using a fixed effects model (RR 2.23, F=2.9%, p=0.026).

Conclusion: Both ACDF and arthroplasty demonstrate excellent two year surgical results for the treatment of one level cervical disc disease with radiculopathy. Arthroplasty is associated with a lower rate of secondary surgery and a higher rate of neurological success at 2 years. Arthroplasty may be associated with a lower rate of adjacent level disease at 2 years.
Oral Posters

200. Pulsed Electromagnetic Field Bone Growth Stimulation for High Risk Fusion Patients: An Analysis of 452 Consecutive Cases

Naresh P. Patel MD (Mayo Clinic Arizona); Barry D. Birch MD (Mayo Clinic Hospital); Mark K. Lyons MD (Mayo Clinic Hospital); Richard S. Zimmerman MD (Mayo Clinic); Stacie DeMent PA-C; Gregy Elbert PA-C; Orland K. Boucher PA-C (Mayo Clinic Hospital); Amy Thieier PA-C

Introduction: Pseudarthrosis occurs in up to 10-15% of instrumented spinal fusion cases, often requiring revision surgery (1). High risk patients including diabetics, smokers, and those undergoing multi-level fusion or revision surgery have demonstrated higher pseudarthrosis rates (1,2). Patients with multiple risk factors pose an even greater treatment challenge (3,4). Bone Morphogenetic Protein (BMP) has been used increasingly to help promote fusion in high risk patients, but due to side effects and the cost may not be suitable for all patients (5). The authors describe their experience with a consecutive series of patients undergoing adjunctive treatment with an external bone growth stimulator to achieve successful fusion.

Methods: Between 2001-2009, 452 high risk patients underwent instrumented fusion surgery at the Mayo Clinic Arizona. 95 cervical and 357 lumbar cases were identified. Fusion was performed with iliac crest autograft and allograft in the lumbar spine and allograft alone in the cervical spine. No BMP was used. Each patient was fitted with an external pulsed electromagnetic field bone growth stimulator within two weeks of surgery which was worn for at least 2 hours/day for a minimum of 6 months. Follow-up was obtained at two weeks, three months, and one year post-operatively with radiographs and CT scans.

Results: In the cervical fusion group there were 88 solid fusions and 7 pseudarthroses (92.6% fusion rate). In the lumbar group there were 339 solid fusions and 18 pseudarthroses (94.9% fusion rate). There were no complications or side effects associated with the use of the stimulator.

Conclusion: Bone growth stimulation following standard fusion techniques in this large series of high risk patients led to fusion rates greater than 90% in both the cervical and lumbar spine. Based on efficacy and safety, external bone growth stimulation appears to be a reasonable adjunctive treatment to promote fusion in high risk patients.

201. Preservation of Segmental Motion with Anterior Contra–lateral Cervical Microdisectomy and Interbody Fat Graft: Prospective Study

Yunus Aydin; Halit Çavuşoğlu MD (Sisli Etfal Eğitim ve Araştırma Hastanesi); Cengiz Tuncer; Osman Nuri Türkmenoglu; Ahmet Murat Müsluman

Introduction: The aim of our study is to evaluate the results and effectiveness of this minimal invasive technique with or without interbody fat graft replacement in patients with cervical paramedian disc herniations.

Methods: This prospective observational study was undertaken for the analysis of 330 patients with cervical paramedian disc herniation who underwent one -or adjacent two-level anterior contralateral microdisectomy without fusion between 1992 and 2009. Interbody fat graft replacement were performed on 91 of 340 patients (Group 2). The mean follow up time was 10 years (range 1 - 16 years). Preoperative and postoperative lateral dynamic cervical radiographs were obtained and, the presence of a reduction in the height of interspace and spontaneous osseous union at the disectomy level were investigated. Surgeries were done by the senior author (YA). Clinical outcomes were assessed using the Neck Disability Index and Short Form 36.

Results: Despite fusion procedures were not performed, spontaneous radiological fusion signs were obtained in 12% of group 1 patients. Follow-up radiological studies revealed healing without fusion in group 2 patients. There was no significant change in the mean overall cervical curvature (C2 - 7) angles postoperatively in late follow-up findings (p = 0.77). It represented a statistically significant mean loss of 2.24 degree of segmental lordosis (p < 0.001). The NDI scores decreased significantly in both early and late follow-up evaluations and the SF-36 scores demonstrated significant improvement in late follow-up results in two groups. Analysis of clinical outcome showed no statistical differences between two groups (p = 0.77).

Conclusion: Anterior contralateral microdiscectomy without fusion achieves better exposure for resection of the offending foraminal or far lateral lesions, ventral osteophytes, or a disc fragment under direct microscopic visualization. Collapse, loss of motion and, instability of the involved disc level can also be avoided via this less invasive technique and interbody fat graft.

202. Radiographic Outcomes in Two-Level ACDFs: Comparison of PEEK and Allograft Interbody Devices at 1 and 2-Year Follow-Up

Jody A. Rodgers MD, FACS (Spine Midwest, Inc.); W.B. Rodgers MD; Edward J. Gerber

Introduction: In our single-site prospective series of 184 two-level ACDF patients, 100 had the PEEK interbody device, and 84 had the Allograft device. To date, 60 patients have presented for 24-month follow-up.

Methods: 184 patients underwent instrumented 2-level ACDFs. Patients were assigned to arm of treatment that included a composite of DBM plus autogenous endplate reamings, incorporated into allograft bone dowels or PEEK spacers and stabilized with dynamic anterior plating. Fusion was defined as uninterrupted bridging of well mineralized bone across the interbody space and no significant motion on flexion-extension radiographs. Both operative levels were assessed for fusion using a modified Lenke score. Any pseudarthrosis at either level was considered a failure.

Results: Of 184 patients, 84 were treated with allograft interbody dowels (27M, 57F; age 60.8 yrs; 33 smokers) and 100 were treated with PEEK spacers (23M, 42F; age 52.4yrs; 15 smokers). Average 12-month Lenke score across all subsets was 1.07 (allograft 1.15; PEEK 1.01). At 24 months, average Lenke scores across all subsets was 1.03 (allograft 1.10, PEEK 1.00). There were no infections, neurologic complications or plate breakages. Only one patient (allograft) developed a clear pseudarthrosis.

Conclusion: The combination of a demineralized bone matrix-local bone composite contained within allograft dowels or PEEK spacers resulted in similar fusion rates (> 97%) at 12 months post-operatively. Based on Lenke scores, allograft dowels appear to fuse more slowly than PEEK spacers but this may be perceptual.

203. Safety, Efficacy, and Dosing of Recombinant Human Bone Morphogenetic Protein-2 (rhBMP-2) for Posterior Cervical and Cervico-Thoracic Instrumented Fusion with a Minimum Two-Year Follow-Up

D. Kojo Hamilton MD (University of Maryland Medical Center); Justin S. Smith MD, PhD (University of Virginia Health System); Davis Reames MD (University of Virginia); Brian Jeremy Williams MD (University of Virginia Hospital); Daniel R. Chernavvsky MD; Christopher I. Shaffrey MD, FACS (University of Virginia)

Introduction: Considerable attention has focused on concerns of increased complications with rhBMP-2 use for anterior cervical fusion, but few reports have assessed its use for posterior cervical fusions. This study evaluates the safety, efficacy, and dosing of recombinant human bone morphogenetic protein (rhBMP)-2 as an...
adjunct for instrumented posterior cervical arthrodesis using a retrospective consecutive case series.

Methods: All patients were treated by the senior author with posterior cervical or cervico-thoracic instrumented fusion augmented with rhBMP-2 and had minimum follow-up of two-years. Diagnosis, levels fused, rhBMP-2 dose, complications, and fusion (Lenke grade applied by two neuroradiologists) were assessed.

Results: 53 patients (22 men/31 women) met inclusion criteria, with a mean age of 55.7 years and an average follow-up of 40 months. Surgical indications included basilar invagination (n=6), fracture (n=6), atlanto-axial instability (n=16), kyphosis/kyphoscoliosis (n=22), osteomyelitis (n=1), spondylolisthesis (n=1), cyst (n=1). 15 patients had confirmed rheumatoid disease. The average rhBMP-2 dose was 1.79mg/level with a total of 282 levels treated. Among 53 patients, only 2 complications (3.8%) were identified, a superficial wound infection and an adjacent level degeneration. At last follow-up, all patients had achieved fusion.

Conclusion: Augmentation of posterior cervical fusion with rhBMP-2 appears to be safe and has a very low complication rate. Despite complex pathology and/or rheumatoid arthritis, a 100% fusion rate was achieved, which is considerably higher than comparable historical comparisons without rhBMP-2 (62-94%). Collectively, these data suggest that use of rhBMP-2 as an adjunct for posterior cervical fusion is safe and effective at an average dose of 1.8mg per level.

204. Prospective Results from the US IDE Feasibility Study of a Novel Peek-On-Peek Nucleus Replacement Device With Minimum Two-Year Follow-Up

Domagoj Coric MD (Carolina Neurosurgery & Spine); Matthew Songer MD; John J. Regan MD

Introduction: Nucleus replacement (partial disc replacement) offers a less invasive alternative to traditional fusion or total disc replacement techniques in the treatment of symptomatic lumbar degenerative disc disease (DDD). NUBACTM is the first PEEK-on-PEEK articulated intradiscal arthroplasty device. The authors report the results of 20 consecutive patients treated with NUBAC nucleus replacement in the prospective, multi-center US FDA IDE feasibility clinical study. On the strength of the results of this pilot feasibility study, NUBAC became the first nucleus replacement device to enter US IDE pivotal study.

Methods: Patients with symptomatic DDD at L4-5 were enrolled at three investigational sites in the IDE feasibility study. All devices were placed via a lateral transpsoas approach. Effectiveness is evaluated by prospectively recording pre-op and post-op (at 1.5, 3, 6, 12 and 24 months) Oswestry Disability Index (ODI) and Visual Analog Scale (VAS) scores.

Results: A total of 20 NUBAC devices were implanted in 20 patients. Average OR time was 124 minutes; EBL was 47 cc. Average time to discharge home was 1.4 days. There were no major intra- or postoperative neurological or vascular complications. Average age=41 years. Clinical results showed statistically significant improvement in pain relief and function compared to preop at all time intervals. The mean preoperative VAS (7.1) and ODI (53.9) scores improved significantly at six weeks (3.4 and 30.7, respectively) and were maintained through 2 years (1.8 and 6.3, respectively). There were no device expulsions or reoperations.

Conclusion: This early, prospective clinical experience with NUBAC PEEK-on-PEEK nucleus replacement is promising. NUBAC is currently in prospective, randomized, multicenter FDA IDE pivotal study and those results will continue to define the role of nucleus replacement in the treatment of symptomatic DDD.

205. Pre-Operative Grading Scale To Predict Survival in Patients Undergoing Resection of Malignant Primary Osseous Spinal Neoplasms

Scott Parker; Kaisorn L. Chaichana MD (Johns Hopkins Hospital); OranAaronson MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Ziya L. Gokaslan MD (Johns Hopkins University); Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Large population-based studies of malignant primary osseous spinal neoplasms are lacking and are necessary for sufficient power to determine prognostic factors. Using a 30-year U.S. national cancer registry (SEER), we introduce a pre-operative grading scale that is associated with survival in patients undergoing surgical resection for malignant primary osseous spinal neoplasms.

Methods: The SEER registry (1973-2003) was queried to identify adult patients undergoing surgical resection of histologically confirmed primary spinal chordoma, chondrosarcoma, or osteosarcoma via ICD-O-2 coding. Variables independently associated with survival were determined via Cox proportional-hazards regression analysis for all tumor types. A grading scale comprised of these independent survival predictors was then developed and applied to each histology-specific tumor cohort.

Results: 342 patients were identified that underwent surgical resection of a malignant primary osseous spinal neoplasm (114 chordoma, 156 chondrosarcoma, 72 osteosarcoma). Overall median survival after surgical resection was histology specific (osteosarcoma: 22 months; chordoma: 100 months; chondrosarcoma: 160 months). Increasing age (years) and increasing tumor extension (1. confined to periosteum; 2. invasion through peristeum into adjacent tissues; 3. distal site metastasis) were the only variables independently associated with decreased survival (p<0.05) for all tumor types. For spinal chordoma, sacrum/pelvic location (p<0.05) and earlier year of surgery (p<0.005) were also independently associated with decreased survival. Utilizing variables of patient age, extent of local tumor invasion, and metastasis status in a five-point grading scale, increasing score (1-5) closely correlated (p<0.001) with decreased survival for chordoma, chondrosarcoma, and osteosarcoma. Figure 1.

Conclusion: In our analysis of a U.S. population based cancer registry (SEER), a grading scale consisting of age, metastasis status, and extent of local tumor invasion was associated with overall survival after surgical resection of chordoma, chondrosarcoma, and osteosarcoma of the spine. This grading scale may offer valuable prognostic data based on variables available to the surgeon and patient prior to surgery and may help guide level of aggressiveness in subsequent treatment strategies.

206. Clinical Outcomes Following En Bloc Sacrectomies via Posterior Approach

Michelle J. Clarke MD (Mayo Clinic); Daniel M. Sciuabba BS, MD (Johns Hopkins University); Matthew McGirt MD (Vanderbilt University Medical Center); Timothy F. Witham MD, BS (Johns Hopkins Hospital); Ali Bydon MD (Johns Hopkins Hospital); Patrick C. Hsieh MD, MS (University of Southern California Department of Neurological Surgery); Ziya L. Gokaslan MD (Johns Hopkins University); Jean-Paul Wolinsky MD (Johns Hopkins University)

Introduction: En bloc resection of primary sacral tumors has a demonstrated survival benefit. Total and high sacral amputations traditionally involved both an anterior and posterior approach. However, we have found that en bloc resection and biomechanical reconstruction is possible from a posterior-only approach in many cases.

Methods: Sixty-nine consecutive patients underwent sacral resections for tumor at our institution between 2004 and 2009. Medical records of all patients were reviewed, and patients were excluded if they had an intentional intraskeletal resection, hemipelvectomy or were previously operated. The records of the resulting 37 consecutive patients who underwent primary posterior-only en bloc sacral resections and all 4 patients who underwent a traditional anterior-posterior en bloc sacrectomy were retrospectively reviewed.

Results: All posterior-only patients underwent midline posterior approaches for en bloc sacral resection. Surgical level was defined...
Introduction: Recent genomic interrogation of chordomas has identified Brachyury gene duplication as a major susceptibility mutation in familial chordomas. Current understanding of the role of this transcription factor in chordoma is limited due to the lack of a fully characterized chordoma cell line expressing Brachyury. We report the establishment of the first fully characterized primary chordoma cell line (JHC7) expressing Brachyury and demonstrate that silencing of Brachyury using shRNA leads to complete growth arrest in vitro.

