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Twelfth Annual Scientific Conference

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Abstracts • Résumés

Canadian Spine Society abstracts

Podium presentations

Thursday, March 1, 2012

1.1.01

Supraspinal modulation of gait abnormalities associated with noncompressive radiculopathy may be mediated by altered neurotransmitter sensitivity. ***M. Shamji,*†** ***P. Hwang,†*** ***K. Allen,†‡*** ***L. Jing,†*** ***B. Mata,†*** ***M. Gabr,†*** ***W. Richardson,†*** ***L. Setton.†*** **From the *University of Ottawa, Ottawa, Ont., †Duke University, Durham, NC, and the ‡University of Florida, Gainesville, Fla.**

Background: Radiculopathy resulting from intervertebral disc herniation involves mechanical compression and biochemical inflammation of apposed neural elements. Heterotopic disc placement induces early and persistent allodynia alongside pathological asymmetry of gait. Nevertheless, the mechanisms responsible for resolution of patient symptoms remain elusive and have hitherto been uninvestigated in animal models. 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:** Radiculopathy was induced in Sprague-Dawley rats by harvesting autologous nucleus pulposus (NP) from a tail intervertebral disc followed by exposure of the L5 DRG. Control animals (n = 12) underwent exposure only, and experimental animals received NP placement onto the DRG (n = 12). Animals were evaluated (1 or 4 wk) for mechanical allodynia and gait symmetry. Following sacrifice, the midbrain was evaluated by immunohistochemistry for neurotransmitter receptor expression. All parameters were tested at the 0.05 level of significance. **Results:** Persistent mechanical allodynia occurred in rats subjected to NP stimulation at 1 and 4 weeks, although gait asymmetry and impaired propulsive impulse was only noted at the early (1 wk) time point with late normalization (4 wk). Immunohistochemical evaluation of the ventral periaqueductal grey 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. **Conclusion:** Persistent mechanical allodynia with only transient gait abnormality in noncompressive disc herniation suggests early deficits to be mediated by both spinal and supraspinal mechanisms. Early midbrain serotonin and glutamate receptor expression may aggravate early allodynia, whereas late opioid receptor expression may permit adaptive response to normalize gait.

1.1.02

Neuroprotective effects of the sodium-glutamate blocker riluzole in the setting of experimental chronic spondylotic myelopathy. ***E. Su Moon,* S. Karadimas,* M. Fehlings.*†*** **From the *Toronto Western Research Institute, and Spinal Program, Krembil Neuroscience Centre, University Health Network, and the †University of Toronto, Toronto, Ont.**

Background: There is evidence that glutamatergic excitotoxicity contributes to the pathobiology of neural degeneration in cervical myelopathy (CSM). Given this, we sought to assess the neuroprotecive potential of the sodium-glutamate antagonist riluzole, currently in clinical trials for acute traumatic spinal cord injury, in a rat model of CSM. **Methods:** The spinal cords of rats were gradually compressed with a titanium screw at C6 over an 8-week period. The animals were blindly and randomly divided to 3 groups: the treatment group (n = 17), which received riluzole (8 mg/kg); the control group (n = 18), which received artificial cerebrospinal fluid (aCSF); and the sham group (n = 6). Intraperitoneal injections were performed daily for 7 weeks after the first compression. Mechanical and thermal allodynia were evaluated using the Von Frey and the tail flick tests, respectively. Gait analysis was performed using CatWalk. Demyelination was assessed by hematoxylin and eosin/luxol fast blue stain. *N*-methyl-D-aspartate receptor-1 (NR-1)–positive cells in the dorsal horn were assessed immunohistochemically. **Results:** There was a statistically significant decrease in mechanical and thermal allodynia with riluzole compared with the control group at 8 weeks postsurgery. Moreover, increased swing speed was observed in the treatment group. Interestingly, riluzole administration resulted in decreased glial scar formation and preservation of grey matter compared with the control group. Finally, NR-1–positive cells in the dorsal horns of the grey matter were found to be decreased in the treatment group compared with the control group (mean [SD] 218.6 [4.297] v. 294.6 [20.87], $p < 0.05$). **Conclusion:** These results suggest that riluzole represents a potential neuroprotective strategy in CSM that could be complementary to surgery.

1.1.03

The effect of timing to decompression in cauda equina syndrome using a rat model. ***R.A. Glennie, J. Fleming, C.S. Bailey, K. Gurr, S. Bailey, F. Siddiqi, A. Lawendy, D. Sanders, M. Staudt.*** **From the University of Western Ontario, London, Ont.**

Background: Cauda equina syndrome is a devastating injury for which surgery is the only treatment option; however, controversy exists regarding the optimal timing of surgery. Clinical studies have investigated the effect of the timing of surgical decompression on motor recovery, but no definitive recommendations exist. The effect on bladder function and sensation has been sparsely investigated. Our objective was to determine the effect of duration of extradural cauda equina compression on bladder, sensory and motor dysfunction using a rat model. **Methods:** Under general anesthesia, a balloon-tipped Fogerty catheter (2 mm diameter) was inserted underneath the fifth and sixth lumbar vertebral bodies and inflated to rapidly compress the cauda equina. A 3-way

stopcock allowed pressure monitoring to ensure consistent extradural compression of 250 mm Hg. The compression was maintained for 1 hour or 4 hours, at which time the balloon was deflated, representing surgical decompression. Sham animals had the catheter inserted underneath the vertebral bodies, but the catheter was not inflated. Over a 4-week period, pain scores, urinary residual volumes and locomotor function were assessed. Postmortem, bladders and kidneys were collected for analysis. **Results:** Final bladder pressure and bladder weights were greater in the 4-hour compression group versus the 1-hour compression group ($p < 0.05$). Pain scores were greater for 1-hour cauda equina syndrome rats and remained consistently elevated to the end of the protocol. The locomotion data could not detect a difference in gait coordination between all groups. **Conclusion:** Our data suggest that motor function after urgent or delayed decompression will likely lead to full recovery. Bladder functional recovery is much less predictable and seems to be very sensitive to longer durations of compression. This has significant implications on patients presenting with acute cauda equina syndrome and how to proceed if these symptoms are identified.

1.2.04

Intraoperative waste in spine surgery: incidence, cost and effectiveness of an educational program. ***A. Soroceanu,* E. Canacari,† E. Brown,† A. Robinson,† K. McGuire.*** **From *Dalhousie University, Halifax, NS, and the †Beth Israel Deaconess Medical Center, Boston, Mass.**

Background: This study aims to quantify the incidence of intraoperative waste in spine surgery and to examine the efficacy of an educational program directed at surgeons to induce a reduction in the intraoperative waste. Spine procedures are associated with high costs. Implants are a main contributor of these costs. Intraoperative waste further exacerbates the high cost of surgery. **Methods:** This was a prospective observational study. Data were collected during a 25-month period from one academic medical centre (15 mo observational period, 10 mo post–awareness program). The total number of spine procedures and the incidence of intraoperative waste were recorded prospectively. Other variables recorded included the type of product wasted, cost associated with the product or implant wasted, and reason for the waste. **Results:** Intraoperative waste occurred in 20.2% of the procedures before the educational program and in 10.3% of the procedures after the implementation of the program ($p < 0.0001$). Monthly costs associated with surgical waste were, on average, $17 680 before the awareness intervention and $5876 afterwards ($p = 0.0006$). Prior to the intervention, surgical waste represented 4.3% of the total operative spine budget. After the awareness program, this proportion decreased to an average of 1.2% ($p = 0.003$). **Conclusion:** Intraoperative waste in spine surgery exacerbates the already costly procedures. A simple educational program proved to be and continues to be effective in making surgeons aware of the import of their choices and the costs related to surgical waste.

1.2.05

Looking beyond the clinical box: the health services impact of surgical adverse events. ***C. Lin, C. Chrysostoum, Y. Raja Rampersaud.*** **From the Arthritis and Spine Program, University Health Network, Toronto Western Hospital, University of Toronto, Toronto, Ont.**

Background: In the Canadian healthcare system, access to inpatient beds is an ongoing and escalating problem. For surgical wards, cancellation of elective surgery directly impacts access to care and is an increasing source of frustration to all stakeholders. The primary purpose of this study was to assess the impact of perioperative adverse events (AEs) on available hospital bed days. **Methods:** We conducted preliminary analysis of data from a prospective observational study. Information regarding patient demographics, diagnosis, procedure and length of stay is being captured on all in-patient surgical orthopaedic and spinal procedures at our institution. Occurrence of AEs is documented and categorized daily using the OrthoSAVES system. Data from the first 6 months ($n = 908$) were analyzed. **Results:** In this period, there were 227 AEs (intraoperative and postoperative) in 154 patients. Overall unadjusted mean length of stay was 6.05 days for patients without AEs and 13.39 days for those with AEs. The most common AEs were urinary tract infection ($n = 33$), dural tear ($n = 23$) and delirium ($n = 21$). The majority of AEs ($n = 196$, 86%) were grade 1–2 (did not require treatment or required minor treatment but were not likely to impact patient outcome). Controlling for procedure groups, these low-grade AEs led to approximately 654 total aggregate additional days in hospital. In the same period, 22 (9.7%) grade 3 or 4 AEs (required complex treatment and were likely to impact patient outcome) resulted in approximately 373 additional days in hospital. Additionally, there was 1 life-threatening event (grade 5) and 3 events leading to death (grade 6). **Conclusion:** Cumulatively, low-grade (1–2) AEs were responsible for a significant amount of added days in hospital. The majority of these are preventable or modifiable, and thus the development of clinical protocols targeting these often-marginalized AEs can lead to improved system efficiency.

1.2.06

Brace versus no brace for the treatment of thoracolumbar burst fractures without neurologic injury: a multicentre prospective randomized controlled trial. ***C.S. Bailey,* M.F. Dvorak,† K.C. Thomas,‡ M.C. Boyd,† K.R. Gurr,* S.I. Bailey,* M. Nadeau,* C.G Fisher.†*** **From the *London Health Science Centre, University of Western Ontario, London, Ont., the †Vancouver Hospital and Health Sciences, University of British Columbia, Vancouver, BC, and the ‡Foothills Hospital, University of Calgary, Calgary, Alta.**

Background: Thoracolumbar burst fractures with neurologic injury have good outcomes when treated with a thoracolumbosacral orthosis (TLSO) and early ambulation. However, anecdotal experience and low-grade evidence suggest these fractures may be satisfactorily treated without a brace. Our purpose was to compare the functional outcome of patients with AO type A3 burst fractures randomly treated with a TLSO versus no orthosis (NO). **Methods:** This randomized controlled trial recruited patients from 3 Canadian tertiary spine centres. Inclusion criteria were AO type A3 burst fractures between T11 and L3, skeletally mature and younger than 60 years of age, admitted within 72 hours of their injury, kyphotic deformity less than 35° and no neurologic deficit. The primary outcome measure was the Roland Morris Disability Questionnaire (RMDQ) assessed at 3 months postinjury. Secondary outcomes were assessed at 2, 6, 12, 24, 52 and 104 weeks and included pain, RMDQ, SF-36, patient

satisfaction, kyphosis, length of hospital stay and complications. The NO group was encouraged to ambulate immediately with bending restrictions for 8 weeks. The TLSO group was weaned from the brace after 8–10 weeks. **Results:** In all, 47 patients were enrolled into the TLSO group and 49 patients into the NO group. No difference was found between groups for any of the primary or secondary outcomes at any of the follow-up periods (Student *t* test). One-way analysis of variance identified a significant improvement of the RMDQ within both groups at 6 weeks and at 3 months for the NO group ($p < 0.05$), but not afterward. The average kyphotic deformity was 14° (range –1° to 35°) at admission, which increased to 21° at 6 weeks and did not progress further. Six patients required surgical stabilization, 5 of these before initial discharge. **Conclusion:** Neurologically intact thoracolumbar burst fractures can be successfully treated using early ambulation without a brace.