Methods: Establishment of Chordoma Cell Line Intraoperatively

The JHC7 chordoma cell line represents the first in a novel molecular target.

Results: Establishment of Chordoma Cell Line, JHC7, and the Identification of Brachyury as a Novel Molecular Target

Wesley Hsu MD; Ahmed Mohyeldin; Sagar R. Shah MS; Lakesha Johnson; Neda I. Sedoras-Roman; Thomas Kosztowski BS; Colette Ap Rhys; Ola Awad; Edward McCarthy; David Loeb; Jean-Paul Wolinsky MD (Johns Hopkins University); Ziya L. Gokaslan MD (Johns Hopkins University); Alfredo Quinones-Hinojosa MD (Johns Hopkins University)

Introduction: Neuronal cell rescue treatment using human acellular dermal matrix (HADM) and gluteus maximus myocutaneous flaps.

Methods: Reconstruction of posterior sacrectomy defects using a combination of human acellular dermal matrix (HADM) and gluteus maximus myocutaneous flaps.

Conclusion: The JHC7 chordoma cell line represents the first in vitro system with chordoma cells characterized for Brachyury expression. We propose that shRNA-mediated suppression of Brachyury is a novel and attractive therapeutic target in the treatment of chordoma.

208. Reconstruction of Extensive Defects from Posterior In Bloc Resection of Sacral Tumors Using Human Acellular Dermal Matrix and Gluteus Maximus Myocutaneous Flaps

Hormuzdiyar H. Dasenbrock BA; Michelle J. Clarke MD (Mayo Clinic); Ali Bydon MD (Johns Hopkins Hospital); Timothy F. Witham MD, BS (Johns Hopkins Hospital); Daniel M. Scuibba BS, MD (Johns Hopkins University); Oliver P. Simmons MD; Ziya L. Gokaslan MD (Johns Hopkins University); Jean-Paul Wolinsky MD (Johns Hopkins University)

Introduction: Performing a sacrectomy solely from a posterior approach allows for the en bloc resection of tumors without the additional morbidity of a laparotomy. However, the reconstruction of the resultant extensive soft-tissue defects is challenging, particularly as a vertical rectus abdominis myocutaneous flap is not harvested. We report the largest series (with the longest follow-up) of sacral reconstructions using a combination of human acellular dermal matrix (HADM) and gluteus maximus myocutaneous flaps.

Methods: 34 patients with sacral tumors who had a follow-up of at least one year were reviewed retrospectively. Intraoperatively, after the tumor was excised, HADM (AlloDerm) was secured to create a pelvic diaphragm. Subsequently, the gluteus maximus muscles were freed from their origins, elevated, rotated or advanced in the midline to cover the HADM, and sutured together.

Results: The mean age of the patients was 50 years and the histopathology revealed a chordoma in 82.4% 8 patients (23.5%) developed a post-operative wound dehiscence, of whom 6 (17.6%) required operative debridement. An estimated blood loss of >2500 mL and an operative time of >9 hours during sacrectomy, as well as post-operative bowel or bladder incontinence, were all associated with a significantly higher rate of subsequent debridement procedures (p=0.018). The average length of hospital stay was 12.2 (range 3-66) days; the development of a surgical site infection and the performance of a debridement procedure were both associated with a longer length of hospital stay (p=0.037). With a mean follow-up of 45.7 months, only 1 patient developed an asymptomatic para-sacral hernia, which was adjacent to a local tumor recurrence.

Conclusion: Reconstruction of posterior sacrectomy defects with HADM and gluteus maximus myocutaneous flaps may be a valid technique. This approach may have rates of wound dehisence comparable to other techniques and low rates of para-sacral herniation.

209. En Bloc Resection of Cervical Chordomas: Series of 12 Patients and Clinical Outcomes

Daniel M. Scuibba BS, MD (Johns Hopkins University); Camilo A. Molina BA; Ziya L. Gokaslan MD (Johns Hopkins University); Dean Chou MD (University of California San Francisco); Jean-Paul Wolinsky MD (Johns Hopkins University); Timothy F. Witham MD, BS (Johns Hopkins Hospital); Ali Bydon MD (Johns Hopkins Hospital); Christopher P. Ames MD (UCSF Neuro Surgery)

Introduction: Chordomas of the mobile spine often undergo en-bloc resection with reconstruction to optimize local control and possibly offer cure. In the cervical spine, local anatomy is challenging and obtaining clean margins may be limited. Complications may also be higher due to juxtaposition of the skull base, vasculature, aerodigestive system and upper spinal cord. In this review, we present a series of 12 cases of cervical chordomas removed en-bloc. Particular attention was paid to clinical outcome, complications, and recurrence. In addition, outcomes were assessed according to position of tumor in C1/C2 versus the subaxial spine.

Methods: The patients undergoing en-bloc resection of cervical chordoma were reviewed from two large spine centers. Patients were included if the lesion epicenter was involving C1 to C7 vertebral bodies. Demographics, details of surgery, follow-up course, and complications were obtained. Outcome was correlated with presence of tumor in C1/2 versus subaxial spine (C3-C7) via a student’s t-test.

Results: 12 patients were identified with a mean age at presentation of 60, 7/12 (58%) and 5/12 (42%) of cases involved the C1/C2 and subaxial spine, respectively. En-bloc resection was attempted via an anterior approach in 33% of cases (29%-C1/C2; 40%-subaxial), a posterior approach in 25% of cases (43%-C1/C2; 9%-subaxial), and a combined approach in 42% of cases (29%-C1/C2; 60%-subaxial).
Tumor margins were found to be wide in 2/12 (17%-overall; 14%-C1/C2; 20%-subaxial), marginal in 6/12 (50%-overall; 29%-C1/C2; 80%-subaxial), or contaminated in 3/12 (25%-overall; 43%-C1/C2; 0%-subaxial) of cases. No operative complications were encountered. Postoperative complications occurred in 5/12 (42%-overall; 57%-C1/C2; 20%-subaxial; p<0.05) patients and included: hoarseness, dysphagia, prolonged/permanent use of a feeding tube, and pneumonia. Average follow-up was 42 months (range 30-60 months). Recurrence occurred in 5/12 (42%-overall; 57%-C1/C2; 20%-subaxial; p<0.05) cases. Of note, in comparing C1/C2 tumor resections with subaxial lesions, we found a greater incidence of post-operative complications and rates of recurrence.

Conclusion: En-bloc resection of cervical chordomas involving the upper cervical spine (C1-2) are associated with poorer outcomes such as higher rates of complications, and recurrence.

210. Identification of Cancer Stem Cells in Human Chordoma

Wesley Hsu MD; Ahmed Mohyeldin; Sagar R. Shah MS; Thomas Kosziowsk BS; Lakesha Johnson; Ola Awad; Neda I. Sedorano-Roman; David Loeb; Edward McCarthy; Jean-Paul Wolinsky MD (Johns Hopkins University); Ziya L. Gokaslan MD (Johns Hopkins University); Alfredo Quinones-Hinojosa MD (Johns Hopkins University)

Introduction: Chordomas are the most common malignant primary tumor of the osseous spine. The mechanisms underlying the resistance of chordoma to chemotherapy and radiation therapy is unknown. The role of cancer stem cells (CSCs) in chordoma pathophysiology has not been defined. We have performed a series of experiments that provide evidence for the presence of CSCs within human chordoma.

Methods: Establishment of Chordoma Sarcospheres: Chordoma tumor samples were dissociated into single cells, plated in adherent conditions, and expanded to confluence. Cells were then transferred into serum-free, non-adherent conditions to form sarcospheres. Differentiation Studies: For adipogenic differentiation, chordoma sarcospheres were plated at 100% confluency and differentiated using a commercial human adipogenic differentiation kit. Differentiation was evaluated using oil red staining using normal human mesenchymal stem cells as a positive control. For neuronal and astrocyte differentiation, chordoma sarcospheres were maintained in serum free media and plated in 10% FBS for 10 days. Xenograft Studies: BALB/c male nude mice were injected subcutaneously with either chordoma sarcospheres (500,000, 1 million, or 2 million cells) or non-sphere chordoma cells in 50 ul PBS:Matrigel (1:1). Differentiation Studies: For adipogenic differentiation, chordoma sarcospheres were maintained in serum-free, non-adherent conditions to form sarcospheres. Results were analyzed with ANOVA.

Results: After surgery, coccodynia (13/17 pts, 76.5%), radicular pain (11/14 pts, 78.6%), and perineal parasthesias (6/8, 75.0%) improved most consistently following operation. One patient without pre-existing sensory symptoms developed new perineal parasthesias. Bladder control returned in 5 of 8 patients (62.5%) and a single patient developed new bowel and bladder incontinence. There was a single cerebrospinal fluid leak that required return to OR. MRI was completed in all 14 patients with >6-month follow-up and no imaging demonstrate evidence of recurrence.

Conclusion: Microsurgical fenestration with laminoplasty is a safe and effective treatment for carefully selected patients with large, symptomatic Tarlov cysts. The authors describe their results for this subset of patients who may benefit from surgery.

211. Sacral Laminoplasty for the Treatment of Symptomatic Sacral Perineural (Tarlov) Cysts, Clinical Outcomes and Surgical Observations

Zachary Adam Smith MD (Los Angeles Spine Clinic); Larry T. Khoo MD (The Spine Clinic of Los Angeles)

Introduction: The surgical treatment of symptomatic sacral perineural cysts or Tarlov cysts remains controversial. Traditional approaches have been described using sacral laminectomy. Our aim was to evaluate the efficacy and potential complications of treatment of these cysts with microsurgical fenestration, local muscle/fat grafting, and laminoplasty of the sacral lamina.

Methods: This is a retrospective study of 17 prospectively followed patients with 19 large sacral perineural cysts (avg-ag=2.40 cm, range 1.8-8.0 cm) of the sacrum treated by the senior author between May 2004 and June 2010. All patients presented with symptoms non-responsive to medical treatment. Presenting symptoms included coccodynia (n=17), radiculopathy (n=14), back pain (n=11), perineal parasthesias (n=8), incontinence (n=8), and weakness (n=6). We performed a sacral laminoplasty with fenestration of the cyst with intraoperative electromyography in all patients. All patients had closures reinforced with either fat or muscle graft with fibrin glue with subsequent fixation of the sacrum with titanium mini-plates. Outcomes were evaluated by telephone questionnaire or clinic follow-up at average 12.5 months (range 4-44 mo).

Results: After surgery, coccodynia (13/17 pts, 76.5%), radicular pain (11/14 pts, 78.6%), and perineal parasthesias (6/8, 75.0%) improved most consistently following operation. One patient without pre-existing sensory symptoms developed new perineal parasthesias. Bladder control returned in 5 of 8 patients (62.5%) and a single patient developed new bowel and bladder incontinence. There was a single cerebrospinal fluid leak that required return to OR. MRI was completed in all 14 patients with >6-month follow-up and no imaging demonstrate evidence of recurrence.

Conclusion: Microsurgical fenestration with laminoplasty is a safe and effective treatment for carefully selected patients with large, symptomatic Tarlov cysts. The authors describe their results for this subset of patients who may benefit from surgery.

212. Hydrostatic Strength Dural Patch Repair Materials

Michael A. Finn MD (University of Colorado); Paul Anderson MD; Nathan Faulkner MD (University of Wisconsin)

Introduction: We hypothesize that different dural patch materials will vary in their initial hydrostatic strength and that the use of a biologic glue will increase the hydrostatic strength of dural patch repairs.

Methods: Twenty-four calf thoracic spines were prepared with laminectomies and spinal cord evacuation, leaving the dura intact. Foley catheters were inflated on either side of a planned dural defect and baseline hydrostasis was measured using a fluid column at 30, 60 and 90 cm of water. A standard dural defect (1x2cm) was created and 8 patches of each material (human fascia lata, Duragen, and Preclude) was sutured in place using a 5-0 Prolene HS running suture. Hydrostasis was again tested at the same pressures. Finally, Duraseal was placed over the defect and hydrostasis was again tested. Results were analyzed with ANOVA.

Results: Leakage rate increased significantly at each pressure tested for all conditions. All patch materials allowed significantly greater leakage than the intact condition. There was no difference in leakage between the three patch materials. The use of duraseal reduced leakage significantly at all pressures when used with Duragen, and at 90 cm of water when used with Preclude. There was a trend towards reduced leakage with duraseal under the remaining conditions. There was no significant difference between the Duraseal group and the intact dura.

Conclusion: The use of all three dural patch materials were of similar hydrostatic strength and allowed greater leakage than intact. The use of Duraseal reduced leakage rates to levels similar to intact.

213. Hydrostatic Comparison of Titanium Clip and Suture Repair of Durotomy

Michael A. Finn MD (University of Colorado); Paul Anderson MD; Nathan Faulkner MD (University of Wisconsin)

Introduction: We hypothesize that the hydrostatic strength of
214. Prospective Randomized Controlled Trial in Spine Patients to Compare Low Swell Formulation of a Polyethylene Glycol Hydrogel Spinal Sealant with Other Methods of Dural Sealing

Kee Duk Kim MD; Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Randall Matthew Chesnut MD (University of Washington); Dean Chou MD (University of California San Francisco); Haroon F. Choudhri MD; Rees Cosgrove MD (Lahey Clinic/Neurosurgery); Shankar Prakash Gopinath MD; R. Scott Graham MD; Richard Gray; Ajit A. Krishnaney MD (Cleveland Clinic Foundation); Paul C. McCormick MD (The Neurological Institute); Ehud Mendel MD (The Ohio State University Dept of Neurosurgery); Jon Park; Mark Edwin Shaffrey MD (UVA Health System); Nathan E. Simmons MD; John M. Tew MD; Jack E. Wilberger MD (Allegheny General Hospital); Neill Marshall Wright MD (Washington University)

Introduction: As an adjunctive measure to sutured dural repair, spine surgeons utilize a variety of methods to ensure that no active leak is present before closing the wound. In 2009, the FDA approved the DuraSeal® spinal sealant specifically as an adjunct to sutured repair during spine surgery. This IDE study compared the safety and efficacy of low swell (10% and 39% of its original volume) PEG hydrogel formulation to other methods of dural sealing.

Methods: Prospective, multicenter, randomized controlled study was conducted to compare a low swell formulation of a PEG hydrogel with other common dural sealing methods as an adjunct to sutured repair. To evaluate those patients operated only in spine, Chiarl malfunction surgery was excluded. The primary endpoint was the efficacy of intraoperative watertight dural closure confirmed by Valsalva maneuver at 20-25 cm H2O. Safety was measured by the assessment of postoperative CSF leak and surgical site infection.