1.2.07

Adverse event rates in surgically treated spine injuries without neurologic deficit. ***A. Simmonds, J. Batke, J. Street, M. Boyd, M. Dvorak, C. Fisher, B. Kwon, S. Paquette.*** **From the University of British Columbia, Vancouver, BC**

Background: Treatment of spine injuries in neurologically intact (American Spinal Injury Association [ASIA] grade E) patients is not uniform across institutions or spine surgeons. At our institution, many of these injuries are managed surgically. Identification of treatment adverse events (AEs) is critical to objective measurement of surgical utility. We are unaware of any published prospective data specifically quantifying the risk of intraoperative and postoperative AEs for surgically treated spine injuries without neurologic deficit. **Methods:** Data were collected prospectively over a 2-year period (January 2009 to December 2010) at our institution on all patients who were treated surgically for traumatic spine injuries with manual ASIA grade E. Data on AEs were collected prospectively during the perioperative period until discharge using the previously validated Spine AdVerse Events Severity system (SAVES) tool. All AEs were reviewed at a weekly, attending-lead, multidisciplinary, adverse events review meeting: 103 patients (69 male, 34 female) with complete SAVES data were identified. Of these patients, 54 (52%) were confirmed discharged without an AE being recorded. The remaining 49 patients accrued 85 AEs in total during their inpatient stay (1.7 AEs per patient). **Results:** The most common intraoperative AE was hardware malposition requiring revision (2.9%). The most common postoperative AEs were delerium (5.8%), urinary tract infection (5.8%), dysphagia (5.8%) and pneumonia (5.8%). **Conclusion:** These data should prove helpful in the preoperative counselling of patients with traumatic spine injuries without deficit in terms of the absolute risk of AEs as well as the risk of specific AEs.

1.2.08

Functional and quality of life outcomes in geriatric patients with type II odontoid fracture: 1-year results from the AOSpine North America Multi-Center Prospective GOF Study. ***M. Fehlings,* A. Vaccaro,† J. Chapman,‡ P. Arnold,§ C. Shaffrey¶, B. Kopjar.*‡*** **From the *University of Toronto, Toronto, Ont., †Thomas Jefferson University, Philadelphia, Pa., the ‡University of Washington, Seattle, Wash., the §University of Kansas, Kansas City, Kan., and the ¶University of Virginia, Charlottesville, Va.**

Background: Clinicians are increasingly encountering elderly patients with odontoid fractures, which can present major management challenges. In particular, there is controversy as to whether surgical or nonoperative management is the best treatment option for these patients. **Methods:** A prospective multicentre cohort study of older than 65 years with type II odontoid fractures was undertaken at 11 sites in North America. Patients received nonoperative or surgical treatment at the discretion of the surgical team and were followed for 12 months using a number of generic (SF-36) and disease-specific (including Neck Disability Index [NDI]) outcome measures. **Results:** Of 159 patients (average age 80.7 (SD 7.5) yr, 59.8% female), 63.5% were treated operatively (11.9% anterior odontoid screw, 79.2% posterior C1–C2 screw fixation, 6.9% posterior transarticular screw fixation, 1.0% Brooks fusion and 1.0% occipital–cervical fusion), 29 (18.2%) expired and 3 withdrew from the study. Follow-up was available for 103 (79.2%) of 130 eligible, surviving patients. Baseline NDI was 21.7 (SD 17.2) and the SF-36v2 physical component score was 40.7 (SD 10.5). At 12 months, NDI worsened by 7.6 (SD 21.0) points ($p < 0.001$) and the SF-36v2 physical component score declined by 1.6 (SD 11.1) points ($p = 0.019$). There was a significant difference in NDI outcomes between the surgically and the nonoperatively treated groups. The decline in NDI among the surgical cases was 5.6 points compared with 14.7 points in the conservatively treated group ($p = 0.0173$). There were no differences in SF-36v2 physical component score outcomes between the treatment groups. No patient in either group sustained neurologic deterioration. **Conclusion:** Elderly patients with type II odontoid fractures experience significant mortality and decline in functional outcomes at 1-year follow-up. Our results suggest that NDI outcomes may be better in the surgical group, though the possibility of selection bias needs to be carefully considered.

1.3.09

National US practices in pediatric spinal fusion: in-hospital complications, length of stay, mortality, costs and BMP utilization. ***E. Dodwell,* B. Snyder,† J. Wright.‡*** **From the *Hospital for Special Surgery and Cornell Medical College, New York, NY, the †Children's Hospital Boston and Harvard Medical School, Boston, Mass., and ‡The Hospital for Sick Children and University of Toronto, Toronto, Ont.**

Background: Bone morphogenetic proteins (BMPs) are not approved for use in the skeletally immature spine. However, a number of case series have reported on BMP utilization in the pediatric population. The primary study objective was to determine the risk of in-hospital complications following pediatric spine fusion surgery, with and without BMP administration. Additional objectives were to determine the risk of in-hospital mortality, length of stay and associated costs, and to determine factors associated with BMP utilization. **Methods:** The Kids' Inpatient Database (KID) contains a US national sample of pediatric hospital admissions. Patients aged 18 and younger who underwent spinal fusion in 2009 were included. Unadjusted and

adjusted analyses were performed to determine odds ratios for in-hospital complications and mortality rates by BMP utilization status, factors associated with in-hospital costs and length of stay, and factors associated with BMP utilization. **Results:** In 2009, 12 443 pediatric spinal fusions were performed. Bone morphogenetic protein was used in almost 10% of these cases. The rate of in-hospital complications was 3.5% and was not related to BMP utilization. Complications were associated with non-Caucasian race, Medicare/Medicaid medical coverage, higher medical comorbidity scores, revision fusions and with high-risk diagnoses. In-hospital mortality was 0.13%. The median length of stay was 4.6 (interquartile range 3.5–6.2) days, whereas median cost was $126 108 (interquartile range $84 701–$182 314). Adjusted analysis showed that surgeries using BMP were 23.2% more expensive (95% CI 15.1–31.3). Factors associated with BMP utilization included older age, lumbosacral fusions, 2- to 3-level fusions and revision fusions. Bone morphogenetic protein was less frequently used in specialized pediatric hospitals and in patients with Medicare/Medicaid health insurance. **Conclusion:** Despite lack of Food and Drug Administration approval for use in children, BMP is used in pediatric spinal fusions on a regular basis and is associated with significantly higher costs. Further research is necessary to delineate the safety and efficacy profiles of BMP in children, as well the cost–benefit balance.

1.3.10

Current trends in the surgical treatment of adolescent idiopathic scoliosis in Canada. ***A. Dold, S. Lewis, R. Zeller, R. El-Hawary, P. Moroz, S. Bacon, P. Jarzem, D. Hedden, J. Howard*. From Orthopaedic Surgery, The Hospital for Sick Children, Toronto, Ont.**

Background: As techniques evolve in spinal surgery, surgeons' preferences change in the treatment of adolescent idiopathic scoliosis (AIS). The purpose of this study is to determine the current trends of AIS treatment among Canadian spinal surgeons, in the hopes of identifying controversies that would be amenable to nationwide multicentred trials. **Methods:** A questionnaire was circulated to all Canadian spinal surgeons performing a minimum of 6 pediatric spinal deformity surgeries annually. Data were analyzed and recorded regarding current trends in the treatment of AIS, areas of controversary and topics of interest for multicentre research. Use of a technique or device was considered positive if it was usually or always used by the surgeon. **Results/Conclusion:** Areas of controversies exist in the treatment of AIS in Canada surrounding issues that include the role of anterior procedures, crosslinks, rod diameter, drains, choice of bone graft, return to activities, timing of radiographs and blood conservation strategies.

1.3.11

Sagittal spinopelvic parameters help predict the risk of proximal junctional kyphosis for children treated with posterior distraction-based implants. ***R. El-Hawary,*† P. Sturm,† P. Cahill,† A. Samdani,† M. Vitale,† P. Gabos,† N. Bodin,† C. d'Amato,† C. Harris,† J. Smith.†* From the *IWK Health Centre, Halifax, NS, and the †Chest Wall and Spine Deformity Study Group, Utah**

Background: Rib-based (RB) and spine-based (SB) posterior growing systems are commonly used for the treatment of early onset scoliosis. The purpose of this study was to determine if preoperative spinopelvic parameters can predict the risk of postoperative proximal junctional kyphosis (PJK). **Methods:** A multicentre, retrospective, institutional review board–approved comparison was performed. Preoperative and minimum 2-year follow-up radiographs were analyzed for a group of 40 children with early onset scoliosis who were treated with posterior distraction-based implants (24 RB, 16 SB). Postoperative PJK was defined as a proximal junction sagittal angle of 10° or greater and at least 10° greater than the preoperative angle. **Results:** At a minimum of 2 years follow-up, 11 patients (27.5%) developed PJK. Follow-up time was not different between groups (PJK 2.4 yr v. no PJK 2.9 yr); however, there was a significant difference in age at time of initial surgery (PJK 7.1 yr v. no PJK 5.0 yr, $p < 0.05$). The rates of PJK were similar between RB and SB growing systems (25% v. 31%). Preoperative radiographic comparisons between PJK and no PJK were: thoracic scoliosis (69.9° v. 76.0°), lumbar scoliosis (38.8° v. 39.1°), thoracic kyphosis (45.1° v. 28.7°, $p < 0.05$), thoracolumbar kyphosis (3.6° v. 12.5°), lumbar lordosis (53.1° v. 44.0°), proximal juntional sagittal angle (2.2° v. 2.8°), sagittal balance (1.5 cm v. 2.6 cm), pelvic incidence (52.8° v. 47.4°), pelvic tilt (14.3° v. 8.7°), sacral slope (37.7° v. 35.9°) and pelvic radius angle (72.7° v. 67°). At final follow-up, differences were found for cervical lordosis (30° v. 16.6°, $p < 0.05$), proximal juntional sagittal angle (21.9° v. 3.1°, $p < 0.05$), sagittal balance (3.7 cm v 0.2 cm, $p < 0.05$) and pelvic radius angle (79.1° v. 62.2°, $p < 0.05$). **Conclusion:** Higher rates of PJK were found for older children who were hyperkyphotic preoperatively and in those who had positive postoperative sagittal balance. Strategies to intraoperatively restore normal sagittal balance may help avoid the development of PJK in these children.