Results: 51 patients were randomized to low swell PEG hydrogel spinal sealant (treatment) and 16 patients to other methods of dural sealing such as additional sutures and/or adhesive glue (control). Efficacy measured by intraoperative watertight closure was significantly greater in the treatment group compared to the control (98% vs. 75%, p=0.010). Also treatment group had lower rate of postoperative CSF leak compared to the control (2% vs. 12.5%, p=0.143) and lower rate of surgical site infection (6% vs. 18.8%, p=0.148).

Conclusion: Common methods for achieving a watertight dural closure during spine surgery include the use of additional sutures and adhesive glue. With this method, however, about 3 out of 4 patients fail to achieve a watertight dural closure. Low swell PEG hydrogel spinal sealant is much more effective in achieving intraoperative watertight dural closure without compromising the safety of the patients.

215. Assessment of Thoracic Laminar Dimensions in a Pediatric Population: A CT-Based Feasibility Study for Pediatric Thoracic Translaminar Screw Placement

Camilo A. Molina BA; Christopher Chaput MD; Daniel M. Sciubba BS, MD (Johns Hopkins University); P. Justin Tortolani; George I. Jallo MD, FACS (Johns Hopkins Hospital); Ryan M. Kretzer MD

Introduction: Translaminar screws (TLSs) were originally described by Wright as a safer alternative to pedicle screw fixation at C2.1 More recently, TLSs have also been used as hilt-out procedure following failed pedicle screw placement in the treatment of adolescent idiopathic scoliosis.2,3 To date, there are no studies that report the anatomical features of the thoracic lamina in the pediatric population.

Methods: 52 patients (26 male, 26 female), average age 9.5 ± 4.8 years, were selected by retrospective review of a trauma registry database after IRB approval. Study inclusion criteria were ages 2 to 16, standardized axial bone-windowed CT images of the thoracic spine, and an absence of spinal trauma. For each thoracic lamina the following anatomical features were measured using eFilm Lite software: width (outer cortical and cancellous), maximal screw length, optimal screw trajectory, and laminar height. Subjects were stratified by age as follows: <8 yrs. of age(yo) vs. >8 yrs. of age(yo) based on presumed spinal maturity.

Results: Collected data (Table 1) demonstrate the following trends: 1) decreasing maximal screw length, 2) stable lamina width (Figure 1), 3) increasing laminar height, and 4) increasing ideal screw trajectory angle as one descends the thoracic spine from T1-T12. When stratified by age, subjects <8yo had significantly larger lamina in both width and height, and allowed significantly longer screw placement at all thoracic levels than the <8yo subgroup (p<0.05). Importantly, all thoracic spinal levels had an average biconvex diameter greater than 3.5 mm, indicating that a 3.5 mm screw could be placed in the majority of cases.

Conclusion: The data collected provide preliminary information regarding optimal TLS length, diameter, and trajectory for each spinal level in the pediatric thoracic spine. Furthermore, based on CT evaluation, biconvex width provides an anatomical limitation to the placement of translaminar screws in the pediatric population.

216. CT Hounsfield Units for Assessing Bone Mineral Density: A Tool For Osteoporosis Management

Paul A. Anderson MD (University of Wisconsin); Joseph Schreiber MD (University of Wisconsin)

Introduction: Osteoporosis is a common disease with enormous implications for affected individuals and society as a whole. Measurements obtained from computed tomography (CT) examination may yield information regarding decreased bone mineral density, without added expense to the patient. The purpose of this study was to determine if Hounsfield Units, the standardized computed tomography attenuation coefficient, correlate with bone mineral density (BMD) as measured by DEXA.

Methods: Twenty-five patients mean age 71.3 years undergoing both lumbar spine Dual-Energy X-Ray Absorptiometry (DEXA) scans and CT were evaluated. In a region of interest, the Hounsfield Units database after IRB approval. Study inclusion criteria were ages 2 to 16, standardized axial bone-windowed CT images of the thoracic spine, and an absence of spinal trauma. For each thoracic lamina the following anatomical features were measured using eFilm Lite software: width (outer cortical and cancellous), maximal screw length, optimal screw trajectory, and laminar height. Subjects were stratified by age as follows: <8 yrs. of age(yo) vs. >8 yrs. of age(yo) based on presumed spinal maturity.

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were 133.0 (CI 118.4 - 147.5), 100.8 (CI 93.1 - 108.8), and 78.5 (CI 61.9 - 95.1).

Conclusion: CT Hounsfield Units correlate strongly with DEXA scores, and can potentially provide an alternative method in determining regional bone mineral density at no additional cost to the patient. The information could conceivably be applied toward fracture risk assessment, diagnosis of osteoporosis, and early initiation of needed treatment. While we are not recommending CT as a substitute for DEXA, when a CT has been obtained for other reasons, regional HU can be measured to aid surgical decision making and as a guide for further testing.

217. Effects of Epidural Steroid Injections on Blood Glucose Levels in Patients with Diabetes Mellitus

Owoicho Adogwa BS, MPH; Jesse Even; Kirk McCullough; Clint Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center

Introduction: Epidural steroid injections (ESI) are commonly used in the treatment of multiple spinal disorders. Corticosteroid injections have been evaluated in the total joints and hand literature showing systemic effects to diabetics. There has not been a clinical study to evaluate if ESI cause systemic effects in diabetics.

Methods: Diabetic patients who were scheduled for an ESI were given an opportunity to enroll in our IRB approved study. We collected the patient’s most recent hemoglobin Alc (hA1c) and then asked them to track their blood glucose numbers at least twice per day for two weeks prior to and after their ESI.

Results: We noted a statistically significant increase in blood glucose levels in diabetic patients (N=30) after epidural steroid injection. The mean blood glucose level prior to ESI injection was 157.97 ± 45.71 and after ESI it was 304.00 ± 112.63. This represents an average 146.03 ± 88.5 increase in blood glucose levels after injection, which was significantly higher than 0 (p=0.0001, Wilcoxon signed-rank test). Using a nonlinear mixed effect model the estimated half life of this increase was 1.54 days (95% CI 0.86, 7.37), meaning that the patients were back within their normal standard deviation mean glucose levels within two days of injection. The Spearman correlation when evaluating the association between pre injection hA1c levels and maximum blood glucose change was 0.174 (p=0.502) indicating there is no correlation between pre injection hA1c levels and systemic response to ESI.

Conclusions: Epidural steroid injections were noted to cause a significant increase in the blood glucose levels in diabetics. There was no correlation between pre injection diabetic control, represented by hA1c levels, and post injection response. Diabetics who are candidates for ESI should be counseled that a blood glucose increase may be apparent post intervention but effects should not last longer than approximately two days.

218. The Prognostic Value of a Cervical Selective Nerve Root Block: A Correlation with Surgical Outcomes

Luis M. Tumialan MD; David C. LoPresti M.D.; Angelina N. Garvin BA; Wayne Gluf MD

Introduction: To compare the results of a selective nerve root block in the cervical spine with surgical outcomes from posterior cervical foraminotomy or anterior cervical discectomy for management of a single level cervical radiculopathy.

Methods: The authors prospectively followed patients with a unilateral single level cervical radiculopathy. All patients in this study had radicular symptoms which correlated with clinical history, neurological examination and MR imaging findings and had failed nonoperative management for a minimal period of 3 months. All patients were initially managed with a CT guided selective nerve root block. Pre-injection, post-injection and postoperative visual analogue scores (VAS) were obtained at 0, 30 and 90 days. Duration of relief was also documented.

Results: A total of 42 patients underwent a transforaminal cervical selective nerve root block for initial management of their unilateral single level cervical radiculopathy. Fifteen of these patients experienced recurrence or only temporary relief of their symptoms and opted for operative management. At 6 months, the remaining 37 patients required no further intervention. The mean preinjection/preoperative VAS was 57.1 mm (21-97). The mean post-injection VAS was 15.2 mm (0-45). The mean duration of relief was 20.3 days (1-75). The mean postoperative VAS at 30 days was 18.4 mm (0-60). A regression analysis demonstrated that reduction in pain from the baseline VAS to the postinjection VAS was highly predictive of outcomes 30 days after surgery (p =< 0.034). The coefficient of determination was 32%.

Conclusion: The pain reduction at 30 days after a posterior cervical foraminotomy or anterior cervical discectomy is well predicted by the initial reduction from the selective nerve root block. There is prognostic value in the cervical selective nerve root block for prospective surgical patients.

219. The Prognostic Value of a Lumbar Selective Nerve Root Block: A Correlation with Surgical Outcomes

Luis M. Tumialan MD; David C. LoPresti M.D.; Angelina N. Garvin BA; Wayne Gluf MD

Introduction: To compare the results of a selective nerve root block in the lumbar spine with surgical outcomes from a microdiscectomy for management of a single-level lumbar radiculopathy.

Methods: The authors prospectively followed patients with a unilateral single-level lumbar radiculopathy. All patients in this study had radicular symptoms which correlated with clinical history, neurological examination and MR imaging findings and had failed nonoperative management for a minimal period of 3 months. All patients were initially managed with a CT guided selective nerve root block. Pre-injection, post-injection and postoperative visual analogue scores (VAS) were obtained at 0, 30 and 90 days (when applicable) along with preinjection/preoperative and postoperative Oswestry Disability Indices (ODI).

Results: A total of 51 patients underwent a transfornaminal selective nerve root block for initial management of their unilateral single level radiculopathy. Fifteen of these patients experienced recurrence or only temporary relief of their symptoms and opted for operative management. At 6 months, the remaining 36 patients required no further intervention. The mean preinjection/preoperative VAS and ODI was 56.8 mm (17-98) and 23.5 (11-35) respectively. The mean post-injection VAS was 17.25 mm (0-38). The mean duration of relief was 18.3 days (0-70). The mean postoperative VAS and ODI at 30 days were 21.4 mm (0-57) and 13.4 (1-33) respectively. A regression analysis demonstrated that reduction in pain from the baseline VAS to the postinjection VAS was highly predictive of outcomes 30 days after surgery (p < 0.001). The coefficient of determination was 81%.

Conclusion: The pain reduction at 30 days after a microdiscectomy is well predicted by the initial reduction from the selective nerve root block. There is prognostic value in the selective nerve root block for surgical patients.

220. Proximal Junctional Kyphosis in Adult Thoracolumbar Instrumented Fusion: Time to Development, Clinical and Radiographic Characteristics, and Management Approach in 32 Consecutive Cases

Davis Reames MD (University of Virginia); Justin S. Smith MD, PhD (University of Virginia Health System); D. Kojo Hamilton MD (University of Maryland Medical Center); Vincent Arlet MD; Christopher I. Shaffrey MD, FACS (University of Virginia)

Introduction: Proximal junctional kyphosis (PJK) is a common mode of failure following instrumented thoracolumbar deformity...

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surgery and often necessitates revision. Our objective was to assess the clinical and radiographic factors in a consecutive series of adults who developed PJK.

Methods: Consecutive cases of adults treated for thoracolumbar deformity that developed PJK from the contributing authors from 2004-2009 were identified. PJK was defined based on previously published criteria. Clinical records were reviewed and standard radiographic measurements were performed.

Results: 32 cases of PJK were identified (mean age 66 years, range: 46-80; 24 women/8 men). 17 (53%) had surgery prior to the index procedure. The most common comorbidities included osteopenia/osteoporosis (31%), hypothyroidism (31%), osteoarthritis (22%), and movement disorder (13%). The most common diagnosis for the index procedure was degenerative spondylolisthesis (n=26, 81%). The uppermost instrumented vertebrae were T4 (n=1), T10 or T11 (n=30), or L1 (n=1), and the lowermost instrumented levels were: L:4 (n=1), L5 (n=1), S1 (n=5), or ilium (n=25). Mean follow-up was 34 months. 16 (50%) required revision (mean of 1.7 revisions, range: 1-3) at a mean of 9.6 months (range: 0.7-40), and 16 (50%) did not require revision at last follow-up. Respective comparison of pre- and post-index surgery radiographic parameters showed no significant change in sagittal balance (9.6 vs. 8.0 cm, p=0.76), but there was a significant increase of lumbar lordosis (24 vs. 42 degrees, p<0.001) and T5-T12 kyphosis (30 vs. 53 degrees, p<0.001) and reduction of pelvic tilt (29 vs. 23 degrees, p=0.011).

Conclusion: Collectively, these data suggest that susceptibility to PJK may relate to development of an exaggerated postoperative compensatory thoracic kyphosis to offset a significant, intended surgical correction of lumbar lordosis. The resulting inadequate maintenance of sagittal balance, combined with the increased kyphosis, may predispose to development of PJK.

221. Direct Vertebral Body Derotation: A Comparison of Different Techniques
Amer F. Samdani MD; Steven Wei-Hung Hwang MD (Tufts University/New England Medical Center); Michelle Mark ET, MA; Tracey Bastrom MA; Randal Betz MD; Patrick Cahill

Introduction: Pedicle screw fixation has permitted the application of rotational forces to assist in correcting the 3-D deformity of the scoliotic spine. Surgeons may routinely apply a combination of derotation techniques when correcting deformity, but little is known of the impact from each maneuver. Theoretically, unnecessary derotation maneuvers may weaken the screw-bone interface. We sought to compare outcomes of various direct vertebral body derotation (DVBD) techniques as defined by inclinometer measures.

Methods: A large, multicenter, prospective database was retrospectively queried for patients with the diagnosis of AIS who have undergone posterior spinal fusion with application of DVBD techniques. All patients had at least 2 years of follow-up, and those having undergone thoracoplasty were excluded. Segmental derotation was defined as corrective rotational forces applied to one vertebral level, whereas en bloc derotation referred to maneuvers involving more than one level.

Results: A total of 195 patients were identified. 104 patients underwent segmental derotation, 20 had en bloc derotation performed, and 71 patients had both. No significant radiographic or clinical differences existed between the groups preoperatively or postoperatively. When subdivided into categories based on the magnitude of preoperative inclinometer measures (0-9 degrees, 10-15 degrees, and 16+ degrees), no significant difference in postoperative inclinometer measures were identified (p=0.43 to 0.95) (Table 1).

Conclusion: The use of varying derotation techniques in the correction of AIS deformity did not correlate with any difference in outcomes based on inclinometer measures. The additional use of en bloc derotation to segmental derotation does not provide any more rib prominence correction.

222. Direct Vertebral Body Derotation, Thoracoplasty or Both: Which is Better with Respect to Inclinometer and SRS-22 Scores?
Amer F. Samdani MD; Steven Wei-Hung Hwang MD (Tufts University/New England Medical Center); Peter Newton; Baron Lonner; Michelle Marks PT, MA; Tracey Bastrom MA; Patrick Cahill; Randal Betz MD

Introduction: Direct vertebral body derotation (DVBD) and thoracoplasty (Th) are powerful tools for correction of rib deformities in patients with AIS. We evaluated Th, DVBD, and both (Th/DVBD) with respect to postoperative inclinometer readings and SRS scores to determine which provides the best correction of rib deformity and better patient satisfaction.

Methods: A prospective longitudinal database was queried to identify AIS patients who underwent a posterior spinal fusion with pedicle screws and 2 years’ follow-up. 203 patients were identified and grouped as follows: 1) Th alone (n=30), 2) DVBD alone (n=122), and 3) both Th/DVBD (n=51). Patients were sub-divided based on their preoperative inclinometer reading: 1) = 9 degrees (mild), 2) 10-15 degrees (moderate), and 3) = 16 degrees (severe). Pre- and postoperative inclinometer readings and SRS scores were compared using ANOVA.

Results: Overall, the groups were similar preoperatively except for the DVBD group having higher percent thoracic flexibility. The preoperative rib deformity values were Th=13.2, DVBD=14.0, and Th/DVBD=12.9 (p=0.27). Taken collectively, the post-op 2 year inclinometer readings were similar for all three groups (Th=5.2, DVBD=7.0, Th/DVBD=5.6, p=0.66). However, the SRS-22 self-image scores were significantly better for patients having both Th/DVBD (Th=3.4, DVBD=3.4, Th/DVBD=3.8, p<0.01). When patients were stratified by severity of pre-op rib deformities, all with mild prominences achieved similar corrections, although SRS self-image scores were highest in the Th/DVBD group. In patients with moderate and severe preoperative rib prominences, the addition of Th was necessary for optimal rib deformity correction, but there was no difference in SRS-22 domains (Table 1).

Conclusion: Our results suggest that Th alone, DVBD alone, or both provide equivalent inclinometer results in patients with mild preoperative rib deformities, but higher SRS-22 self-image scores are achieved using both Th/DVBD. For more severe rib prominences (> 10 degrees), better inclinometer readings are achieved with thoracoplasty, although SRS-22 self-image scores are comparable.

223. Differences in Treatment and Inpatient Outcomes for Hospitalized Scoliosis Patients in the United States from 1998 to 2007
Doniel Drazin MD; Miriam Nuno; Frank L. Acosta MD

Introduction: Differences in access to treatment and outcomes have been documented in a variety of conditions in recent years. This study evaluates potential disparities in treatment selection and outcomes for hospitalized scoliosis patients. Patient- and hospital-specific factors were analyzed as independent variables for predicting surgical versus non-surgical management of these patients, as well as for in-hospital patient outcomes.

Methods: Using Nationwide Inpatient Sample (NIS) administrative 1998-2007 data, we captured cases having a primary diagnosis of scoliosis. Univariate and multivariate analyses evaluated race, gender, socioeconomic factors, and hospital characteristics as predictors of treatment (surgical versus non-surgical) and in-hospital outcomes (discharge, mortality, and complications).

Results: The study analyzed 9522 (surgical) and 2617 (non-surgical) cases. Univariate analysis showed both patient and hospital-level variables as strongly associated with treatment selection and outcomes. Concerning treatment selection, multivariate analysis revealed African-Americans and Hispanics as less likely to be treated.
surgically, while Caucasians and private insurance patients were more likely to undergo surgery (p<0.05). These differences in treatment selection for minorities persisted even when controlling for comorbidities. Additionally, Caucasians showed a reduced risk of mortality, complications and adverse discharge compared to African-Americans and Hispanics (p=0.01). Large hospitals had higher surgical treatment rates than small or medium-sized facilities as well as a lower risk of mortality. Higher proportions of Caucasian patients were admitted to large teaching hospitals than African-American or Hispanic patients.

Conclusion: Significant disparities were found in the selection of operative versus non-operative treatments, as well as in in-hospital morbidity and mortality for hospitalized scoliosis patients based on racial and socioeconomic variables. This may in part be due to differences in access to the resources of large teaching hospitals for different racial and socioeconomic groups. Additional reasons for these disparities, and their impact on quality-of-life measures and future health resource utilization for scoliosis patients requires additional research.

224. The Safety and Efficacy of Transformaminal Lumbar Interbody Fusion for Deformity Correction in Degenerative Scoliosis with Spinal Stenosis

Alan T. Villavicencio MD; Ewell Lee Nelson MD; Alexander Mason MD; Sharad Rajpal MD (Neurological Institute - Cleveland Clinic); Frances A. Carr BA; Sigita Buneikiene MD

Introduction: The utilization of a TLIF (Transforaminal Lumbar Interbody Fusion) approach for scoliosis offers patients deformity correction without the morbidity associated with more invasive reconstructive surgeries. The purpose of this study was to analyze intra- and postoperative complications associated with the TLIF surgical approach in patients undergoing surgery for spinal stenosis and degenerative scoliosis correction.

Methods: This study included a total of 29 patients that underwent TLIF for degenerative scoliosis with neurogenic claudication and painful lumbar degenerative disc disease. TLIF surgery was performed using a posterolateral pedicle screw construct. The average follow-up time was 27.4 months (range, 6-47).

Results: The average age of patients was 65.9 years (range, 49-83). TLIF procedures were performed at 2.2 levels on average (range, 1-4) in addition to 7.0 (range, 3-11) levels of posterolateral fusion. The mean preoperative coronal Cobb angle was 32.3 degrees (range, 15-55) compared to the mean of 15.4 degrees (range, 1-49) postoperatively. The mean operative time was 8.8 hours (range, 4.6-15.1), EBL - 1091.7 mL (range, 150-2500) and hospitalization time was 8.0 days (range 3-28). Clinical outcome was excellent/good in 17 (77%) of patients. The overall patient satisfaction rate was 77% (range, 42-100). Mean VAS decreased from 7.6 (range, 4-10) preoperatively to 3.6 (range, 0-8) postoperatively. There was a total of 14 (48.3%) hardware and surgical technique related complications, 8 (27.6%) of which required additional surgeries. The systematic complications (31%) included death (1), cardiopulmonary arrest with resuscitation (1), myocardial infarction (1), pneumonia (5) and pulmonary embolism (1). A total of 5 patients (17.2%) had pseudoarthrosis.

Conclusion: This study suggests that the TLIF approach is a feasible and effective approach to treat degenerative adult scoliosis, but is still associated with a high rate of intra- and postoperative complications and a long recovery process.

225. Biomechanical Analysis of Iliac Screws versus S2 Alar-Iliac Screws

Cyrus Wong MD, BSc (Vanderbilt University); Chase Corn MD; Colin Crosby MD; Jesse Even; Gregory A. Mencio MD; Clinton J. Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Current techniques of pelvic fixation have been associated with high rates of lumbo-sacral pseudarthrosis, failure of fixation and hardware complication. Hence, newer techniques were devised that allow for placement of screws into the ilium across the lumbosacral pivot point to improve biomechanical stability. However, some of these techniques require additional incisions and extensive soft-tissue dissection. This study describes and compares the biomechanical strength of two techniques that provide low-profile, in-line fixation without the necessity of additional incisions or soft-tissue dissection.

Methods: Embalmed cadaveric specimens (n=8, 4-male, 4-female) were utilized. Anatomically-referenced iliac screws and S2 alar-iliac screws measuring 7.5 mm by 80 mm were placed in situ on opposite sides of each specimen, alternating between right and left for each type of fixation. Appropriate placement of screws was confirmed with fluoroscopy and direct examination after dissection of each pelvis. The pelvis were then harvested, hemi-sectioned and potted for biomechanical testing. Utilizing an MTS Bionix 858 Machine, screws were coaxially loaded at a rate of 5 mm/minute and pull out strength was measured in Newtons.

Results: Mean pull-out strength for anatomically-referenced iliac screws and S2 alar-iliac screws were 576 N (SD-185) and 933 N (SD-440), respectively. A statistically significant higher pull-out strength was noted in the S2 alar-iliac screws as compared to standard iliac screw (p=0.05).

Conclusion: Iliac fixation is often performed in a revision setting to successfully achieve arthrodesis across the lumbosacral junction. In this study, we demonstrate that utilizing an S2 alar-iliac fixation technique provides superior pullout strength potentially avoiding these complications and helping achieve arthrodesis.

226. Reduced Surgical Site Infections in Patients Undergoing Posterior Spinal Stabilization of Traumatic Injuries Using Vancomycin Powder

Owoicho Adogwa BS, MPH; Kevin O’Neill; Jason S. Smith; Amir Ahtabhi; Kristen Archer-Swygert; Clint Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Despite improvements through the use of prophylactic systemic antibiotics, surgical site infections remain a significant problem in the treatment of traumatic spine injuries. Infection rates as high as 10% have been reported in this population. The impact on patients and cost of treating such infections is profound. Local delivery of antibiotics has been found to be efficacious in animal and human studies as an adjunct to systemic antibiotics in surgical site infection prophylaxis. We set out to evaluate the efficacy of using vancomycin powder in surgical sites to prevent infections.

Methods: Fifty-eight consecutive patients with traumatic spine injuries treated with instrumented posterior spine fusions at a single academic center received intra-operative vancomycin powder applied to their surgical site and prospectively followed for infection. This prospective cohort was compared to 60 consecutive patients undergoing posterior fusion for trauma immediately prior to the prospective cohort. History of previous spine surgeries, substance use, diabetes, and body mass index were compared. Incidence of infection was the primary outcome evaluated.

Results: The control (N=60) and treatment groups (N=58) were statistically similar, Table 1. There were no adverse reactions to the vancomycin powder. A statistically significant difference in infection rate was found between the treatment group (0%) and control group (12%, p=0.02), Table 2. No adverse effects were noted from use of the vancomycin powder.

Conclusion: The use of vancomycin powder in surgical wounds may significantly reduce the incidence of infection in patients with closed traumatic spine injuries treated with instrumented posterior spine fusion. Applying vancomycin powder to surgical wounds is a promising means of preventing costly and harmful post-operative wound infections.
227. Intra-Operative Glucose Levels and Its Association With Developing Post-Operative Surgical Site Infections Following Spine Surgeries

Frances Mao; Ajit A. Krishnaney MD (Cleveland Clinic Foundation)

Introduction: Post-operative wound infections following major surgical procedures continue to be a significant source of morbidity and mortality in the United States. Current recommendations from ICU and cardiac surgery management indicate that aggressive management of intra-operative glucose levels result in lower rates of surgical site infections. This study is a retrospective cohort analysis to determine the incidence of surgical site infections following elevated intra-operative glucose levels during spine surgeries.

Methods: Peri-operative glucose levels and infection control surveillance data were analyzed for 2208 patients who underwent cervical, thoracic, or lumbar spine surgical procedures at the Cleveland Clinic Center for Spine Health between March 2005 and March 2010.

Results: Out of 2208 patients, 112 (5.1%) developed a surgical site infection during the 30-day post-operative period. Non-infected patients had a mean intra-operative glucose level of 132.11 mg/dl (95% CI 130.72 - 133.5) compared to infected patients with a mean intra-operative glucose level of 130.95 mg/dl (95% CI 126.03 - 135.87 mg/dl). An independent two sample t-test found no significant difference in mean intra-operative glucose level between these two groups (p = 0.6523). Univariate logistic regression revealed a risk ratio per unit glucose of 1.00116 (95% CI 0.9953 - 1.0075, p = 0.7081). Chi-square analysis found no association between high glucose level (>110 mg/dl) and surgical site infection (chi-square value = 0.232, p = 0.6304). Follow-up analyses will be repeated to account for diabetes status.

Conclusion: We did not find a significant association between elevated intra-operative glucose levels and a higher incidence of post-operative surgical site infection. Our results add to previous case-control studies exploring the same association in neurosurgery. Because the causes of surgical site infection are multi-factorial, the role of other peri-operative variables in decreasing SSI incidence should be explored.

228. Multiple-Day Drainage When Using BMP for Long Segment Thoraco-Lumbar Instrumented Fusions Results in Low Reoperation Rates for Infection and Seroma

Dwight Saulle MD (UVA Neurosurgery); Kai-Ming G. Fu MD, PhD (University of Virginia Hospital); Justin S. Smith MD, PhD (University of Virginia Health System); Christopher I. Shaffrey MD, FACS (University of Virginia)

Introduction: Concerns over increased infection and seroma rates have been raised when BMP is employed as an aid to fusion in spinal surgery. Few studies have explicitly documented these complications. In this study we evaluated 87 consecutive patients undergoing long segment thoracolumbar spinal fusions with BMP to assess drain output and the rates of reoperation for infection or seroma.

Methods: Inclusion criteria included: patients undergoing 4 or more levels of posterior instrumented thoracolumbar fusion, use of BMP for posterolateral arthrodesis, age >18 years, and a perioperative followup of 60 days. 87 consecutive cases from a single institution were assessed. Typically, 2 1/8th inch hemovac drains were placed at surgery and discontinued when two consecutive shifts (8 hrs) demonstrated less than 30cc of output. Drain output, length of time of drainage, and need for reoperation for wound seroma or infection were retrospectively reviewed.

Results: Mean age was 58.5 (SD 16.2, range 20-81). Primary operative indications were deformity, with 43 patients undergoing revision surgery. The average number of levels instrumented and arthrodesed with BMP was 9.2 (SD 3.7, range 4-18). The average dose of BMP was 31.2 mg or 2.6 large sponges (SD 9.6mg, range 12-48). Patients required drainage for a mean of 4.9 days (SD 1.3 days, range 3-9 days). The average total output was 1856cc (SD 787, range 530-4310cc). There were no significant differences between dose of BMP used and amount or days of drainage (p=0.3 and p=0.3, respectively). The wound infection rate was 2.3% (2 cases, deep wound infection, required reoperation), and 2 (2.3%) sterile seroma occurred that required reoperation for drainage. No other wound complications were noted.

Conclusion: Use of BMP for long-segment posterior thoracolumbar fusions may be associated with significant drain output, requiring multiple days of drainage. However, when drained adequately, reoperations for infections and seromas occur infrequently.

229. Efficacy of Prophylactic Preoperative Inferior Vena Cava Filters for Major Spinal Surgery in Adults: A Review of 219 Patients at a Single Institution

Jamal McClendon MD (Northwestern University Hospital); Brian A. O’Shaughnessy MD (Dreyer Medical Group); Timothy R. Smith MD (Northwestern University); Patrick Alexander Sugme MD (Northwestern University Medical School); Ryan J. Halpin MD (Northwestern University); Tyler R. Koski MD; Stephen L. Ondra MD

Introduction: Venous thromboembolism (VTE) is a serious complication following major spinal reconstructive surgery in adults. Specifically, pulmonary embolism (PE) can result in significant morbidity and mortality, and has been reported in up to 13% of patients. Placement of prophylactic inferior vena cava filter (IVCF) was initiated as standard protocol for all high-risk spine patients after a pilot study demonstrated decreased VTE-related morbidity and mortality.