1.4.12

Correlations between changes in surface topography and changes in radiograph measurements from before to 6 months after surgery in adolescents with idiopathic scoliosis. ***M. Hashem,* E. Parent,*† D. Hill,*† D. Hedden,*† M. Moreau,*† J. Mahood.**** From *Alberta Health Services and the †University of Alberta, Edmonton, Alta.**

Background: Scoliosis surgery aims to stop curve progression, improve 3-dimensional spinal alignment and correct cosmetic deformity. It is not clear which radiological changes are most influential of cosmesis. Our purpose was to determine the correlation between changes in surface topography and changes in radiographic measurements from the preoperative period to 6 months after surgery for adolescent idiopathic scoliosis (AIS). **Methods:** This retrospective study includes 42 patients ages 10 to 18, who had posterior spinal instrumentation and fusion corrective surgery for AIS. All had back surface topography and radiographs collected before and 6 months after surgery. The surface parameters quantified included decompensation, cosmetic score, posterior trunk symmetry index (POTSI), deformity in the axial plane index (DAPI), kyphosis angle, lordosis angle, trunk rotation and hump sum. Radiological parameters included frontal Cobb angles, frontal and sagittal balance, lordosis and kyphosis angles. Parameters were extracted by an evaluator blinded to patient identity. Correlations between the changes occurring over time in surface and radiological parameters were quantified using Pearson coefficients. **Results:** Preoperatively mean age was 14.5 (SD

4.9) years and largest Cobb angle was 60.6° (SD 13.1°). Significant correlations were observed between the changes in the following surface topography parameters and the changes in radiograph measures from before to 6 months after surgery: cosmetic score versus sagittal balance (r = –0.32); DAPI score versus Cobb angle (r = –0.27) and coronal balance (r = –0.26), surface kyphosis angle versus Cobb angle (r = 0.26) and kyphosis angle (r = 0.56); surface lordosis angle versus coronal balance (r = 0.38); hump sum scores versus kyphosis angle (r = –0.32). Changes in decompensation, POTSI and trunk twist from surface topography did not correlate with any of the radiological changes quantified. Changes in radiological lordosis measurements did not correlate with surface topography. **Conclusion:** Improvements in cosmesis after surgery are moderately related to different radiographic measurements. Surgical improvements in kyphosis angles, sagittal and coronal balance were as strongly associated with improvement in external deformity as Cobb angle improvements.

1.4.13

High upper instrumented vertebra (UIV) sagittal angle is associated with UIV fracture in adult deformity corrections. ***A. Dold, S. Lewis, A. Bodrogi, H. Abbas, S. Goldstein, Y. Bronstein, S. Bacon, S. Chua, S. Magana.*** **From Orthopaedic Surgery, Toronto Western Hospital, Toronto, Ont.**

Background: Selecting the appropriate upper instrumented vertebra (UIV) in adult deformity is often difficult. The purpose of this study is to determine the impact of the sagittal inclination of the UIV on proximal junctional failure. **Methods:** We retrospectively reviewed 27 consecutive patients from 2001 to 2008 with a minimum of 4 levels fused, lower instrumented vertebra of L5 or S1, UIV of T10 or distal, and no previous surgery proximal to the UIV. We describe the UIV angle, the sagittal angle of the UIV with the horizontal. Patients were divided into 3 groups: group 1 (n = 7) patients sustained UIV fractures, group 2 (n = 6) patients sustained other proximal failures and group 3 (n = 14) patients had no proximal complications. **Results:** Our series of long lumbar fusions had a high long-term complication and revision rate. A high UIV angle on intraoperative lateral radiograph was strongly associated with UIV fractures. Upper instrumented vertebrae of L1 or L2 had a higher rate of adjacent segment or UIV failure. **Conclusion:** Our series of 27 consecutive patients from 2001 to 2008 with long lumbar fusions with UIV from T10 to L2 showed that constructs with sagittal UIV angles greater than 18° were associated with a high risk of UIV fracture, that UIVs of L1 or L2 had a higher rate of adjacent segment or UIV failure than patients with UIVs ending at T10, 11 or 12, and that Oswestry Disability Index scores were poor at a minimum of 2 years.

1.4.14

Correction of adult idiopathic scoliosis using intraoperative skeletal traction. ***A. Dold, A. Van Houwelingen, E. Halpern, S. Jhaveri, S. Lewis.*** **From the Toronto Western Hospital, University of Toronto, Toronto, Ont.**

Background: Intraoperative skull–skeletal traction facilitates implant curve correction in scoliosis surgery. It is considered that scoliosis surgically corrected in childhood would have greater correction than that achieved in adulthood. This project aims to determine if intraoperative skeletal traction can help achieve comparable scoliosis correction in adults as seen in children. **Methods:** We retrospectively reviewed radiographs and charts of 44 consecutive scoliosis patients undergoing surgical correction using intraoperative skeletal traction with a minimum 2 years of follow-up. The adult group (n = 27) was divided into deformities with (n = 10) and without (n = 17) rotatory listhesis and compared with a consecutive series of adolescents (n = 17) undergoing similar treatment. Statistical analysis was done using a 2-sample t test, assuming unequal variance. **Results:** Blood loss (3664, 2129, 762 mL), total operative time (6.9, 5.8, 5.4 h), patients requiring decompressions (50%, 17%, 0%), fusions to the pelvis (80%, 6%, 0%) were significantly ($p < 0.05$) greater in the listhesis group compared with the nonlisthesis and adolescent groups, respectively. The angulation (29° to 12°) and displacement (11.5 to 5.4 mm) of the lateral listhesis significantly improved ($p < 0.05$) in the listhesis group. There were no traction-related complications. There were no postoperative neurologic deficits or infections. Two patients encountered instrumentation-related complications. Scoliosis Research Society scores were significantly better in the adolescent group (92%) compared with the adult groups (76%, 77%). **Conclusion:** The use of intraoperative skeletal traction facilitated scoliosis correction in our series, providing older patients, even those with degenerative rotatory listhesis, with correction comparable to young adults and adolescents. Final outcome scores were better in the adolescent group.

1.5.01

Cauda equina: using management protocols to reduce delays in diagnosis. ***S. Jones, A. Lim.*** **From the Poole Hospital, Poole, Dorset, UK**

Background: Acute cauda equina is a surgical emergency. It is widely accepted, though not evidence-based, that there is a 48-hour "golden window" from onset of symptoms to definitive surgery to minimize long-term neurologic sequelae. Cauda equina diagnosis is complicated by atypical (lack of "red flag" symptoms) or late presentations. We conducted a retrospective study over 1 year to identify how many patients were admitted under the orthopedic team with a diagnosis of possible cauda equina, whether they experienced red flag symptoms and whether they fell within the golden window for onset of symptoms to surgery. For positive cases, subsequent management was reviewed. **Methods:** Over the 1-year period, 26 patients were admitted as possible cauda equina: 21 patients experienced "red flag" symptoms; only 9 of these patients had positive scans. Ages ranged from 27 to 86 years old. Time from admission to scan varied between 3 and 48 hours. **Results:** Of the 26 patients, 10 scans were positive for cauda equina, 5 revealed spinal stenosis and 11 were normal. Of the 10 positive scans, 4 patients went on to have emergency decompression, 4 were treated conservatively and 2 had radiotherapy. Of the 4 positive scans of patients who underwent emergency surgery, 3 of those were within the 48-hour time frame, compared with only 1 patient in the conservative group. **Conclusion:** This highlights the importance of early presentation and quick radiological diagnosis of cauda equina. In these cases, surgical intervention within 48 hours is much more likely, hence hopefully leading to a more favourable neurologic outcome. Hospitals should have protocols in place for facilitating emergency MRIs and subsequent referral to neurosurgical centres.

1.5.02

Predicting the need for tracheostomy in patients with acute traumatic spinal cord injury. ***C.S. Bailey,*† *P. Leelapattana,*† *J. Fleming,** *F. Siddiqqi,*‡ *S. Bailey,*† *K. Gurr.**

From the *Spine Program, London Health Sciences Centre, the †Division of Orthopaedic Surgery, Department of Surgery, University of Western Ontario, and the ‡Division of Neurosurgery, Department of Neurosciences, London, Ont.

Background: Approximately 75% of hospitalized patients with a cervical spinal cord injury (CSCI) will require intubation and mechanical ventilation because of compromised respiratory function. It is difficult to predict which CSCI patients will require prolonged ventilation and therefore will most benefit from early tracheostomy. This study intended to show the benefits of tracheostomy, particularly early, and to identify predictors of prolonged mechanical ventilation after CSCI. **Methods:** A retrospective review of patients 16 years of age and older with acute CSCI admitted to a level 1 trauma centre from 1991 to 2010 was performed. Demographic data and clinical parameters were extracted from medical records and the trauma registry. Regression analysis was used to identify predictors of prolonged mechanical ventilation. **Results:** There were 66 eligible patients: 62% of patients required tracheostomy, 5 patients were ventilator-dependent, and 7 patients died more than 10 days following the accident secondary to sepsis. After adjusting for the number of ventilator days following injury, patients who had a tracheostomy had fewer pulmonary complications than those who did not have a tracheostomy ($p = 0.001$). Furthermore, mortality was significantly lower in patients who had a tracheostomy after adjusting for age and Injury Severity Score (ISS; 2.4% v. 24%, $p = 0.025$). Early tracheostomy provided for a quicker extubation and a shorter hospital stay. Clinical parameters that predicted mechanical ventilation would be required longer than 7 days were ISS greater than 32, a complete spinal cord injury and a PaO_2/FiO2 ratio less than 300 three days following a CSCI. **Conclusion:** We recommend early tracheostomy if the ISS is greater than 32, the patient has a complete spinal cord injury and the PaO_2/FiO2 ratio is less than 300 three days after injury.

1.5.03

A novel animal model of cervical spondylotic myelopathy: an opportunity to identify new therapeutic targets. ***S. Karadimas,** *E. Su Moon,** *K. Satkunendrarajah,** *M. Fehlings.*†

From the *Division of Genetics and Development, Toronto Western Research Institute, and the †Division of Neurosurgery, University of Toronto, Toronto, Ont.

Background: In order to validate potential neuroprotective and neuroregenerative strategies for cervical spondylotic myelopathy (CSM), we have developed a novel translationally relevant rat model of CSM. **Methods:** Following posterior exposure of the cervical spine, the ligamentum flavum is opened at C5–6 and C6–7, and gradual and progressive compression (over 10 wk) was achieved by introducing a piece of aromatic polyether with absorbent properties under the C6 lamina in 10 Sprague-Dawley rats. Sham operation was performed on 8 animals (controls). The extent of compression was evaluated using MRI. Gait patterns were evaluated using the automated gait analysis system (CatWalk). Demyelination was assessed by hematoxylin and eosin and luxol fast blue stain. The loss of interneurons at the site of compression and at the lumbosacral enlargement were measured by En1(+) and Chx10(+) immunohistochemistry. Moreover, retrograde labelling of the long descending propriospinal tract was performed by injecting fluorogold bilaterally at the lumbosacral enlargement (L2–L5). At 10 weeks, somatosensory and motor evoked potential recordings (SSEPs and MEPs) were performed. Analysis of variance were used for the statistical analysis. **Results:** Magnetic resonance imaging at 10 weeks revealed 50.2% (SD 4.8%) compression ratio in the compression group. There was a statistically significant decrease in stride length and swing speed. In addition, statistically significant increases were observed in running time, stance phase, 4-limb % support, number of steps and base of support. The normalized grey matter area at the compression epicentre was decreased compared with the control group (mean [SD] 5.15 [0.25] v. 32.04 [0.17]). Moreover, the normalized glial scar tissue area at the compression epicentre was mean 54.2 (SD 1.33). Decreases in SSEP, MEP peak amplitudes and in axonal conduction were noticed in the compression group compared with the sham operation group. **Conclusion:** This model reproduces the neurobehavioural abnormalities, gait deficits and neuropathological features of human CSM and hence has the potential to facilitate discovery of novel clinical translational therapeutic targets.