Methods: After IRB approval, medical records of all patients receiving an IVCF at a single institution were reviewed. Age, sex, surgical approach, postoperative deep vein thrombosis (DVT), postoperative superficial thrombus, presence of PE or paradoxical embolus, mortality, and IVCF complications were reviewed. Placement indications included history of DVT or PE, malignancy, hypercoagulability, prolonged immobilization, staged procedures > 5 levels, combined anterior/posterior approaches, iliocaval manipulation during exposure, and anesthesia > 8 hours. Descriptive statistics were used for the analysis of patient characteristics. Non-parametric, frequency statistics (odds ratios, chi-square) were used for analysis of main outcomes.

Results: 219 patients (150F, 69M) were analyzed with mean age of 58.8 years (range 17-86 years). There were two complications from IVCF placement (66 Greenfield and 157 retrievable). Incidence of lower extremity DVT was 18.7% in 36 patients. PE incidence was 3.7% (8/219), and the paradoxical embolus rate was 0.5% (1 patient). Prophylactic IVCF use reduced the odds of developing PE (OR=3.7, p<0.05) compared to population controls. Mean follow-up was >2 years. Patients receiving Greenfield filters had significantly higher VTE incidence compared to those receiving retrievable filters (OR=2.8, p=0.008). Anesthesia duration longer than 8 hours significantly increases VTE incidence (p=0.029). There were 14 deaths, none related to PE or paradoxical embolus.

Conclusion: VTE-related morbidity and mortality have heighten ed the awareness within the spine community to the peri-operative management of patients receiving major spinal reconstruction. Prophylactic IVCF placement significantly lowers PE rate.

230. Defining the Role of Early Surgical Decompression After Traumatic Spinal Cord Injury: Results of a Canadian Multicenter Study

Michael G. Fehlings MD, PhD, FRCCS, FACS (Toronto Western Hospital); Jefferson Wilson MD (University of Toronto, Toronto Hospital); Anoushka Singh PhD; Catharine Craven MD; Henry Ahn; Brian Drew MD; Michael Ford MD

Introduction: Although there exists compelling experimental evidence supporting early spinal cord decompression after spinal cord...
A prospective cohort study of patients within the Ontario Spinal Cord Injury Rehabilitation (OSCIR) program was performed. Eighty-six ASIA A-D SCI patients, from six Ontario trauma centers were enrolled between 2007 and 2009. Patient information was collected preoperatively, postoperatively, at acute care discharge and at discharge from rehabilitation. A grouped analysis was performed comparing the cohort of patients who received early surgery (<24 hours after SCI) to those receiving late surgery (=24 hours after SCI). Fisher's exact test was used to examine for differences in baseline characteristics and outcomes between early versus delayed surgery patients.

Results: Of the 86 patients treated surgically there were 69 males and 17 females, with a mean age of 46.3 years. There was a trend towards older age and increased number of co-morbidities within the late surgery group. More patients had a 2 grade or more improvement in their ASIA Impairment Score (AIS) from admission to rehabilitation discharge in the early surgery group (p<0.05). This improvement was most marked amongst the early surgery ASIA A subgroup as compared to injury matched patients who underwent late surgery. Early surgery patients also experienced significantly greater improvements in ASIA sensory score over follow-up. The only significant predictor of acute care and overall length of stay was the admission AIS.

Conclusion: The results of this study support the growing body of literature which supports the principle of early intervention in the setting of spinal trauma and SCI.

231. Age Related Changes in Neurologically Intact Human Spinal Cords Assessed Using Diffusion Tensor MR Imaging

Shekar N. Kurpad MD, PhD (Medical College of Wisconsin); Marjorie C. Wang MD, MPH (Medical College of Wisconsin); Michael Jirgis; Brian Schmit PhD; John L Ulmer MD; Brian Shender; Narayan Yoganandan PhD (Medical College of Wisconsin); Allison Hyngstrom

Introduction: Diffusion Tensor MR Imaging (DTI) is an important imaging modality that can be useful for monitoring changes in tissue structure in the brain and spinal cord. We present the largest dataset of DTI derived indices in the cervical spinal cord of a cohort of non-myelopathic individuals. The aim of this study was to characterize diffusion characteristics in the human cervical spinal cord at various ages.

Methods: With appropriate IRB approval, twenty-eight neurologically intact age and sex matched subjects, 22-85 years old, were enrolled in this study. A single-shot, twice-refocused, spin-echo, echoplanar pulse sequence was used to obtain axial images throughout the cervical segments of the spinal cord (C1-C8) on a 1.5 Tesla Clinical MR imaging Scanner in 45 minutes.

Results: Diffusion images indicated a significant decrease (p<0.05) in fractional anisotropy (FA) and an increase in mean diffusivity (MD) after 65 years of age in both male and female subjects. Cervical mean diffusivity averaged 0.98±0.03 x 10(-3) mm(2)/s, fractional anisotropy averaged 0.63±0.02 mm(2)/s.

Conclusion: To date, this is the largest study of DTI indices in a non-myelopathic population. This study provides evidence of changes in diffusion characteristics in the cervical spinal cord after the age of 65 years. Changes in spinal cord diffusion with increasing age likely reflect changes in spinal cord tissue structure. We believe that the definition of the normative values of DTI indices in these individuals will assist in evaluating DTI index differences in patients with spinal cord disease in the future. These significant changes in diffusion characteristics should be accounted for when using DTI to diagnose abnormalities in older patients.

232. A Combined Neuroprotective Immuno-Modulatory Therapy Mitigates Early Bladder Dysfunction After Experimental Spinal Cord Injury

Daniel J. Hoh MD (Cleveland Clinic); John H. Shin MD (Cleveland Clinic Foundation); Megan Clark MS; Christopher A. Iannotti MD, PhD; Ran Harel MD; Nico van Rooijen; Hai-Hong Jiang MD, PhD; Margot Damaser PhD; Michael P. Steinmetz MD (Spine Institute)

Introduction: Traumatic spinal cord injury (SCI) can result in devastating motor and sensory deficits. Of these, impaired bladder function is particularly significant as urinary tract complications rank among leading causes of morbidity and mortality in acute and chronic SCI. Experimental SCI in a rat contusion model demonstrates characteristic bladder dysfunction that parallels clinical SCI including abnormal micturition, urinary retention, and pathologic changes in functional bladder wall compliance. Previously, our group demonstrated that a combined immuno-modulatory strategy of cAMP elevation and peripheral macrophage depletion improves not only late but early hindlimb motor function after SCI. In the present study, we investigated the same combined immuno-modulatory therapy to determine if it confers similar neuroprotective benefit in mitigating early bladder dysfunction after SCI.

Methods: 12 rats were subjected to T8 weight-drop contusion injury. Post-SCI, animals either were treated with combined cAMP elevation + peripheral macrophage depletion (treated=6) or were untreated (control=6). Early bladder dysfunction was assessed using 2 techniques. First, severity of urinary retention was evaluated by measuring residual urine volumes (RUV) after daily timed manual bladder expression. Second, on post-SCI day 7, functional bladder wall compliance was assessed by measuring bladder capacity at micturition during transurethral single cycle filling cystometry (0.125ml/min).

Results: Animals had equivalent initial thoracic SCI (hindlimb BBB score<1, post-SCI day 1) with resulting abnormal micturition. Control animals, however, demonstrated progressively increasing daily RUV signifying worsening urinary retention, whereas treated animals did not (p<0.05)(Figure1). On post-SCI day 7, bladder capacity with filling cystometry was significantly increased (p<0.01) in control (4.9±0.7ml) compared to treated (3.5±0.6ml) animals, signifying increased disturbance in functional bladder wall compliance among control animals.

Conclusion: Experimental SCI results in early bladder dysfunction characterized by urinary retention and abnormal functional bladder wall compliance. A combined immuno-modulatory strategy reduces these pathophysiologic findings in acute experimental SCI. Clinical translation of this therapy may decrease risk of urinary complications in SCI patients.


George Al Shamy MD (Baylor College of Medicine); Bettina Keller PhD (Baylor College of Medicine); Philippe Campeaux MD (Baylor College of Medicine); Brendan Lee MD, PhD (Baylor College of Medicine)

Introduction: Acute spinal cord injury (SCI) occurs worldwide with an annual incidence of 15-40 cases per million per year. Recent advances have led to better understanding of the pathophysiology of SCI. Alterations in nitric oxide (NO), a neurotransmitter produced by Nitric oxide synthase from L-arginine have been implicated with different isoforms showing distinct temporal patterns. Arginase negatively regulates NO production through competition with NOS for the substrate L-arginine. Our aim is to develop a transgenic mouse model that over-expresses arginase in distinct cell populations to understand their role in NO production after SCI.

Methods: We used standard techniques to develop transgenic mouse models over-expressing the enzyme Arginase exclusively in the CNS.
neurons as well as in astrocytes. Plasmids containing the gene for arginase were cloned under the neuronal specific thy1 promoter as well as the Glial specific GFAP promoter. Transgenic founders were generated by pronuclear injections of the plasmids. Transgenic mice were identified at birth by eye pigmentation and confirmed by PCR using primers specific for Arginase. Western blot analysis, RNA extraction, enzyme assays as well as histology were established in the transgenic models and compared to control animals.

Results: Our transgenic animals show an up to 30 fold overexpression of Arginase with comparable enzyme activity. Arginine and citrulline levels are reduced in plasma of transgenic animals when compared to wild type controls. Despite these physiological discrepancies, our animals sustain normal growth. Under nonstressful conditions, these animals survive comparably to wild type litters, are fertile with offspring born in mendelian ratio and have no physiological abnormalities.

Conclusion: We were able to generate viable and fertile mice overexpressing Arginase specifically in neurons and glial cells. These mice will be a valuable tool to understand the role different cells play in the pathophysiology of acute spinal cord injury.

Hormuzdiyar H. Dasebrook BA; Timothy F. Witham MD, BS (Johns Hopkins Hospital); Daniel M. Sciubba BS, MD (Johns Hopkins University); Ziya L. Gokaslan MD (Johns Hopkins University); Ali Bydon MD (Johns Hopkins Hospital)

Introduction: Many studies have suggested that patients who are admitted on the weekend have inferior outcomes compared to those admitted on a weekday. However, the impact of weekend admission on the timing of intervention and outcomes after surgery for acute spinal cord injury has not been previously evaluated.

Methods: Data from the national inpatient sample (2005-2008) were retrospectively extracted. Patients were included if they had a diagnosis of acute spinal cord injury, underwent spinal decompression with or without fusion and were admitted emergently or urgently. Multivariable logistic regression analyses were conducted to calculate the odds of death, the development of a post-operative complication and the performance of surgery on the day of or day after admission depending on if the hospital admission day was a weekend or a weekday. Logarithmic multivariate regression was used to evaluate the association of admission on a weekend with length of stay and hospital charges. All analyses were adjusted for differences in patient age, gender, co-morbidities, race, primary insurance, admission type and hospital characteristics.

Results: A total of 4,991 admissions were evaluated, of which 35% were on the weekend. Weekend admission was not significantly associated with a higher adjusted odds of in-hospital mortality (OR: 1.00, 95% CI: 0.70. 1.44). Patients admitted on the weekend did not have significantly different adjusted odds of performance of surgery on the day of or day after surgery (OR: 0.91, 95% CI: 0.77, 1.07). Post-operative complications, length of stay and total hospital charges were not significantly different between patients admitted on the weekend or a weekday.

Conclusion: Unlike other surgical diseases, the outcomes of patients admitted in the United States for acute spinal cord injury during the weekend do not differ from those admitted during the week. Nationwide, surgery is not delayed for patients with acute spinal cord injury who present on the weekend.

Hormuzdiyar H. Dasebrook BA; Mohamad Bydon MD (Johns Hopkins Hospital); Gayane Yenokyan PhD; Timothy F. Witham MD, BS (Johns Hopkins Hospital); Ziya L. Gokaslan MD (Johns Hopkins University); Ali Bydon MD (Johns Hopkins Hospital)

Introduction: Although posterior decompression is preferred for multilevel cervical ossification of the posterior longitudinal ligament (OPLL), few studies have evaluated the long-term outcomes of patients undergoing different posterior techniques. We report a meta-analysis of observational studies comparing the improvement in myelopathy and long-term complications including the development of post-operative kyphosis, the prevalence of axial pain and the progression of OPLL in patients with multilevel disease undergoing laminectomy, laminoplasty and laminectomy & fusion.

Methods: A literature search was performed using MEDLINE of studies indexed between January 1980 and June 2010. Pre-determined study inclusion criteria included reporting outcomes for patients with OPLL separately from other etiologies of myelopathy; studies were excluded if they reported a total of ten or fewer patients. Data on the severity of myelopathy (measured by the Japanese Orthopedic Association (JOA) scale) and long-term complications were extracted and pooled assuming random effects.

Results: 40 studies with a total of 1,549 patients were included of which 8 reported laminectomy, 34 reported laminoplasty and 2 reported laminectomy and fusion. Among studies with a long-term mean follow-up (of at least four years), patients undergoing laminectomy and fusion had a non-significantly higher recovery rate of JOA score 62.5%, compared to 57.2% after laminoplasty and 53.4% after laminectomy. With an intermediate mean follow-up (of at least two years), kyphosis developed in 28.4% after laminectomy, 7.5% after laminoplasty and 0% after laminectomy and fusion. Axial pain was present in 35% of patients who underwent laminoplasty; progression of OPLL was noted in 70% after laminectomy and 66% after laminoplasty.

Conclusion: Substantial long-term improvement in myelopathy was seen regardless of the posterior technique utilized. However, long-term complications – particularly the development of kyphosis or neck pain and progression of OPLL – were common after laminectomy or laminoplasty. Additional research is needed on the long-term outcomes of patients with OPLL after laminectomy and fusion.

236. Assessment of Potential Predictors of Long-Term Outcomes of Surgery for Cervical Spondylotic Myelopathy: Clinical, Demographics and MR Imaging Factors

Michael G. Fehlings MD, PhD, FRSCS, FACS (Toronto Western Hospital); Alina Karpova BSc (University Health Network); Abhaya Vivek Kulkarni MD (Hospital for Sick Children); Aileen Davis PhD (Toronto Western Research Institute, University Health Network and the University of Toronto); Eric M. Massicotte (Toronto Western Hospital)

Introduction: Cervical spondylotic myelopathy (CSM) is the common cause of spinal cord dysfunction worldwide, leading to severe neurological impairments and major socio-economic costs. Nevertheless, prospective data on factors which predict surgical outcomes are lacking.