1.5.04

A review of preference-based measures of health-related quality of life in spinal cord injury research. ***D. Whitehurst,** *V. Noonan,*† *M. Dvorak,*† *S. Bryan.**

From the *School of Population and Public Health, University of British Columbia, and the Centre for Clinical Epidemiology and Evaluation, Vancouver, BC, and the †Division of Spine, Department of Orthopaedics, University of British Columbia, and the Rick Hansen Institute, Vancouver, BC

Background: We intend to provide an overview of the adoption and assessment of preference-based measures of health-related quality of life (HRQoL) within the peer-reviewed spinal cord injury (SCI) literature. **Methods:** A systematic search was conducted to identify SCI-related publications that contained at least 1 of the following preference-based HRQoL instruments: 15D, AQoL-4D, AQoL-6D, EQ-5D, EQ-5D-5L, HUI-2, HUI-3, QWB, QWB-SA or SF-6D. In addition to providing an overview of how different preference-based measures have been used in SCI research (e.g., frequency of use, analytic purpose, reporting of index scores), a focus of our evaluation was to collate and appraise evidence for measurement properties and identify knowledge gaps. **Results:** From a total of 420 unique abstracts identified in the database search, 22 articles were included (19 from a database search, 3 from a bibliographic search). No studies have used preference-based measures in their conventional form, i.e., to calculate quality-adjusted life years using patient-level data for the purposes of economic evaluation. Eleven papers reported mean utility scores. Directly comparable data exist for only 1 SCI patient sample, which showed variation across EQ-5D (0.63), HUI-2 (0.81) and HUI-3 (0.68) scores. Indirect comparisons also suggested differences between QWB-SA and SF-6D index scores within tetraplegic and paraplegic patient groups.

Only the QWB-SA and SF-6D have undergone (partial) psychometric evaluation, with the authors concluding that the measures have potential for SCI research. **Conclusion:** Despite "cost-effectiveness" being an increasingly important consideration for decision-makers in all areas of health care, there is a distinct lack of conceptual or empirical research regarding the appropriateness of alternative preference-based HRQoL measures for SCI populations. Given the support for economic evaluation within a cost–utility framework and the paucity of psychometric evidence regarding current instruments, further evaluation of the suitability of these instruments is necessary to ensure that they reflect the values of patients and society.

1.5.05

Predicting postoperative neuropathic pain following surgery involving nerve root manipulation based on intraoperative electromyographic activity. ***J. Norton, K. Aronyk, R. Fox, A. Nataraj, J. Pugh*. From the University of Alberta, Edmonton, Alta.**

Background: Postoperative pain control is best achieved when appropriate analgesia is initiated early. Surgical procedures in which the spinal nerve roots are manipulated or stimulated electrically as part of the neurophysiological monitoring (e.g., Schwannoma removal, tethered cord release) may lead to nerve root–type pain in the immediate postoperative period. In many of these surgeries, intraoperative monitoring of electromyography (EMG) activity is a routine component of the procedure. We wished to determine if there was a relationship between intraoperative EMG activity and postoperative nerve root–type pain. **Methods:** We retrospectively examined spontaneous EMG activity and evoked EMG activity in 70 procedures in which spinal nerve roots were manipulated intraoperatively and neuromonitoring was performed over the last 4 years. When root stimulation was performed, the amplitude and duration of any activity following stimulation were recorded, along with how frequently this occurred. In the absence of direct electrical stimulation of the nerve roots, we recorded the amplitude and duration of EMG activity as well as how frequency such activity occurred. We also compiled a composite score of total EMG activity. To separate surgical incision pain from nerve root pain we only looked at visual analogue pain scores for the arms or legs (depending on the site of surgery) and use of pharmacological agents related to nerve root pain. **Results:** There was a moderate relationship ($r^2 = 0.84$) between the total amount of EMG activity and the postoperative nerve root–type pain. In particular, very low levels of EMG activity were most often associated with no nerve root–type pain, whereas high levels of activity were always associated with nerve root–type pain postoperatively. **Conclusion:** This study, while retrospective in nature, and using a surrogate marker of pain, suggests that intraoperative neuromonitoring may be able to predict postoperative pain levels associated with spinal nerve root stimulation and manipulation.

1.5.06

Detecting positional injuries in prone spinal surgery. ***J. Norton*. From the University of Alberta, Edmonton, Alta.**

Background: Prone position surgery carries a greater risk of positional injuries than supine position surgeries. Increasingly, intraoperative neuromonitoring is used during spine surgery to reduce the risk of neurologic injury. The prime concern is the preservation of spinal cord function; however, the same techniques can be used to usefully monitor peripheral nerves, including those at risk of positional injuries. In particular, the brachial plexus may be at risk when the patient is positioned in the "superman" position. **Methods:** We report our experience of 500 prone position surgeries in patients 1 day to 88 years of age. We routinely record from the upper limb, using both sensory and motor evoked potentials when the surgery is below T1. These recordings serve to act as controls for the neuromonitoring team, but also to detect positional injuries in the upper limbs, although below the site of surgery responses from the lower limbs can also be used to detect positional injuries. Unilateral loss of evoked potentials or an increase in conduction delay can be reliable markers of peripheral nerve damage. **Results:** We detected changes in evoked potentials during 20 surgeries (some patients had more than 1 surgery), which we believed were owing to positional effects, with 18 of them being in the upper limbs. Eighteen of the patients were pediatric (90% of the instances, but 65% of the cases). Pediatric patients therefore appear to be at higher risk for positional injuries than adult patients. In all instances, corrective action by nursing or anesthesia staff resulted in the normalization of the evoked potentials, and no patients awoke with a deficit related to positioning. **Conclusion:** Evoked potentials are a useful adjunct to the assessment of the positioning of the prone patient.

1.5.07

Percutaneous thoracolumbar stabilization for trauma: surgical morbidity, clinical outcomes and revision surgery. ***N.A Manson,*† R. Elliott,† M. McKeon,† E.P. Abraham.*† From *Dalhousie University, Halifax, NS, and the †Canada East Spine Centre, Saint John, NB**

Background: Percutaneous pedicle screw-rod instrumentation (PercStab) without direct decompression or fusion is a surgical option to manage thoracolumbar trauma. The current standard of care includes instrumentation removal following osseoligamentous healing. It is hypothesized that instrumentation removal is not required following PercStab. Our purpose was to evaluate the utility of PercStab as follows: 1) patient satisfaction, 2) return of function and 3) need for repeat surgery including instrumentation removal or revision decompression and/or fusion procedures. **Methods:** We conducted a retrospective review of a prospective database of patients receiving PercStab for trauma from January 2007 to August 2011. Validated clinical outcome measures, patient demographics, perioperative data and the need for further surgery were assessed via clinic follow-up, chart review and telephone interview. Medians and ranges are reported. **Results:** Twenty-six trauma patients with a median Injury Severity Score of 10 (range 9–41) received PercStab to treat spinal instability over 2 levels (range 1–5) and were followed for 22 months (2 mo to 4.5 yr). Minimal surgical morbidity was incurred: operating room time: 36.5 (25–63.5) min/level; blood loss/level 40 (12.5–250) mL, time postoperatively to hospital discharge: 6 (1–37) days. Patients reported satisfaction: visual analogue scale (VAS) back: 2 (0–8), VAS leg: 1 (0–7), Oswestry Disability Index: 16 (0–54), 3 (0.5–6) months to return to work. Patients scored a median

outcome satisfaction of 5 (3.75–5) out of 5 on a Likert-type questionnaire. Only 4 patients required instrumentation removal: 2 for screw loosening causing back pain and 2 thin patients for screw prominence causing discomfort with direct pressure. **Conclusion:** This surgical option provides rapid mobilization and discharge from hospital, medium-term satisfaction, with minimal surgical morbidity. Instrumentation removal can be considered on an individual basis. Further research is required to quantify the utility of this technique in comparison to traditional surgical options.

1.5.08

Systemic inflammatory response syndrome in spinal cord injury patients: Does its presence at admission affect patient outcomes? ***A. Kesani,*[*] *J. Fleming,*[*] *K.R. Gurr,*[*†] *S.I. Bailey,*[*†] *F. Siddiqi,*[*‡] *C.S. Bailey.*[*†] **From the *Spine Program, London Health Science Centre, the †Division of Orthopaedics, Department of Surgery, University of Western Ontario, and the ‡Division of Neurosurgery, Department of Neurosciences, London, Ont.***

Background: Severe trauma triggers a systemic inflammatory response syndrome (SIRS) that is detrimental to organ function. This study's purpose was to determine whether the presence of SIRS in patients with traumatic spinal cord injury (SCI) at admission is related to subsequent clinical outcome in terms of severity of injury, length of stay (LOS), complications and mortality. **Methods:** The charts of 50 patients with acute traumatic SCI who were hospitalized at our institution during a 4-year period were retrospectively analyzed. Comparisons of demographics, injury characteristics and outcomes were performed between individuals who had 2 or more SIRS criteria (SIRS+) versus individuals who had 0 or 1 SIRS criteria (SIRS–) at admission. Using binary logistical regression, the predictive ability of having 2 or more SIRS criteria at admission was determined. **Results:** At admission, 32% of patients had 2 or more SIRS criteria. SIRS+ patients compared with SIRS– patients, had a more severe injury (Injury Severity Score [ISS] 15.8 v. 27.3 for SIRS– v. SIRS+), a lower American Spinal Injury Association motor score (62.8 v. 41.4) and a higher likelihood of complete SCI (12.2% v. 81.0%). These patients had a longer hospital LOS (median 17 d v. 27 d, $p < 0.001$), a longer intensive case unit LOS (median 3.5 d v. 17 d) and greater rate of complications, including respiratory failure (8.0% v. 28.0%) and urinary tract infections (10.3% v. 38.0%; $p < 0.05$ for each comparison). However, there was no difference in mortality. The odds ratio of having a major complication in SIRS+ patients was 6.8. Binary regression predicted an LOS longer than 25 days in patients having SIRS at admission and a complete SCI. **Conclusion:** A protocol to identify SCI patients with SIRS at admission may be beneficial with respect to preventing adverse outcomes and decreasing hospital costs. These results warrant further investigation in a larger study cohort.

Friday, March 2, 2012

2.1.15

One hundred years of spine surgery — a review of the evolution of our craft and practice in the spine surgical century [presentation]. ***Drew Bednar.* From McMaster University, Hamilton, Ont.**

Spine surgery came to prominence and common practice exactly 100 years ago this year with the landmark publications of Albee and Hibbs. The author presents a brief review of the evolution of spine surgical concept, practice and technique since that time, to arrive at the current defined state of our art.