Methods: 65 consecutive patients with CSM were treated at a university-based centre. After excluding 4 patients who were lost to follow-up, 61 (follow-up: 94%) were analyzed for prediction of surgical outcomes. There were 42 males and 19 females with mean age of 57 years (range: 32 to 86 years). The mean mJOA score improved from 12.8 ± 2.7 points pre-operatively to 15.8 ± 2.3 points at 12 months post-operatively (p<0.0001). The modified Japanese Orthopaedic Association Scale (mJOA) was used as the primary outcome measure to quantify functional disability at admission and at 12-months follow-up. Potential predictors of functional outcomes included age, gender, duration of symptoms, severity of myelopathy, number of compressed segments, antero-posterior diameter [AP] and transverse area [TA] of the spinal cord at the site of maximal com-
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237. The AOSpine North America Cervical Spondylotic Myelopathy Study: Perioperative Complication Rates Associated with Surgical Treatment Based on a Prospective Multicenter Study of 302 Patients

Justin S. Smith MD, PhD (University of Virginia Health System); Christopher I. Shaffrey MD, FACS (University of Virginia); Branko Kopjar MD; Paul M. Arnold MD; Sangwook Yoon MD (Emory, Orthopedic); Alexander R. Vaccaro MD; Darrel S. Brodkle MD; Michael Janssen MD; Jens Chapman MD; Rick Sasso MD; Eric J. Woodard MD (New England Baptist Hospital); Robert J. Banco MD; Eric M. Massicotte (Toronto Western Hospital); Mark B. Dekutoski MD (The Mayo Clinic); Ziya L. Gokaslan MD (Johns Hopkins University); Christopher Bono MD; Michael G. Fehlings MD, PhD, FRCS, FACS (Toronto Western Hospital)

Introduction: Cervical spondylotic myelopathy (CSM) often warrants surgical treatment. Our objective was to assess complication rates associated with the surgical treatment of CSM based on a prospective multicenter study.

Methods: The AOSpine North America CSM study is a recently completed prospective multicenter study of patients surgically treated for CSM. Standardized forms were used to collect clinical and surgical data. Perioperative complication rates (within 30 days of surgery) were assessed.

Results: A total of 302 patients (178 men/124 women) were enrolled, with a mean age of 57 years (range: 29-86). Surgical approaches included anterior-only (n=176, 58%), posterior-only (n=107, 35%), and combined anterior-posterior (n=19, 6%). Fusion, laminoplasty, and corpectomy were performed in 27%, 13%, and 15% of patients, respectively. The most common complications included: cardio-pulmonary events (3.3%), infection (7 superficial/2 deep, overall 7.0%), dysphagia (3.0%), C5 radiculopathy/palsy (1.7%), worsened myelopathy (1.3%), new radiculopathy other than C5 (1.0%), epidural/wound hematoma (1.0%), instrumentation malposition/migration (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%). Single cases (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%). Single cases (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%). Single cases (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%). Single cases (1.0%), durotomy (1.0%), other neurological deficit (0.7%), renal complications (0.7%), and altered mental status (0.7%).

Conclusion: The data suggest that functional outcomes can be predicted by age and baseline mJOA scores. Moreover, age negatively affects functional outcomes following surgical treatment.

238. Spinal Injuries in Children and Adolescents

Jan Stulik; Jan Kryl; Michal Barna (FN Motol); Petr Nesnidal MD (FN Motol)

Introduction: In this retrospective study, the effectiveness of conservative and surgical treatment of injured spines in children is evaluated in a 10-year period.

Methods: All patients from birth to the completed 18th year of age treated in our departments between 1996 and 2005 were included in this study. The patients, evaluated in three age categories (0-9, 10-14, 15-18), were allocated to two groups according to the treatment used.

Results: During 1996 through 2005, we treated a total of 15646 patients with injury to the skeleton, aged 0 to 18 years. The spine was affected in 571 cases, which is 3.6%. We used conservative treatment in 528 (92.5%) and surgery in 43 (7.5%) children. The group of patients treated conservatively consisted of 292 boys (55.3%) and 236 girls (44.7%); 219 (41.5%) were in the 0-9 year category, 251 (47.5%) were between 10 and 14 years old and 58 (11%) were 15 to 18 years old. In all age categories, injury to the thoracic spine was most frequent (340; 64.4%). Multi-segment injury in 124 patients (23.5%). The thoracolumbar spine was affected in 22 patients (4.2%), and lumbar vertebrae in 28 patients (5.3%), upper cervical spine in 4 (0.8%) and lower cervical spine in 10 (1.9%) patients.

Conclusion: Childhood spinal injuries account for only 2 to 5% of all spinal injuries and for 3.6% of all skeletal injuries in children. Conservative treatment is preferred; surgery before 12 years of age is strictly individual, while after 12 years therapy is similar to that used in adults.

239. Diffusion Tensor MR Imaging in Rats with Varying Spinal Contusion Severity

Shekar N. Kurpad MD, PhD (Medical College of Wisconsin); Brian Schmit PhD; Michael Jirjis BS; Mohammed Ali Jazayeri; John L. Ulmer MD

Introduction: Diffusion Tensor Imaging (DTI) is a promising novel MRI based technique for spinal cord tractography. We have previously shown that DTI derived indices, including mean diffusivity (MD), fractional anisotropy (FA), lateral and transverse apparent diffusion coefficients (LADC and TADC) correlate with structural and functional changes after SCI at the zone of injury. We present the preliminary results of our recent investigations in the validation of DTI FA as a biomarker for distal changes in the cervical spinal cord after experimental thoracic injuries of varying severity.

Methods: Four groups of rats were used for the experiments. These included animals with sham surgery, mild, moderate and severe thoracic injuries derived from a standard NYU impactor. Animals were imaged in vivo using a 9.4T magnet, and axial diffusion weighted images were collected at a b-value of 500 seconds/mm(2). Average FA values were calculated in axial sections of the cervical spinal cord with five slices representing C2-3/C3-4/C4-5/C5-6 and C6-7 respectively.

Results: In all three injury groups, average FA values showed a progressive decreasing trend in a caudal cephalad direction ranging from 0.69 to 0.59 mm(2)/s in FA. Severely injured rats showed the greatest reduction in FA values (average of 0.9 decrease in FA) with moderate and mild injured animals showing slightly lesser reduction (average of 0.6 and 0.4 mm(2)/s decrease in FA respectively). FA values in the severe injury group were significantly different (analysis of variance [ANOVA], p > 0.05) than the other two groups. No significant difference was observed between the mild and moderate groups.

Conclusion: We have demonstrated that FA can be a reliable biomarker for estimating spinal cord structural changes in the cervical spinal cord after thoracic injury. In addition, our studies show that FA changes in the cervical cord can reflect injury severity in the thoracic cord. These observation carry important implications in further refining DTI indices to assess SCI severity.
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240. CTA Screening for Vertebral Artery Injury in Transverse Foramen Fractures in 320 Patients

Sanjay S. Dhall MD (Emory University School of Medicine); Albert Jesse Schuette MD (Emory University School of Medicine); Jack Barrow; Gerald E. Rodts MD (Emory Spine Center); Daniel L. Barrow MD (The Emory Clinic)

Introduction: Transverse foramen fractures are a common finding after cervical spine trauma. Computed tomography angiography (CTA) is a rapid method to screen for vertebral artery injury in patients who sustain these fractures.

Methods: We reviewed the prospective trauma database of 2084 consecutive cervical spine fractures from 2000 to 2009. We identified 320 patients with transverse foramen fractures and computed tomography angiography. The primary goal is to identify the incidence of vertebral artery injury in this blunt trauma population.

Results: CTA results were obtained on all 320 patients with cervical transverse foramen fractures. In this population, 19% of patients were found to have sustained vertebral artery injury on CTA.

Conclusion: Transverse foramen fractures of the cervical spine should undergo screening with CTA to evaluate for vertebral artery injury. Fracture patterns associated with vascular injury will be discussed. Outcomes of various treatment methods employed will be discussed.

241. Dens Fractures in Patients Over 65 Years of Age: Anterior Screw Fixation of the Dens Versus Posterior Fixation of C1-C2

Jan Stulik; Jan Kryl; Petr Nesnidal MD (FN Motol)

Introduction: This study is a retrospective evaluation of dens fractures in patients over 65 years of age treated with anterior screw fixation of the dens (ASF) or posterior atlantoaxial fixation and fusion (PF).

Methods: We treated surgically 28 patients older than 65 years with dens fractures, with a mean age of 77.4 years (65-90 years). According to the type of treatment the whole cohort was divided into 2 groups that were subdivided into two age groups of patients 65-74 years old (N=8, mean age 68.5) and older then 75 years (N=20, mean age 81). Neurological deficits were found in three patients, Frankel D type. All patients underwent radiograph examination in two projections, CT scans and in most cases also MRI examination. Based on these examinations, the type of injury was determined and method of treatment indicated. Follow-up was 12 to 78 months after the surgery (mean 31.3 months) with consideration on aetiology and type of injury, neurological finding, method of treatment, union of the fracture lines or C1-C2 fusion, stability of the spine and the final outcome.

Results: There was statistically significant difference in the mortality (p<0.05), with 0 % in the younger group and 40 % in the older group. Mortality within 6 weeks after the injury was 28.6 %. Mortality after ASF was 21.4% and mortality after PF was 35.7% (p=0.05). Of the 20 surviving patients, 11 were treated with ASF and 9 with PF. We found only one case of nonunion of the dens (9.1 %) and one fibrous callus in the region of C1-C2 fusion and the fracture line in the dens (11.1 %) (p<0.05).

Conclusion: Active surgical treatment conduces the improvement of the quality of life of elderly patients after dens fractures. Mortality is influenced by the age rather than by the surgical technique used. Elderly patients with a neurological deficit mostly die of associated diseases.

242. A Pilot Evaluation of the Role of Bracing in Stable Thoracolumbar Burst Fractures

Mohammed F. Shamji MD, PhD (University of Ottawa Hospital -Civic Campus); Darren Roffey; Don Chow; Joseph O’Neil; Garth Johnson MD, FRCS; Daryl Young; Eugene Wai

Introduction: The management of thoracolumbar burst fractures may depend on clinical presentation of neurological deficit as well as radiographic features of fracture severity suggestive of instability.[1] When patients are neurologically intact and have mild deformity on computed tomography (CT), conservative therapy may be applied, conventionally involving bracing over months to permit fracture stabilization.[2,3] We investigated the utility of bracing versus no bracing among stable thoracolumbar burst fractures.

Methods: Patients with stable thoracolumbar burst fractures, single level between T12 and L2, without neurological deficit or lower extremity injury were entered into this study. Randomization was computer-generated in sealed envelopes. Investigated endpoints were at time of presentation and at 6-months follow-up and included radiographic outcomes of kyphotic progression and loss of vertebral height and clinical outcomes of self-reported pain and disability. Continuous variables were analyzed by two-factor ANOVA (time and treatment as factors), at the 0.05 level of significance.

Results: There were no differences between patients treated with or without bracing regarding the level of injury (p=0.18) and initial spine geometry including extent of fragment retropulsion (p=0.97), anterior loss of height (p=0.56), or Cobb angle (p=0.26). Progressive loss of height occurred to by additional 1.7±4% in both groups (p=0.06) and degree of kyphotic progression was also no different by treatment (brace 6±2, no brace 8±2, p=0.59). Improvements in self-reported pain and disability were observed in both treatment groups, to similar extent regardless of management arm (Figure 1, p=0.40).

Conclusion: Patients with stable thoracolumbar burst fractures treated with or without bracing had similar outcomes at 6 months. Radiographic outcomes of fracture geometry and clinical outcomes of pain and disability scores were no different by treatment type. These patients may benefit from conservative therapy simply involving sequential imaging without brace immobilization, although larger series of patients may be required.

243. Clinical Outcome and Risk of Reoperation for Recurrent TCS in 99 Consecutive Children Operated for Tight or Fatty Filum

Lauren Rose Ostling MD (University of Cincinnati Department of Neurosurgery); Karin S. Bierbrauer MD (Cincinnati Children’s Hospital Medical Center); Charles Kuntz MD (University of Cincinnati, Mayfield Clinic)

Introduction: For operative division of a tight or fatty filum in pediatric patients, the clinical outcome is often assumed to be favorable, while complications and risk of reoperation for recurrent tethered cord syndrome (TCS) are frequently considered negligible.

Methods: In this retrospective study, the authors reviewed the medical records of 99 consecutive children who underwent initial division of the filum terminale at Cincinnati Children’s Hospital Medical Center (November 1995 - May 2006) for a tight or fatty filum. Presenting symptoms/signs, MRI findings, complications, postoperative symptoms/signs, and need for reoperation were recorded. Mean follow-up for all patients was 32 months; 79 were followed for greater than or equal to 6 months and 67 were followed for greater than or equal to 12 months.

Results: The most common presenting symptoms were bladder and/or bowel dysfunction, followed by gait abnormality, back pain, and spasticity. At last follow-up, 86 patients were improved or stable, while 11 patients had at least one symptom/sign which had worsened. There were a total of 12 complications in 9 patients including 5 wound infections, 4 CSF leaks, 1 pseudomeningocele, 1 stitch abscess and 1 transient headache. Five children underwent a reoperation for recurrent TCS with further detethering of the spinal cord. Worsening back pain was the most common symptom in those patients requiring reoperation. Mean time to reoperation was 58 months (range 22 - 73 months). Arachnoid adhesions were found to have accounted for the retethering at the time of reoperation in four of the five patients.

Conclusion: Division of a tight or fatty filum, in this consecutive...
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series of pediatric patients, resulted in improved or stable symptoms in 89% of patients. However, the complication rate and 5.1% rate of reoperation for recurrent TCS are not insignificant.

244. Determination of the Minimum Improvement in Pain, Disability, and Health State Associated With Cost-Effectiveness: Introduction of the Concept of Minimum Cost Effective Difference (MCED)

Scott Parker; Owoicho Adogwa BS, M.P.H; Brandon J. Davis MD, PhD (Vanderbilt University Hospital); Clint Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center).

Introduction: Spinal surgical outcome studies rely on patient-reported-outcomes (PRO) to assess effect. A shortcoming of these outcome-metrics is that extent of change in numerical scores lack a direct meaning or clinical significance. Hence, the concept of minimum clinical important difference (MCID) was adopted as smallest improvement in PRO needed to achieve treatment-effectiveness. While total cost of <$50,000 per QALY-gained is considered cost-effective for a particular treatment, a measure for smallest improvement in PRO that is associated with cost effectiveness has yet to be introduced. Here we utilize a common MCID-calculation method with a cost-utility threshold-anchor to introduce the concept of minimum cost effective difference (MCED).