2.1.16

Prevalence of preoperative MRI findings of adjacent segment disc degeneration in patients undergoing anterior cervical discectomy and fusion. ***K. Lundine,*[*†] *G. Davis,*[*†] *M. Rogers,*[*†] *M. Staples,*[†] *G. Quan.*[*] **From the *Austin Hospital and the †Cabrini Private Hospital, Melbourne, Australia**

Background: Cervical disc disease is a common presenting problem, with anterior cervical discectomy and fusion (ACDF) being a proven effective surgical intervention. Adjacent segment disc degeneration (ASDD) and/or adjacent segment disease are frequently reported complications of this procedure. Cervical disc arthroplasty is another surgical option in the setting of cervical spine disease. Some proponents argue that it results in less adjacent segment degeneration and disease than ACDF by maintaining more physiologic motion at the operative site and thereby not transferring additional stress to the adjacent discs. To our knowledge, no authors have demonstrated the prevalence of ASDD in symptomatic patients before surgical intervention. **Methods:** A database review of 3 surgeons' (2 neurosurgeons, 1 orthopedic surgeon) practice was carried out to identify patients who had undergone a single or 2-level ACDF for degenerative disc disease. Patients were excluded if they were operated on for recent trauma, had an inflammatory arthropathy (i.e., rheumatoid arthritis) or had previous spine surgery. The preoperative MRI of each patient was reviewed and graded based on the scheme developed by Matsumoto and colleagues (*Spine* 2010). **Results:** The cervical spine MRI of 106 patients was assessed: 51% of patients were male and mean age at time of surgery was 51 (SD 12) years. In all, 73% (77 of 106) underwent single-level ACDF. The most common surgical level was C5/6 (45%). **Conclusion:** One hundred percent of patients had MRI evidence of adjacent segment degeneration. The MRI grade of disc degeneration was significantly worse at the operative level than at nonoperative levels ($p < 0.001$). Evaluation of the nonoperative levels demonstrated that disc degeneration was significantly worse at the levels adjacent to the operative levels than at nonadjacent levels ($p < 0.001$) and that the level above the operative level was more severely affected than the level below ($p < 0.001$).

2.1.17

Adverse event rates of surgically treated cervical spondylopathic myelopathy. ***D. Hartig,*[*] *J. Batke,*[†] *M. Boyd,*[*] *M. Dvorak,*[*] *C. Fisher,*[*] *B. Kwon,*[*] *S. Paquette,*[*] *J. Street.*[*] **From the *Vancouver General Hospital and the †University of British Columbia, Vancouver, BC**

Background: In recent years, an increased understanding of the natural history of cervical spondylopathic myelopathy (CSM) in parallel with advancements in anesthetic and perioperative

practice has led to broadened surgical indications and more aggressive surgical management. As Canadian demographics, particularly population age and ethnicity, continue to change, the surgical burden of CSM will continue to increase. Identification of treatment adverse events (AEs) is critical to objective measurement of surgical utility. We are unaware of any published prospective data specifically quantifying the risk of intraoperative and postoperative AEs for surgically treated CSM. **Methods:** Data were collected prospectively over a 3-year period (2008–2010) at our institution on all patients with surgically treated CSM. Data on AEs were collected prospectively during the perioperative period until discharge using the previously validated SAVES tool. All AEs were reviewed at a weekly, attending-lead, multidisciplinary AE review meeting. In all, 113 patients (81 male, 32 female) with complete SAVES data were identified. Of these patients, 43 (38%) were confirmed discharged without an AE being recorded. The remaining 70 patients accrued 105 AEs in total during their inpatient stay (1.5 AEs per patient). **Results:** The most common intraoperative AEs were hardware malposition requiring revision (3.3%) and dural tear (1.7%). The most common postoperative AEs were dysphagia (11.7%), urinary tract infection (11.7%) and postoperative neuropathic pain (10%). Pneumonia was reported in 5% and wound infections in 5%. **Conclusion:** A significant trend was identified demonstrating increased rate of AEs in older patients and those with more severe disease before surgery. These data should prove helpful in the preoperative counselling of patients in terms of the absolute risk of AEs as well as the risk of specific AEs.

2.1.18

Morphometricand dynamic changes in the cervical spine following anterior cervical discectomy and fusion and cervical disc arthroplasty. ***A. Fichadi, M. Shamji, R.J. Hurlbert, W.B. Jacobs, S. Duplessis, S. Casha.*** **From the University of Calgary, Calgary, Alta.**

Background: Whereas anterior cervical discectomy and fusion (ACDF) can be an effective option to treat cervical radiculopathy or myelopathy, the concern about consequent altered stress at adjacent levels and subsequent symptomatic adjacent-level degeneration has prompted the development of cervical disc arthroplasty (CDA). We used cervical spine radiography to understand the static and dynamic differences in spine morphometry consequent to these procedures. **Methods:** Consecutive single-level anterior cervical discectomy and fusion (ACDF) and CDA patients treated at a single centre were included in the analysis. Demographic data were collected retrospectively. Preoperative and postoperative cervical radiograph measurements included static features of disc and vertebral body heights and dynamic features of flexion and extension motion for both the whole cervical spine and targets adjacent to the operated level. Continuous and categorical variables were analyzed by analysis of variance with time point as a factor, at the 0.05 level of significance. **Results:** Of 34 patients treated, 20 underwent ACDF and 14 underwent CDA, in both groups most commonly at C5/6 and C6/7, with no differences in age or sex between treatment groups ($\alpha = 0.05$). Subaxial cervical spine flexibility was increased among patients with CDA compared with ACDF, as was local 3-segment motion through the operated region. Nevertheless, dynamic changes at the adjacent segment below a fusion construct consistently revealed increased motion compared with both preoperative measurement and arthroplasty patients. At last follow-up, early decreases in adjacent disc height also become apparent, more frequent among female patients. **Conclusion:** This cohort of patients reveals the expected decrease in whole-spine flexibility among ACDF patients, although higher local movement is observed primarily at the motion segment below the fusion. Arthroplasty patients demonstrate no compromise of spine flexibility and have unchanged dynamic characteristics above and below the operated level. Further prospective work will help understand if these differences in disc stress are associated with clinically relevant delay or adjacent segment degeneration.

2.1.19

Is surgery for cervical spondylotic myelopathy cost-effective? A cost–utility analysis based on data from the AO Spine North American Prospective Multicentre CSM Study. ***M. Fehlings,* N. Jha,* S. Hewson,* E. Massicotte,* B. Kopjar.†*** **From the *University of Toronto, Toronto, Ont., and the †University of Washington, Seattle, Wash.**

Background: Surgical intervention for appropriately selected patients with cervical spondylotic myelopathy (CSM) has demonstrated favourable outcomes. However, the cost-effectiveness of this intervention is unclear. This study evaluates the cost-effectiveness of surgery for CSM, based on data obtained from the AOSpine North America Prospective Multicentre CSM Study using quality-adjusted life year (QALY) metrics. **Methods:** The direct treatment costs for 71 patients undergoing surgery for CSM at a single Canadian university-based institution — the lead site in a large multicentre study — were obtained from hospital and provincial health insurance plan billing data. Utilities were estimated on the entire sample of 278 patients enrolled in the study using SF-6D derived utilities from 12- and 24-month follow-up information. A 10-year horizon with 3% discounting was applied to health utilities estimates. **Results:** The SF-6D scores improved significantly (mean change 0.0734, 95% CI 0.0557–0.0912, $p < 0.01$) at 12 months and remained unchanged at 24 months. The 10-year discounted QALY gain was 0.64. Costs of medical treatment were estimated at an average of Can$21 066. The estimated cost–utility ratio was calculated as Can$32 916 per QALY. The sensitivity analysis showed a range from $27 326 to $40 988. These estimates are within the limits of $50 000 for interventions with a highly effective cost–utility ratio. **Conclusion:** Surgery for CSM is associated with statistically significant improvement in utility scores as measured by the SF-6D variable. The cost per QALY gained would indicate that surgery for CSM is a cost-effective procedure, which results in sustained improvement in quality of life and reduction in disability.

2.2.20

Cost–utility of lumbar decompression with or without fusion for patients with symptomatic degenerative lumbar spondylolisthesis (DLS). ***S. Kim,* S. Mortaz,† P. Coyte,†‡ Y.R. Rampersaud.§*** **From the *Lawrence S. Bloomberg Faculty of Nursing and †Department of Health Policy, Management and Evaluation, Faculty of Medicine, University of Toronto, the ‡Institute for Clinical Evaluative Sciences and Chair in Health Services Research, the §Division of Orthopaedic Surgery and**

Neurosurgery, Department of Surgery, University of Toronto, and the Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, Toronto, Ont.

Background: The most common surgical treatment of symptomatic degenerative lumbar spondylolisthesis (DLS) is a decompression and instrumented fusion. However, contemporary, midline-sparing microdecompressive techniques have shown good results for selected patients with stable grade 1 DLS. Growing concerns over rising costs and rates of spinal fusion warrant both clinical and economic comparative effectiveness research in this common spinal diagnosis. Our purpose was to determine the relative cost–utility of decompression with and without concomitant instrumented fusion for selected patients with DLS. **Methods:** Probabilities and utilities were estimated from an observational cohort study and current literature. Costing information was obtained from our institution (micro case-costing data/patient) and the literature. Probabilities considered were perioperative and general mortality, probability of clinical improvement and clinical worsening, and reoperation. The primary outcome measure was the incremental cost–utility ratio (ICUR) expressed as the differential cost per relative gain in quality-adjusted life years (QALY). A Markov model with 10-year follow-up was developed. The analyses were carried out from the hospital's perspective. Sensitivity analysis was used to test model robustness. **Results:** The cost–utility of decompression with fusion and decompression alone at 10 years postintervention was $3281/QALY and $1040/QALY, respectively. Compared with decompression alone, decompression and instrumented fusion was associated with an improvement in quality of life at a cost of $185 878/QALY in the base-case analysis. The ICUR was invariant to changes in clinical effectiveness of decompression alone, percentage of in-patient decompressions, and varying cost or QALY discounting rates. The ICUR was sensitive to change in QALY and cost structure changes. **Conclusion:** For a select subgroup of DLS patients (leg-dominant pain with a stable grade 1 spondylolisthesis), decompression without fusion is significantly more cost-effective than instrumented fusion and provides an opportunity for increased service delivery and/or cost savings for this growing population.

2.2.21

Minimally invasive surgery lumbar fusion for low-grade isthmic and degenerative spondylolisthesis: 2- to 5-year follow-up. *S.A. Harris, Y.R. Rampersaud.* From the University Health Network, Toronto Western Hospital, University of Toronto, Toronto, Ont.

Background: Minimally invasive surgeries (MIS) for lumbar spondylolisthesis (LS) have been shown to be safe and efficacious in the short-term, but little is known about the intermediate or long-term success. **Methods:** A retrospective cohort analysis was performed on prospectively collected data from patients undergoing 1- to 2-level MIS lumbar fusion for low-grade LS. Surgeries were performed from 2005 to 2009 by a single surgeon. Global Satisfaction Rating (GSR), Oswestry Disability Index (ODI) and Short Form-36 (SF-36) scores were evaluated preoperatively and postoperatively at 6 weeks, 3, 6, 12, 24, 36, 48 and 60 months. Receiver operating characteristic curves were used to evaluate SF-36 component subscores at 2 years with "success" anchored to GSR. For each SF-36 component, the 2-year score and the 2-year norm-based score (NBS; age- and sex-matched to normal Canadian equivalents) were analyzed. **Results:** In all, 72 patients were at or over 2-year follow-up: 66 met inclusion criteria. The mean age at surgery was 54 years, 44.2% were female and mean follow-up was 3.58 years. Baseline ODI scores (n = 66, mean 38.32%, 95% CI 42.01–33.99) continued to improve until 2 years postoperatively (n = 66, mean 17.24%, 95% CI 13.26–20.80) and are maintained to 5 years (n = 27, mean 16.81%, 95% CI 10.03–23.60). The receiver operating characteristic curve analysis of 2-year SF-36 component scores identified physical functioning (cut-off score 50, area under curve 0.89, sensitivity 0.78, specificity 0.84) and bodily pain (cut-off score 41, area under the curve 0.88, sensitivity 0.77, specificity 0.86) as the strongest correlates of satisfaction. The cut-off score for the 2-year SF-36 norm-based scoring components that correlated best with satisfaction were consistently 1 standard deviation below their Canadian age- and sex-matched equivalents. **Conclusion:** The benefits of MIS lumbar fusion for low-grade spondylolisthesis are maintained for 2–5 years. Despite SF-36 component scores below their mean Canadian age- and sex-matched equivalents, 85.7% of patients were satisfied with their outcome.

2.2.22

Results and complications of posterior-only reduction and fusion for high-grade spondylolisthesis. *C. Lin, S. Goldstein, B. Andrew, H. Modi, S. Magana, S. Lewis.* From the Spine Program, Toronto Western Hospital, Toronto, Ont.

Background: The surgical treatment of high-grade spondylolisthesis remains controversial. The presence of significant lumbosacral kyphosis, preoperative neurologic symptoms and sagittal malalignment has influenced surgical treatment. **Methods:** A retrospective review of 10 consecutive patients with symptomatic high grade spondylolisthesis was peformed. All patients were treated with a posterior L4–pelvis instrumentation, Gill laminectomy with thorough decompression of the L5 nerve roots and L5–S1 discectomy. With the rod secured to the S1 and iliac screws, a blunt disc knife was introduced into the L5–S1 disc space and levered to correct the L5 kyphosis. The neural elements were protected with the use of annular flaps and angled nerve root retractors. The rod was cantilevered and reduced to the L5 and L4 pedicle screws to reduce the deformity. An interbody device was placed in the L5–S1 disc space. **Results:** In all, 10 patients were included in this study. The mean preoperative pelvic incidence was 79.0° (53°–95°), mean listhesis 70.2% (55%–93%), L5 body slope 54.5° (41°–68°) and C7 sagittal plumb line of 71.6 mm (36–99 mm). The listhesis improved to 26.3% (11%–43%, $p < 0.0001$), the L5 body slope improved to 34.2° (22°–41°, $p = 0.0002$) and the C7 sagittal plumb line improved to 42.3 mm (19–75 mm, $p = 0.05$). There were 2 pseudarthroses requiring revision: 1 required removal of the iliac screws, and 1 patient had new L5 radicular symptoms. All patients noted significant improvement in their back pain and self-image, and 9 had significant improvement in their preoperative neurologic symptoms. The patients' height increased a mean of 2.2 cm. **Conclusion:** Posterior-only partial reduction in the angular and translational deformities of high-grade spondylolisthesis can effectively improve patients' neurologic and mechanical symptoms. The use

of annular flaps and discectomies that extend laterally to relieve the foraminal compression minimize risk to the nerve roots.

2.3.23

Fusion versus no fusion in patients with central lumbar spinal stenosis and foraminal stenosis undergoing decompression surgery: comparison of outcomes at baseline and follow-up. ***J. Gill,*† D. Roffey,*‡ I. Miles,*† E. Wai.*§*** **From the *University of Ottawa Spine Unit, the †Faculty of Medicine, University of Ottawa, the ‡Clinical Epidemiology Program, Ottawa Hospital Research Institute, and the §Division of Orthopaedic Surgery, University of Ottawa, The Ottawa Hospital, Ottawa, Ont.**

Background: Patients with lumbar spinal stenosis are also often afflicted with foraminal stenosis. Previous results from our group indicated patients with foraminal stenosis had poorer clinical outcomes than those without foraminal stenosis after decompression surgery, suggesting increased instability due to aggressive treatment or incomplete decompression when a foraminotomy was required. The aim of the current study was to assess whether the addition of a fusion would be beneficial in improving stability and hence clinical outcomes. It was hypothesized that patients with central lumbar spinal stenosis and foraminal stenosis undergoing decompression plus fusion would have improved postoperative disability scores compared with similar patients undergoing decompression alone. **Methods:** Fifty-six patients with foraminal stenosis underwent decompression alone ("no-fusion," $n = 26$) or decompression plus fusion ("fusion," $n = 30$). The degree of foraminal stenosis was determined by 2 blinded independent reviewers using JImage digital imaging software. The presence of fat around the exiting nerve root was also determined from MRI and/or CT scans. Patient outcomes were compared using the modified Oswestry Disability Index (ODI) at a minimum of 1 year postoperative follow-up. **Results:** No significant differences were detected between the 2 groups in regards to age, sex, comorbidities, previous surgeries or preoperative clinical outcomes. Almost 80% (23 of 30) of fusion patients reported a minimal clinically important difference (MCID) in ODI (mean improvement 23.0, SD 18.7), whereas only 50% (13 of 26) of no-fusion patients reported a similar MCID (mean improvement 17.5, SD 21.9). Comparing the 2 groups, a significantly higher proportion of fusion patients improved in regards to the MCID in ODI ($p = 0.04$). **Conclusion:** This study suggests that the addition of a fusion to decompression surgery to address central lumbar spinal stenosis with foraminal stenosis is associated with more successful postoperative clinical outcomes. Verification of these findings calls for a larger, prospective study to determine whether a change in practice may be warranted.

2.3.24

Two-year results of interspinous spacers (DIAM) as an alternative to arthrodesis for lumbar degenerative disorders. ***E. Abraham,*† N. Manson,*† D. Eastwood,*‡ R. Elliot,*‡ M. McKeon.*‡*** **From the *Horizon Health Network, Department of Orthopaedics, †Dalhousie University, Saint John Campus, and the ‡Canada East Spine Centre, Saint John Regional Hospital, Saint John, NB**

Background: DIAM (Device for Intervertebral Assisted Motion, Medtronic) is a flexible silicone interspinous spacer providing stability and preserving motion for herniation of the nucleus pulposis (HNP) and providing relief of neurogenic claudication secondary to lumbar spinal stenosis (LSS). Arthrodesis is often considered as an adjunct in these patients, particularly in central or recurrent HNP and in LSS requiring extensive decompression. DIAM can be performed as a day surgery procedure and was used in cases of HNP and LSS as an alternative to arthrodesis. We evaluated its implantation in patients who were considered for arthrodesis (central or recurrent HNP or LSS). **Methods:** In all, 53 patients between 2007 and 2009 with HNP or LSS were considered for decompression and fusion but were offered alternative treatment in the form of decompression and DIAM performed as a day surgery procedure. Preoperative Oswestry Disability Index (ODI), SF-36 and visual analogue scale (VAS) back and leg scores were compared with values at 1.5, 3, 6, 12 and 24 months postoperatively. The average follow-up was 3.5 years with a minimum of 2 years. The need for reoperation and other complications were tabulated. Inclusion criteria were patients with single-level pathology and HNP (central or recurrent) or LSS (with or without degenerative spondylolisthesis). Exclusion criteria were multilevel disease and/or severe deformity. **Results:** Forty-nine of 53 (92%) patients were available for minimum 2-year follow-up. Statistically significant improvements were noted for ODI, SF-36, VAS back and leg scores at all time-points compared with preoperatively. Three failures were identified necessitating further surgery: recurrent HNP in 2 patients (arthrodesis) and sepsis in 1 patient (implant extraction). Forty-six of 49 (94%) patients had a highly significant success based on the criteria at the 2-year follow-up for the entire group, demonstrating potential longer term survival for the implant and clinical success. **Conclusion:** DIAM interspinous spacers can provide very high clinical benefit 2 years postimplantation in patients with HNP or LSS as an adjunct to decompression where arthrodesis might be considered.

2.3.25

Treatment of herniated lumbar disc by sequestrectomy or conventional discectomy. ***M. Shamji, I. Bains, E. Yong, G. Sutherland, R.J. Hurlbert.*** **From the University of Calgary, Calgary, Alta.**

Background: The optimal surgical technique for treatment of a herniated lumbar disc remains uncertain. Advocates of sequestrectomy cite less perioperative pain and preserved disk architecture, whereas advocates of conventional discectomy cite less frequent reherniation. We investigated perioperative and postoperative end points to evaluate the comparative success of each procedure. **Methods:** Consecutive discectomy patients were treated at a single centre by surgeons whose technique consistently involved either sequestrectomy or conventional discectomy. Retrospective collection of demographic, radiographic and outcomes data provided analysis of each procedure's efficacy, with particular attention to clinical outcome and reherniation, with or without need for further operation. Continuous and categorical variables were analyzed by analysis of variance and Pearson likelihood ratios, with surgical technique as a factor, at the 0.05 level of significance. **Results:** Of 172 patients treated, 74 underwent conventional discectomy and 98 underwent sequestrectomy; they were followed for a median of 6 years. There were no differences

in age, sex, smoking status and level of disc herniation ($\alpha = 0.05$). Intraoperatively, conventional discectomy was not associated with any greater blood loss ($p = 0.90$) or longer duration of surgery ($p = 0.67$), nor with any perioperative difference in length of stay. Postoperatively, we reoperated for disc herniation in 14% of patients, variable by surgical technique ($p < 0.01$). Among conventional discectomies, the reoperation rate was 10% (6% same-level, 4% adjacent-level), which was lower than sequestrectomy, with a reoperation rate of 19% (15% same-level, 4% adjacent-level). In the latter group, a trend of reherniation was observed among smokers. **Conclusion:** This cohort of patients with good long-term follow-up exhibited a reoperation rate of 14%, more frequent with sequestrectomy than conventional discectomy. No significant differences occurred with blood loss, surgical time or hospital length of stay. Clearly, whereas a larger prospective randomized controlled trial may more definitively answer this question, this study provides substantial support for a more conventional surgical approach.