Methods: Forty-five patients undergoing trans-foraminal lumbar interbody fusion (TLIF) for degenerative spondylolisthesis were included. BP-VAS, LP-VAS, ODI, EQ-5D were administered before and 2-years post-operatively. Cost was calculated from Medicare reimbursement rates and commercial payer charge data were used to estimate the direct medical costs of SSI in patients undergoing MIS versus open P/TLIF from a perspective. SSI was defined as a subsequent diagnosis of postoperative infection and/or reoperation for recurrent TCS are not insignificant.

Results: MIS versus open-TLIF cohorts were similar at baseline. Median [IQR] length of hospitalization following surgery was significantly less for MIS- vs. open-TLIF (3 [3-3] vs. 5.5 [4-6] days), p=0.001. MIS- versus open-TLIF patients demonstrated similar two-year improvement in VAS-BP, VAS-LP, ODI, and EQ-5D scores, Figure 3. Overall, median [IQR] length of post-operative narcotic use was 3.0 [1.4-4.6] weeks and significantly shorter for MIS- vs. open-TLIF patients (2.0 [1.0-3.0] vs. 4.0 [1.4-4.6] weeks, p=0.008). Figure 1. Overall, median [IQR] time to return to work was 13.9 [2.2-25.5] weeks and significantly shorter for MIS- vs. open-TLIF patients (8.1 [4.4-21.4] vs. 17.1 [13-35.9] weeks, p=0.01). Figure 2.

Conclusion: Both minimally invasive and open-TLIF provide long-term improvement in pain, disability, and quality of life in patients with back and leg pain from grade I degenerative spondylolisthesis. However, MIS-TLIF may allow for shortened hospital stays, reduced post-operative narcotic use, and accelerated return to work, influencing factors associated with direct medical costs and indirect costs of lost work productivity.

245. Comparative Effectiveness of Minimally Invasive Versus Open Transforaminal Lumbar Interbody Fusion: Analysis of Hospital Billing and Discharge Data from 5,328 Patients

Matthew McGirt MD (Vanderbilt University Medical Center); Scott Parker; Jason Lerner; Luella Engelhart; Michael Y. Wang MD (University of Miami - Lois Pope).

Introduction: Surgical site infection (SSI) following posterior or transforaminal interbody fusion (PTLIF) of the lumbar spine is associated with significant morbidity and medical resource utilization. To date, there have been no studies conducted with sufficient power to compare the incidence of SSI following minimally invasive (MIS) versus open P/TLIF procedures. We assess the incidence and direct costs of SSI in patients undergoing MIS versus open P/TLIF from a hospital-system database representing more than 600 hospitals and 5 million discharges per year.

Methods: In a retrospective longitudinal analysis of hospital discharge and billing records from the Premier PerspectiveTM database, all patients undergoing P/TLIF were identified via International Classification, 9th Revision, Clinical Modification (ICD-9-CM) procedure codes. MIS procedures were identified by instrumentation trade name. SSI was defined as a subsequent diagnosis of postoperative infection or administration of intravenous antibiotics 1-8 weeks post-operatively. Medicare reimbursement rates and commercial payer charge data were used to estimate the direct medical costs of SSI.

Results: 3,793 patients underwent open P/TLIF (1,625 one-level, 2,168 two-level) and 1,535 patients MIS-P/TLIF (882 one-level, 653 two-level). Overall, MIS- vs open-P/TLIF was associated with a reduction in SSI [71 (4.6%) vs 228 (6%), p=0.047], Table 1. Stratified by levels fused, SSI was similar for one-level P/TLIF [41 (4.6%) vs 77 (4.7%), p=0.919], but significantly reduced for two-level MIS-P/TLIF [30 (4.6%) vs 351 (7.0%), p=0.030], Table 2. The estimated cost of surgically managed SSI was $23,380 and medically managed SSI $12,419. For two-level fusion, estimated SSI-associated cost per 100 P/TLIFs performed was $115,959 for open- and $72,306 for MIS-P/TLIF (cost savings: $43,653 per 100 two-level P/TLIFs performed).
247. Endoscopic Image-Guided Transcervical Odontoidecomy: Long-Term Outcomes of 15 Patients with Basilar Invagination

Hormuzdiyar H. Dasenbrock BA; Michelle J. Clarke MD (Mayo Clinic); Ali Bydon MD (Johns Hopkins Hospital); Daniel M. Sciubba BS, MD (Johns Hopkins University); Timothy F. Witham MD, BS (Johns Hopkins Hospital); Ziya L. Gokaslan MD (Johns Hopkins University); Jean-Paul Wolinsky MD (Johns Hopkins University)

Introduction: Ventral decompression with posterior stabilization is the preferred treatment for symptomatic irreducible basilar invagination (BI). However, the standard (and expansive) transoral approaches to the dens can be associated with substantial morbidity. Endoscopic image-guided transcervical odontoidecemy (ETO) may allow for decompression to be performed with less morbidity. We report the largest series with the longest follow-up of patients undergoing odontoidecemy for BI via an endoscopic transcervical approach.

Methods: 15 patients who had a follow-up of at least 9 months were retrospectively reviewed. Intra-operatively, the vertebral body of C2 was removed and the odontoid was resected in a “top-down” manner using endoscopic visualization and frameless stereotactic navigation. Posterior instrumented stabilization was subsequently performed.

Results: The average (± standard deviation) age of the patients was 42.6±24.5 (range 11-72) years; the mean pre-operative degree of basilar invagination (measured above the McGregor line) was 12.0±9.9 (range 0-35) mm. Post-operative complications occurred in 6 patients, including a urinary tract infection (n=2), upper airway swelling (n=2), dysphagia (n=2), gastrostomy tube placement (n=1) and an asymptomatic pseudomeningocele (n=1). The average length of hospital stay was 9.1±4.9 (range 2-23) days. With a mean follow-up of 34.9±14.4 months, myelopathy improved in all patients and the mean modified Japanese Orthopedic Association (mJOA) score increased from 11.1±4.0 to 16.0±1.4 (p=0.0001). Patients with a diagnosis other than rheumatoid arthritis (p=0.003) or who a higher pre-operative mJOA score (p=0.026) were significantly more likely to have a complete neurological recovery; improvement in neurological function was not significantly associated with pre-operative mJOA score (p=0.026). Definitive signs of fusion (Lenke 1-2) were present in 74% at 3 months, 91% at 6 months, 96% at 12 months and 95% at 24 months.

Conclusion: Our experience using XLIF in the ASD population has shown that clinical and radiographic indicators improve commensurately and the overall outcome is encouraging.

248. Minimally Invasive Treatment of Adjacent Segment Degeneration via XLIF

Jody A. Rodgers MD, FACS (Spine Midwest, Inc.); W.B. Rodgers MD; Edward J. Gerber

Introduction: The XLIF approach provides a minimally disruptive alternative to anterior column access that allows for large graft placement, disk height restoration, and indirect decompression, while avoiding posterior scar tissue from the previous procedure. Results of ASD treated with XLIF are presented.

Methods: Of our single-site consecutive series of 932 XLIF patients, 276 were treated for ASD. Clinical and radiographic measures were prospectively collected and evaluated.

Results: Age ranged from 29-91 years (average 61.6 years). 90.6% had one or more comorbidity. 144 patients (52%) were obese or morbidly obese. All but one case included supplemental fixation: 47% unilateral pedicle screws, 4% bilateral pedicle screws, 12% lateral embrodered plate, and 43% laterally tarbed interbody implant. In 15 cases with prior posterior instrumentation, the pre-existing rods were removed unilaterally and revised on that side; in all other cases with prior instrumentation, adjunctive lateral fixation was used. Hospital stay averaged 1.5 days, with 2 blood transfusions and one wound infection. Complications included intraoperative hardware failure (4, revised during same procedure with no incident), ileus (5), gallstone pancreatitis (1), urinary retention (3), kidney stone (1), peritoneal catheter occlusion (1), pulmonary embolism (1), subcutaneous hematoama (1), delirium (1), atrial fibrillation (3), MI at 6 weeks post-op (1), compression fracture at an adjacent level (5), sacral fracture (1), and postoperative quadriiceps weakness (1, resolved within 4 weeks of surgery). Average VAS scores improved by 4.6 points from pre-op to 12 months. Average disk height improved from 6.4 to 10.6 at post-op, settling to 8.7mm at 24 months; slip from 3.5 to 0.0mm. Definitive signs of fusion (Lenke 1-2) were present in 74% at 3 months, 91% at 6 months, 96% at 12 months and 95% at 24 months.

Conclusion: MIS-TLIF, ALIF, and AxiaLIF for Single-Level Arthrodesis

Zachary Adam Smith MD (Los Angeles Spine Clinic); Larry T. Khoo MD (The Spine Clinic of Los Angeles)

Introduction: The development of new minimally invasive spine (MIS) techniques for lumbar sacral fusion has provided the spine surgeon multiple methods for fusion at the L5-S1 interbody space. The authors compare clinical and radiographic outcomes from a cohort of prospectively followed patients treated with three modern techniques, MIS-TLIF, ALIF, and AxiaLIF.

Methods: Between June 2003 and January 2009, 58 patients were treated for isolated degenerative disk disease of the L5-S1 segment. All patients presented with back pain with or without radiculopathy and had failed conservative management. The average patient age was 43.34 years. Twenty patients were treated with TLIF, 19 with ALIF, and 19 with AxiaLIF. All patients were prospectively followed with pre- and post-operative visual analog score (VAS) and Oswestry-Disability Index (ODI) scores as well as routine radiographic follow-up.

Results: Clinical outcome with ODI demonstrated a decrease in ODI of -25 with TLIF, -22 with ALIF, and -24 with AxiaLIF. VAS leg scores decrease 92% in patients treated with TLIF, 76% with ALIF and 71% with AxiaLIF. The time of access to the interbody space was most rapid with AxiaLIF (65m) and slightly longer with ALIF (85m) and TLIF (105m). Radiographic outcomes showed that ALIF produced the best distraction of the interbody space (8.6mm); TLIF (6.3mm), AxiaLIF (5.9mm). Fusion with TLIF and ALIF was 95% and with AxiaLIF 90%. Subsidence was greatest with AxiaLIF 16% followed by TLIF (12%) and ALIF (9%). Complications included 2 patients with radiculitis following TLIF. There was a single CSF leak (TLIF) and a single lumbar plexus injury (ALIF). There was a single vascular injury (ALIF) and a single visceral injury (AxiaLIF).

Conclusion: MIS-TLIF, ALIF, and AxiaLIF are all modern, MIS-type approaches to the L5-S1 interbody space. Patient outcomes suggest each has unique clinical strengths and specific disadvantages. Complications with each approach is unique and primarily related to anatomy of the access route.
250. Cost-Utility Analysis of Minimally Invasive Versus Open Multilevel Decompression for Lumbar Stenosis

Owoicho Adogwa BS, MPH; Brandon J. Davis MD, PhD (Vanderbilt University Hospital); Erin Fulchiero BS; Oran Aaronson MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MD (Vanderbilt University Medical Center); Clint Devin MD; Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Minimally invasive (MIS) multi-level hemilaminectomy for degenerative lumbar spinal stenosis allows for effective treatment of back and leg pain while theoretically minimizing blood loss, tissue injury, and post-operative recovery. No studies to date have evaluated the comprehensive healthcare costs associated with multilevel laminectomy procedures, nor assessed the cost-effectiveness of MIS versus open- multilevel laminectomy.

Methods: Fifty-four patients undergoing MIS paramedian tubular (n=27) or open multilevel hemilaminectomy (n=27) for lumbar stenosis associated radiculopathy were prospectively studied. Total back-related medical resource utilization, missed work, and health-state values (quality adjusted life years (QALYs), calculated from EQ-5D with U.S. valuation) were collected over an average of 2 year follow-up. Two-year resource use was multiplied by unit costs based on Medicare national allowable payment amounts (direct cost) and work-day losses were multiplied by the self-reported gross-of-tax wage rate (indirect cost). Difference in mean total cost per QALY gained for MIS- versus open-laminectomy was assessed as incremental cost-effectiveness ratio (ICER: COSTMIS - COSTOpen/QALYMIS - QALYOpen).

Results: MIS versus open cohorts were similar at baseline, Table 1. Both MIS and open laminectomy were associated with a two-year gain of 0.72 QALYs, Figure 1. Mean direct medical costs ($13,334 vs. $14,291), indirect societal costs ($9,775 vs. $11,130), and total two-year cost ($23,109 vs. $25,420, p=0.21) were similar between MIS- and open-hemilaminectomy, Table 2. MIS was associated with similar total costs and utility, making it a cost equivalent technology compared to the traditional open approach.

Conclusion: MIS- versus open- multilevel hemilaminectomy was associated with similar cost over two years while providing equivalent improvement in quality adjusted life years. In our experience, MIS- versus open- multilevel hemilaminectomy is a cost equivalent technology for patients with lumbar stenosis associated radicular pain.


Glen Pollock MD (University of South Florida); Elias Dakwar MD (University of South Florida); Mark Greenberg MD (University of South Florida); Fernando L. Vale MD (University of South Florida Neurosurgery); William D. Smith MD; Juan S. Uribe MD (University of South Florida-Division of Neurosurgery)

Introduction: Symptomatic herniated thoracic discs remain a surgical challenge and historically have been associated with high levels of complications. While the neurologic outcomes have improved with the abandonment of the decompressive laminectomy; surgical complications, morbidity and the need for fusion have continued. The purpose of this study is to demonstrate the safety and reproducibility of the minimally invasive lateral thoracic approach for symptomatic thoracic herniated intervertebral discs with clinical and radiological outcomes.

Methods: We retrospectively studied 24 patients to assess the clinical and radiographic results using minimally invasive surgery for the treatment of thoracic herniated discs. All patients underwent a lateral transthoracic approach utilizing an expandable tube retractor. Follow up times were an average of 21 months. The patients were followed with neurologic examination, visual analog score (VAS) and Oswestry disability index (ODI). Post-operative computed tomography was performed to assess the extent of bony resection.

Results: The mean blood loss was 415 ml. The mean visual analog scale score improvement for thoracic pain was 4.1. The Oswestry disability index improved an average of 36%. All discs were successfully removed except in one patient. One case was complicated by durotomy and one case was complicated by worsened myelopathy. There was no incidence of wrong-level surgery.