2.4.26

No sustained benefit of continuous epidural analgesia for minimally invasive lumbar fusion: a randomized double-blinded placebo controlled study. ***S. Choi,* Y.R. Rampersaud,† V.W.S. Chan,‡ O. Persaud,‡ A. Koshkin,‡ R. Brull.‡*** **From the *Sunnybrook Health Sciences Centre, University of Toronto, Toronto, the †Division of Orthopedic Surgery, Department of Surgery, Toronto Western Hospital, University Health Network, University of Toronto, and the ‡Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ont.**

Background: The optimal analgesic regimen for patients undergoing lumbar fusion is unclear. The purpose of this explanatory randomized study was to evaluate the analgesic effects of adding continuous epidural analgesia to standard systemic multimodal analgesia following lumbar fusion. **Methods:** Thirty-nine patients undergoing minimally-invasive lumbar fusion (procedure chosen a priori to control for surgical morbidity), stratified for sex and 1- or 2-level surgery, were randomized to receive a continuous postoperative epidural infusion of either 0.1% bupivacaine with 15 mg/mL^{-1} of hydromorphone (CEI group) or 0.9% saline (NS group) at 6 mL/hr^{-1} for 48 hours through an epidural catheter placed intraoperatively by the surgeon. All patients received a standardized postoperative multimodal analgesia regimen, including intravenous patient-controlled hydromorphone. All patients, health care providers and research staff were blinded. The primary outcome measure was cumulative opioid consumption (oral morphine equivalent) during the first 48 hours postoperatively. Postoperative secondary outcomes included pain scores at 12-hour intervals, side effects/complications, time to ambulation, time to discharge and satisfaction with recovery. The sample size was determined to detect a clinically meaningful difference in cumulative opioid consumption of 50% (power 80%, $\alpha = 0.05$). **Results:** Postoperative cumulative opioid consumption was similar between groups at 48 hours (mean [SD] for the CEI group 184.7 [208.1] v. NS group 249.3 [143.3] mg oral morphine, $p = 0.27$). Pain scores were similar between groups at each measured interval during the first 48 hours. There were no differences in any of the other prespecified outcomes. **Conclusion:** Continuous epidural infusion combined with systemic multimodal analgesia appears to offer no clinically relevant benefit compared with systemic multimodal analgesia alone following lumbar fusion. Based on this explanatory study, the routine use of CEI is not recommended for postoperative pain management in this population.

2.4.27

Evidence and current practice in the radiologic assessment of lumbar spine fusion. ***C. Goldstein,* N. Hassan,† S. Petis,† M. Kowalczuk,† B. Petrisor,† B. Drew,† M. Bhandari.†*** **From the *University of Calgary, Calgary, Alta., and †McMaster University, Hamilton, Ont.**

Background: A lack of consensus regarding the radiologic criteria required to diagnose spinal nonunion limits inferences from clinical research. This systematic review and international survey aimed to examine the spectrum of radiologic investigations and definitions used to assess lumbar spinal fusion in the spine literature and surgical community and the evidence in support of these methods. **Methods:** We comprehensively searched 3 electronic databases for clinical studies involving posterolateral fusion of the lumbar spine. English-language studies including adult patients and reporting a definition of successful fusion were included. Key measures included 1) radiologic investigations, 2) definition of successful lumbar fusion and 3) reliability, sensitivity and specificity of the investigations used to assess the spinal fusion. A cross-sectional survey regarding diagnosis of spinal nonunion was then developed and administered to members of the Canadian Spine Society and the North American Spine Society. The current evidence related to lumbar spine nonunion diagnosis was compiled, and comparisons between methods of spine nonunion diagnosis in the literature and clinical practice were made. **Results:** Among 1165 potentially eligible studies, 91 met our inclusion criteria. Of the studies, 78% ($n = 71$) used plain radiographs to diagnose nonunion. In contrast, almost 70% of respondent surgeons ($n = 110$) identify CT scans as the most important investigation when diagnosing lumbar spinal nonunion. The evidence regarding the reliability and validity of diagnostic imaging in the diagnosis of spinal nonunion is limited, though CT scans demonstrate improved clinical utility compared with plain radiographs. **Conclusion:** The radiologic investigations and definitions of successful posterolateral fusion used in the spine literature vary substantially and differ from the methods being used by practising spine surgeons. Studies using fusion criteria that have not been shown to be reliable or valid or that use methods different from those being applied clinically should therefore be interpreted with caution.

2.4.28

Wiltse versus midline approach for decompression and fusion of the lumbar spine. ***Z. Wang, C. DiPaola, M. Boyd, M. Dvorak, C. Fisher, B. Kwon, S. Paquette, J. Street.*** **From the Combined Neurosurgical and Orthopedic Spine Program, Vancouver, BC**

Background: The Wiltse bilateral muscle-splitting approach represents an alternative to the traditional midline approach to the lumbar spine for decompression and fusion of degenerative conditions. When comparing Wiltse to midline approaches, our primary null hypothesis was that there is no difference in rates of

surgical site infection (SSI). The secondary null hypothesis was that there would be no difference in the rates of secondary surgery within. **Methods:** Between July 2005 and June 2008, we identified 183 Wiltse cases and 53 midline cases of 1- or 2-level lumbar fusion, matched for age, sex, comorbidities, number of levels fused and history of previous surgery. There was a minimum of 3 years follow-up, and statistical analysis was performed using the Fisher exact test and 1-sided p values. **Results:** Mean age ($p = 0.02$), length of hospital stay ($p = 0.008$) and intraoperative blood loss ($p < 0.001$) were significantly lower in the Wiltse group. There was no difference in the mean length of the surgical procedure ($p = 0.689$). In the Wiltse group, there was a greater use of bone graft alternatives, in particular bone morphogenetic proteins ($p = 0.005$). The rate of SSI was 1.9% in the Wiltse versus 7.5% int he midline group ($p = 0.11$). The rate of second surgery within 3 years was higher in the midline group ($p = 0.025$). Delayed wound complication (23% v. 0%) and adjacent segment failure (10% v. 0%) was higher in the midline group, whereas pseudarthrosis was higher in the Wiltse group (25% v. 7%). **Conclusion:** The Wiltse approach is a viable alternative for 1- or 2-level lumbar arthrodesis, with lower rates of SSI and lower blood loss. Secondary surgery for junctional failure is less common, but pseudarthrosis is more common.

2.5.09

The effect of soft tissue restraints following type II odontoid fractures in the elderly — a biomechanical study. ***M. McCabe, S. McLachlin, S. Bailey, K. Gurr, C. Bailey, C. Dunning.*** **From the University of Western Ontario, London, Ont.**

Background: The odontoid process is the primary stabilizer at the C1–C2 level; however, little is known about the role of the soft tissue structures that remain intact in the setting of an odontoid fracture following a low-energy fall typical of elderly population. Our purpose was to quantify the role of the C1–C2 facet joint capsules and anterior longitudinal ligaments in the setting of a type II odontoid fracture in the elderly. **Methods:** Ten cadaveric CO–C2 spinal segments were studied. Specimens were tested under simulated axial rotation with an applied moment of ±1Nm and with the direct application of 10N anteriorly-directed force to the body of C2 to induce sagittal translation. Optical motion data were initially collected for the intact state and after a simulated dens fracture. The specimens were then divided into 2 groups, where one group underwent unilateral then bilateral C1–C2 facet capsular injuries followed by anterior longitudinal ligament injuries. The second group underwent the anterior longitudinal ligament injury before the same capsular injuries. Changes in axial range of motion (ROM) and C1–C2 translation were recorded and were analyzed using 2-way repeated-measures analysis of variance and post-hoc Newman–Keuls tests ($\alpha = 0.05$). **Results:** In axial rotation, there was an increase in ROM by approximately 13% with the fracture of the dens compared with the intact state ($p < 0.05$). An increase was also present for each subsequent soft-tissue injury state compared with the previous ($p < 0.05$); however, there was no difference found between the 2 soft tissue sectioning protocols. For sagittal translation testing, it was found that the odontoid fracture alone showed an increase of 3 mm of C1–C2 translation compared with intact ($p < 0.05$). Further soft tissue injuries did not show an increase until the complete injury state. **Conclusion:** Type II odontoid fractures without associated soft tissue injury may be stable under certain loading modes.

2.5.10

Development of an international spinal cord injury (SCI) spinal column injury basic data set. ***V.K. Noonan,[*†] M.G. Fehlings,[‡] A. Vaccaro,[§] P. Wing,[†] E. Itshayek,[¶] F. Biering-Sorensen,[**] M.F. Dvorak.[*†]*** **From the *Rick Hansen Institute and the †Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, the ‡Krembil Neuroscience Centre, Spinal Program, Toronto Western, University Health Network, University of Toronto, Toronto, Ont., the §Department of Orthopaedic Surgery, Thomas Jefferson University, Philadelphia, Pa., the ¶Department of Neurosurgery, Hadassah-Hebrew University Medical Center, Jerusalem, Israel, and the **Clinic for Spinal Cord Injuries, Neuroscience Centre, Rigshospitalet, Copenhagen University Hospital, Copenhagen, Denmark**

Background: Most traumatic spinal cord injuries (SCIs) result from an associated spinal column injury. Currently, there are multiple classifications used to describe spinal column injuries. International SCI data sets are being developed to facilitate the collection and reporting of a minimal amount of clinically relevant information. The objective of this project was to develop a minimal data set to describe spinal column injuries, referred to as the International SCI Spinal Column Injury Basic Data Set. **Methods:** A committee of experts was established to select and define data elements to be included in the International SCI Spinal Column Injury Basic Data Set. The data set was then disseminated to the appropriate committees and organizations for comment. All suggested revisions were considered and the final version was endorsed by both the International Spinal Cord Society and the American Spinal Injuries Association. **Results:** The Spinal Column Injury Basic Data Set consists of 7 variables: 1) penetrating or blunt injury, 2) spinal column injury/ies, 3) single or multiple level spinal column injury/ies, 4) spinal column injury level number, 5) spinal column injury level, 6) disc or posterior ligamentous complex injury and 7) traumatic translation. All variables are coded using numbers or characters. Each spinal column injury is coded (variable 4) and described (variables 5–7). The variables included in this data set incorporate components of contemporary spinal column classifications. Sample clinical cases will be presented to illustrate how the data are coded. **Conclusion:** The International SCI Spinal Column Injury Basic Data Set was developed to facilitate comparisons of spinal column injury data among studies, centres and countries. This data set is part of the National Institute of Neurological Disorders and Stroke Common Data Element project, and tools are now available to assist investigators with the collection these data in their SCI clinical studies.