Conclusion: Our early experience suggests that the minimally invasive lateral transthoracic approach is safe, reproducible and effective for achieving adequate decompression in thoracic disc herniations in a less invasive manner than traditional surgical treatment options. This surgical technique allows the surgeon to directly visualize and protect the dura prior to visualizing the lesion without the need to collapse the lung. As this technique is advanced, the applicability of minimally invasive surgery will likely be expanded and will afford the opportunity for reduced complications.

252. Early Radiographic Outcomes of XLIF in the Minimally Invasive Treatment of Adult Scoliosis: Results from a Prospective Multicenter Non-Randomized Study of 107 Patients

Frank M. Phillips MD (Midwest Orthopaedics at Rush); Safdar Khan MD; Solas Degenerative Study Group

Introduction: Surgical intervention in adult scoliosis patients has traditionally been performed using large open anterior and/or posterior procedures. This report summarizes the early radiographic outcomes of a minimally-invasive approach (XLIF) for the treatment of adult scoliosis, as part of an ongoing prospective, multicenter study. Methods: 107 patients were treated for adult scoliosis with XLIF at 14 US centers. Radiographs were collected preoperatively and postoperatively at 2 weeks, 3, 6, 12, and 24 months. Radiographic analysis included measures of lumbar lordosis (L4 to S1), coronal Cobb angle, device subsidence, and device migration.

Results: Radiographic follow-up was available for 103 patients who were treated at 310 levels between T11 and L5. Procedures included 1-6 levels. 73.8% of patients were female, average patient age was 67.8 years, BMI was 28.4 kg/m2, and 10.7% were smokers. Supplemental fixation included bilateral pedicle screws (49%), unilateral pedicle screws (26%), and anterolateral plating (7%); the remaining 18% were standalone. At 3 months incidence of migration was 0% and subsidence was 26.2%, none requiring revision. On average, patients had normal lordosis preoperatively; with 33 patients having abnormal lordosis (>40°) measuring an average of -28.5°. Lordosis was significantly corrected in hypolordotic patients from preoperative to 2 weeks (p<0.001) which was maintained at 3 months (average 3 month lordosis = -35.4°). Significant corrections in average coronal Cobb angle were observed from preoperative to 2 weeks (p<0.001) and maintained at 3 months. Coronal correction was significantly affected by supplemental fixation (p=0.027) with the greatest corrections in patients with bilateral posterior pedicle fixation and the least in patients with no supplemental fixation (average 12.6° vs. 2.6°).

Conclusion: Significant reduction in deformity was observed with respect to coronal Cobb angle and lordosis, and was maintained through the three month evaluation, providing evidence that the XLIF technique can effectively correct deformity in the adult scoliosis population.

253. Economic Impact of Minimally Invasive Spine Surgery Open Versus MIS Spinal Fusion Costs in the Perioperative Period (First 45 Days)

Jody A. Rodgers MD, FACS (Spine Midwest, Inc.); W.B. Rodgers MD; John Lucio DO, MS, CPE, FACHE (St. Mary’s Health Center); Brent Vanconia MS, MBA (St. Mary’s Health Center); Kevin J. DeLuizio PhD (Queen’s University)

Introduction: Improved clinical and radiographic outcomes have been reported of minimally invasive spinal surgery techniques in
comparison to traditional open approaches. We seek to determine if fewer complications, reoperations, additional therapies and diagnostics yields a lower overall cost among minimally invasive patients.

Methods: Hospital costs were retrospectively obtained for all our center’s two level spinal fusions from 2005-2008. 101 patients had a traditional open procedure, and 109 underwent a minimally invasive fusion. Patients were not randomized; procedure methods were employed sequentially. After our transition to minimally invasive techniques in late 2006, no further open procedures were performed. Costs obtained include surgical procedure and hospitalization, in addition to ensuing hospital costs occurring in the first 45 days postop.

Results: Average cost of the original procedure and hospitalization was 6% less expensive in the MIS group overall, despite higher implant costs in the MIS group. When combined with all perioperative costs within the first 45 days after surgery, the average procedure cost reduction was 10.4%, a savings of $2,825.37 per procedure.

Conclusion: Results indicate an overall reduction of costs of MIS two level procedures compared to traditional open approaches. Costs of the surgical procedure and hospitalization are lower in the MIS group. Early numbers indicate that cost savings increase as length of time postop increases. The open group, although with longer follow-up, has demonstrated a significantly higher incidence of reoperation than the MIS group comparatively. Thus, our continued cost evaluation into the intermediate and long-term follow-up period may demonstrate an ever-increasing improvement in overall costs.

254. Perioperative Outcomes and Complications Following XLIF for the Treatment of Adult Scoliosis: Results of a Prospective, Non-Randomized, Multi-Center Evaluation

Robert E. Isaacs MD (Duke University Medical Center); Jonathan Hyde MD; J. Allan Goodrich, W.B. Rodgers MD; Frank M Phillips MD (Midwest Orthopaedics at Rush); Solas Degenerative Study Group

Introduction: Combined anterior/posterior instrumented fusion is often performed for the surgical treatment of adult scoliosis. Such procedures have been associated with a high risk of complication, particularly in the elderly patient population. Less invasive surgical approaches to neural decompensation and fusion have recently been applied in the treatment of degenerative scoliosis. This report summarizes the perioperative complications following lateral fusion for the correction of degenerative scoliosis.

Methods: In a prospective multicenter observational study of patients who underwent the XLIF procedure for the treatment of degenerative scoliosis, perioperative measures were compiled to identify the short-term outcomes of the procedure. Intraoperative data collection included surgical details, operative time, estimated blood loss, and complications. Postoperative complications, length of hospital stay, and neurological status were recorded.

Results: 107 patients (mean age 68 years; range 45-87) were treated with XLIF. 28% had at least one comorbidity. A mean of 4.4 levels/patient (range 1-9) were treated. Supplemental pedicle screw fixation was used in 75.7% of patients, 5.6% had lateral fixation and 18.7% had standalone XLIF. Mean operative time and blood loss were 178min and 50-100cc. Mean hospital stay was 2.9 days ( unstaged), 8.1 days (staged), 16.5%. 3.8 days overall. 5 patients (4.7%) received a transfusion, 3 (2.8%) required ICU admission, 1 (0.9%) required rehabilitation services. Major complications occurred in 13 patients (12.1%): 2 (1.9%) medical, 12 (11.2%) surgical. Of procedures that involved only less invasive techniques (XLIF standalone or with percutaneous instrumentation), 9.0% had one or more major complications. In those with supplemental open posterior instrumentation, 20.7% had one or more major complication. Early reoperations (3, for deep wound infections) were associated with open posterior instrumentation.

Conclusion: The morbidity in adult scoliosis surgery is minimized with less invasive techniques. The rate of major complications in this study (12.1%) compares favorably to reports from other studies of surgery for degenerative deformity.

255. Correlation of Pre-Operative Depression and Somatic Perception Scales With Post-Operative Disability and Quality of Life After Lumbar Discectomy

Scott Parker; Kaisorn L. Chaichana MD (Johns Hopkins Hospital); Owoicho Adogwa BS, M.P.H; Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: Lumbar discectomy is a common surgical procedure performed in the U.S. for patients experiencing back and leg pain. However, patients with certain psychological predispositions may be especially vulnerable to poor clinical outcomes. The goal of this prospective longitudinal study was to determine the role that preoperative depression and somatic anxiety have on long-term back and leg pain, disability, quality of life for patients undergoing single-level lumbar discectomy.

Methods: 67 adults undergoing discectomy for single-level herniated lumbar disc underwent prospective quantitative measurement of leg and back pain (visual analogue scale; VAS), quality of life (Medical Outcomes Short Form-36; SF-36), and disease-specific disability (Oswestry Disability Index; ODI) pre-operatively, at 6 weeks, 3, 6, and 12 months after surgery. Degree of preoperative depression and somatization were assessed using Zung Self-Rating Depression Scale and modified somatic perception questionnaire (MSQP). Multivariate regression analyses were performed to assess associations between Zung and MSQP scores with achievement of a minimum clinical important difference (MCID) in each outcome measure by 12 months post-operatively.

Results: Overall, a significant improvement in VAS-leg, VAS-back, ODI, and SF-36 PCS was observed by 6 weeks after surgery and maintained throughout 12-months follow-up. Increasing preoperative depression (Zung score) was associated with a decreased likelihood of achieving MCID in disability (p=0.006) and quality of life (p=0.04) but was not associated with leg (p=0.96) or back pain (p=0.85) by 12 months, Fig1&Table 1. Increasing preoperative somatic anxiety (MSQP score) was associated with decreased likelihood of achieving MCID in disability (p=0.002) and quality of life (p=0.03) but was not associated with leg (p=0.64) or back pain (p=0.77) by 12 months, Fig1&Table 1.

Conclusion: Zung and MSQP are valuable tools at pre-operatively risk stratifying patients who may not experience clinically relevant improvement in disability and quality of life after discectomy. Efforts to address these confounding and underlying contributors of depression and heightened somatic anxiety may improve overall outcomes after lumbar discectomy.

256. Microdiscectomy Improves Pain-Associated Depression, Somatic Anxiety, and Mental Well Being in Patients With Herniated Lumbar Disc

Scott Parker; Richard L. Lebow MD (Vanderbilt University Medical Center); Owoicho Adogwa BS, M.P.H; Adam S. Reig MD; Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Matthew McGirt MD (Vanderbilt University Medical Center)

Introduction: In a multi-center, prospective, longitudinal outcome study, we assessed the prevalence of preoperative depression, somatization, and mental well-being in patients with herniated lumbar discs and the effect that microdiscectomy had on these psychological disturbances.

Methods: Patients undergoing surgical discectomy at five medical institutions for a single-level, herniated lumbar disc were prospectively assessed pre-operatively, at 6 weeks, 3, 6, and 12 months after surgery for visual analog scale for low back pain (BP-VAS) and leg pain (LP-VAS), depression via Zung Self-Rating Depression Scale, heightened anxiety somatic perception via the Modified Somatic Perception Questionnaire (MSQP), and mental well-being via the SF-36 mental component summary (MCS).
257. Management of Degenerative Lumbar Stenosis Related to Meyerding Grade I Spondylolisthesis: The Reappraisal of Unilateral Laminotomy

Mario Gana MD, MSBM; Enrico De Micheli MD; Massimo Gerosa

Introduction: The management of degenerative lumbar stenosis related to Meyerding Grade I spondylolisthesis is still a matter of debate: both laminectomy and laminotomy have been advocated, but sometimes fusion may represent an overtreatment. A prospective trial was conducted in 38 patients to evaluate the impact of unilateral laminotomy for bilateral decompression of the lumbar canal in such cases.

Methods: On admission, patients (ratio F:M = 27:11; mean age 69y) underwent clinical evaluation using the Beaufon Scoring System (BSS) and VAS scale. Segmental instability detected on dynamic x-rays were considered exclusion criteria. CT and/or MRI studies of the lumbar spine were performed in all cases preoperatively and 12 months following surgery. Outcome was evaluated in two stages: at discharge using the BSS and VAS scales, and at long-term follow-up time (12 months minimum) using the MacNab classification (grade I-excellent, II-good, III fair, IV-poor).

Results: At discharge, clinical improvement assessed by BSS and VAS scales was significant in all patients; but more interestingly it was sustained even at long-term follow-up (mean 40 months): 81% of the patients were in excellent conditions according to MacNab classification. Following surgery the lumbar spinal canal diameters (anteroposterior, transpedicular, interapophyseal) were significantly larger than the preoperative measurements, and no cases of vertebral instability were found.

Conclusion: The results of our study indicate that, whenever evidence of spinal instability is ruled out, unilateral laminotomy is a valid surgical option in the treatment of degenerative lumbar stenosis related to Meyerding Grade I spondylolisthesis.

258. Determination of Minimum Clinically Important Difference (MCID) in Pain, Disability, and Health State Utility After Transforaminal Lumbar Interbody Fusion (TLIF) for Degenerative Lumbar Spondylolisthesis

Scott Parker; Owoicho Adogwa BS, MPH; Alexandra Paul BS; Bill Anderson; Oran Aaronson MD (Vanderbilt University Medical Center); Joseph S. Cheng MD, MS (Vanderbilt University Medical Center); Matthew McGregor MD (Vanderbilt University Medical Center

Introduction: Spinal surgical outcome studies rely on patient reported outcomes (PRO) to assess treatment effect. Commonly used health-related quality-of-life questionnaires include pain scales for back and leg pain (Visual Analog Scale), the Oswestry Disability Index (ODI), and the EuroQol-5D health survey (EQ-5D). A shortcoming of these questionnaires is that their numerical scores lack a direct meaning or clinical significance. Hence, the concept of minimum clinical important difference (MCID) has been put forth as a measure for the critical threshold needed to achieve treatment effectiveness. By this measure, treatment effects reaching the MCID threshold value imply clinical significance and justification for implementation into clinical practice.

Methods: In 45 patients undergoing transforaminal lumbar interbody fusion (TLIF) for low-grade degenerative lumbar spondylolisthesis associated back and leg pain, PRO measures of BP-VAS, LP-VAS, ODI, and EQ-5D were administered pre-operatively and 2-years post-operatively and 2-year change scores calculated. Four established anchor-based MCID calculation methods were utilized to calculate MCID (1. average change, 2. minimum detectable change (MDC), 3. change difference, 4. receiver operating characteristic curve analysis) for two separate anchors (health transition index (HTI) of the Short Form-36 and satisfaction index).

Results: The mean±SD two-year improvement in BP-VAS, LP-VAS, ODI, and EQ-5D were 4.3±2.9, 3.8±3.4, 19.5±11.3, and 0.43±0.44, respectively(Figure1). The four MCID calculation methods generated a range of MCID values for each of the PROs (BP-VAS: 2.1-5.3, LP-VAS: 2.1-4.7, ODI: 11-22.9, EQ-5D: 0.15-0.54), Table 1. The mean area under the ROC curve (AUC) from the four PRO-specific calculations was greater for the HTI versus satisfaction anchor (HTI AUC: 0.75 vs. satisfaction AUC: 0.69), suggesting HTI as a more accurate anchor.

Conclusion: TLIF specific MCID is highly variable based on calculation technique. The MDC approach with SF-36 HTI anchor appears to be most appropriate for calculating MCID because it provided a threshold above of the 95% confidence interval of the un-improved cohort (greater than the measurement error), was closest to the mean change score reported by improved and satisfied patients, and was least affected by the choice of anchor. Based on MCD method with HTI anchor, MCID following TLIF are 2.4 points for BP-VAS, 2.5 points for LP-VAS, 15.6 points for ODI, and 0.40 QALYs for EQ-5D.

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