2.5.11

Evaluation of instrumentation techniques for a unilateral facet perch and fracture using a validated soft tissue injury model. ***M. Nadeau,[*†] S. McLachlin,[†] S. Bailey,[*†] K. Gurr,[*†] C. Dunning,[†] C. Bailey.[*†]*** **From the *London Health Sciences Centre and the †University of Western Ontario, London, Ont.**

Background: Traumatic flexion–distraction injuries of the cervical spine result in a spectrum of injury and instability. Anterior, posterior or combined fixation has produced successful outcomes when generalized to the entire injury spectrum or catastrophic injury models. However, there is a lack of literature comparing these instrumentation techniques for specific injury patterns, in this case, a unilateral facet perch (UFP) with a facet fracture. Therefore, the purpose of our study was to: 1) develop a reproducible UFP injury model, 2) evaluate the effects of the addition of a facet fracture and 3) compare stability after different instrumentation techniques. **Methods:** Five fresh-frozen spinal segments (C4–5) were mounted in a spinal loading simulator. Stability testing in flexion–extension, lateral bending and axial rotation was performed following each stage of the testing protocol: intact, UFP injury, UFP injury plus a unilateral facet fracture and finally, sequentially after the application of each of the 3 proposed instrumentation techniques (posterior, anterior and combined). The UFP injury model was validated by comparing its range of motion (ROM) data (a measure of stability) to those of a previously produced dynamic UFP. Each instrumentation technique was compared based on its ability to reduce ROM relative to the injured state. **Results:** The UFP cadaveric model replicated ROM and neutral zone (NZ) data similar to a dynamically induced UFP ($p > 0.05$). This ROM was unaffected by the addition of a facet fracture. All 3 fixation techniques reduced ROM from the injured state ($p < 0.001$), but both the posterior and combined approaches allowed less ROM than the anterior approach in axial rotation and lateral bend ($p < 0.001$). **Conclusion:** This UFP injury model is valid and reproducible. The addition of a facet fracture does not further destabilize it. Anterior instrumentation was inferior to both the posterior and combined approaches.

2.5.12

Decreasing neurologic consequences in patients with spinal infection: the testing of a novel diagnostic guideline. ***S. Ferrara, A. Bradi, R. Pokrupa.*** **From Queens University, Kingston, Ont.**

Background: Diagnostic delay of spinal infection (defined as one or more of spinal epidural abscess [SEA], spinal osteomyelitis and discitis) can lead to irreversible neurologic deficits and even death. Initial diagnosis can be difficult given the subtle early presentation, highlighting the clinical need for a screening tool. The implementation of a novel decision guideline, developed by Davis and colleagues for screening of SEA, which incorporates erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels in at-risk patients was found to decrease diagnostic delays and lower the incidence of motor deficits at diagnosis (*J Neurosurg Spine* 2011;14:765-70). The objective of this study was to determine if the Davis diagnostic guideline is applicable for early detection of spinal infection and if ESR can be used as a screening test. **Methods:** This retrospective study analyzed 129 patients admitted to Kingston General Hospital in the 2004 to 2011 fiscal years who were ultimately diagnosed with spinal infection, 102 of whom had spine pain on initial presentation. Data regarding neurologic symptoms, fever, risk factors, ESR and CRP were collected and compared with the SEA algorithm. The Davis guideline was considered predictive when a patient with spine pain would have received emergent/urgent definitive imaging according to the algorithm. **Results:** Of those presenting with spine pain, a total of 92 patients would have been identified as having spinal infection (90.2%) with emergent/urgent diagnostic imaging according to the Davis guideline. Of 102 patients with spine pain, 74 had elevated ESR (72.5%), 2 were within normal ESR limits (1.96%) and 26 had no recorded ESR values (25.5%). Spine pain with elevated ESR was 94.6% sensitive for spinal infection. **Conclusion:** The Davis guideline was highly sensitive for patients with spinal infection; ESR alone in patients with spinal pain was also highly sensitive for spinal infection.

2.5.13

Prospective analysis of adverse events in surgical treatment of degenerative spondylolisthesis. ***A. Kelly, J. Batke, M. Boyd, M. Dvorak, C. Fisher, B. Kwon, S. Paquette, J. Street.*** **From the University of British Columbia, Department of Orthopaedics, Division of Spine Surgery Combined Orthopaedic and Neurosurgical Program, Vancouver, BC**

Background: Surgical literature traditionally focuses on outcomes and comparisons of specific procedures. There is a paucity of data on outcomes and adverse events (AEs) in the context of the presenting diagnosis. Such condition-specific AE information would greatly facilitate informed consent. Specific intra- or postoperative AEs independently associated with a diagnosis of degenerative spondylolisthesis (DS) have never been examined, and the AE data that are available, by virtue of the methods of identification, are substantially underreported. This study prospectively assesses the AE profile of a cohort of surgically treated patients with a primary diagnosis of L4–5 DS, with the secondary aim of identifying risk factors that correlate with those AEs. **Methods:** Prospective AE data using the SAVES tool on patients surgically treated for L4–5 DS between Jan. 1, 2009, and Dec. 31, 2010, were analyzed and compared with outcomes reported in the Spine Patient Outcomes Research Trial (SPORT). **Results:** Of 1444 surgical cases, 97 (6.7%) had the diagnosis of DS, and of these, no complications were seen in 49.5%. The total intra- (10.3%) and postoperative (73.2%) complication rate was 83.5%, suggesting that some of the 50.5% of patients with complications had more than 1 AE each. The most common intraoperative AEs were bone/hardware issues (7.9%) and dural tears (6.5%). The most common postoperative AEs were urinary tract infection (14%), delirium (6.5%), surgical site infection (5.2%) and neuropathic pain (5.2%). SPORT reported substantially lower complication rates: an AE-free rate of 87% intraoperatively and 69% postoperatively, with total complication rates at 4 years' follow-up of 13% each intra- and postoperatively. **Conclusion:** This prospective analysis highlights a notable discrepancy in AE rates compared with published literature not specifically designed to look at AEs. Further distillation of these data may demonstrate diagnosis-specific correlations with specific types of AEs.

2.5.14

Load transfer characteristics between posterior fusion devices and the lumbar spine under anterior shear loading: an in vitro investigation. ***A. Melnyk,[*†] A. Kelly,[‡] T. Wen,[§] S. Kingwell,[¶] J. Chak,[*†] V. Singh,[**] P. Cripton,[*†] C. Fisher,[†‡] M. Dvorak,[†‡] T. Oxland.[*†]*** **From the *Department of Mechanical Engineering, University of British**

Columbia, †ICORD, Vancouver Coastal Health Research Institute, the ‡Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, the §Beijing Army General Hospital, Beijing, China, the ¶Division of Orthopaedics, Department of Surgery, University of Ottawa Hospital, Ottawa, Ont., and **Medtronic Inc., Memphis, Tenn.

Background: Clinical studies have demonstrated enhanced arthrodesis rates with posterior instrumentation for the treatment of unstable degenerative spinal conditions. The optimal stiffness of these systems is unknown. To our knowledge, low-stiffness instrumentation has not been tested under an anterior shear force, a highly relevant force in degenerative spondylolisthesis. Our goal was to determine the percentage of shear force supported by posterior lumbar fusion devices of varying stiffness under anterior shear loading in a degenerative spondylolisthesis model. **Methods:** The effects of implant stiffness and specimen stability on implant load and intervertebral motion were assessed in a biomechanical study. A total of 30 human cadaveric lumbar functional spinal units will be tested (15 analyzed to date), under a static 300N axial compression force and a cyclic anterior shear force (5–250 N). Implants (high-stiffness [HSI]: Æ5.5 mm titanium; medium-stiffness [MSI]: Æ6.35 × 7.2 mm oblong PEEK; and low-stiffness [LSI]: Æ5.5 mm round PEEK)] instrumented with strain gauges were used to calculate loads and were tested in each of 3 specimen conditions simulating degenerative changes: intact, facet instability and facet instability plus disc instability. Intervertebral motions were measured with a motion capture system. **Results:** Implants supported a significantly greater shear force as the specimen was progressively destabilized. Mean implant loads as a percent of the applied shear force in order of increasing specimen destabilization for the HSI were 43%, 67% and 76%, for the MSI were 32%, 56% and 77%, and for the LSI were 18%, 35% and 50%. Anterior translations increased with decreasing implant stiffness and increasing specimen destabilization. **Conclusion:** Implant shear stiffness significantly affected the load-sharing between the implant and the natural spine in anterior shear ex vivo. Low-stiffness implants transferred significantly greater loads to the spine and may possibly reduce adverse effects at the adjacent uninstrumented spine in vivo.

2.5.15

Preoperative predictive clinical and radiographic factors influencing functional outcome after lumbar discectomy.

D. Arora, Z. Wali, D. Yen. **From Queen's University, Kingston, Ont.**

Background: Lumbar discectomy is one of the frequently well-established performed spinal procedures. With widespread use of CT and MRI, there has been an increase in the diagnoses of disc herniations, but outcomes for discectomy are known to depend on patient selection. Our goal was to identify independent clinical and radiographic predictors of surgical outcome to aid in patient selection for discectomy. **Methods:** A prospective non-randomized cohort study done in a university centre providing secondary and tertiary care. We evaluated 92 patients who presented to the senior author's (D.Y.) spine clinic between 1998 and 2003, who were prospectively enrolled in our study. All patients experienced radicular symptoms, consistent with their imaging investigations by either CT or MRI. For the quantitative measure of impingement, we divided the thecal sac into the half affected by the disc herniation and the half unaffected. We then took the ratio of the affected side with the unaffected using the latter as an internal control of the individual's normal sac area. Qualitative measures consisted of disc morphology (bulge, protrusion, extrusion). All patients were treated with standard lumbar discectomy. Clinical outcomes were measured using the modified Roland-Morris questionnaire (a validated patient-oriented disability questionnaire) preoperatively and at 2-year follow-up. **Results:** Overall, patients treated surgically had significant improvement at 2-year follow-up. It was found that increased preoperative disability and duration of symptoms for less than 6 months were positive predictive factors, whereas a work-related injury was a negative predictive factor for significant improvement at 2 years post–lumbar discectomy. There was no significant correlation with quantitative or qualitative radiographic measures. **Conclusion:** On average, patients who opt for surgery will have improvement. However, not all patients improve, and there are predictors of functional outcome, which can help with patient and physician expectations.

2.5.16

A Thoracolumbar Injury Classification and Severity Score (TLICS) of 4: What should we really do?

A. Quateen, A. Alfllouse, A. Alzahrani, H. Jiang, J. Mahood, F. Kortbeek, R. Fox, A. Nataraj. **From the University of Alberta, Edmonton, Alta.**

Background: The Thoracolumbar Injury Classification and Severity Score (TLICS) is steadily gaining acceptance as the best system available for therapeutic decision-making for thoracolumbar injuries. The TLICS system identifies 3 major injury characteristics to describe thoracolumbar spine injuries (injury morphology, posterior ligamentous complex integrity and neurologic status) each characteristic is assigned a numerical score, weighted by severity of injury, which is then summated to yield the injury severity score. When the score is less than 4, nonoperative treatment is recommended, whereas when it is more than 4, operative treatment of the patient is suggested due to significant instability; however' a patient with a score of 4 may be treated either operatively or conservatively. Before this scoring system came to be, the most controversial group of thoracolumbar injuries were patients who had injuries that currently fall into a TLICS score of 4, and their recommended management in this system is also undecided. We wanted to look at our series of patients in that category and compare the venue of treatment that was offered to them as well as any revisions needed based on follow-up. **Methods:** We conducted a retrospective chart review of patients admitted to a level 1 trauma centre over 1 year with a diagnosis of spinal fractures. A blinded fresh review of their images was done by an attending spine surgeon and a fellow (both were not involved in the care of the patient in question), and the patient was "scored." Those with a TLICS 4 were followed for the management they received (surgery or not), and follow-up office visits and images were assessed for any revisions needed (specifically a failure of nonsurgical management). **Results:** We present our data as set of charts and graphs to see our trends in managing this group, with illustrative cases of potential controversy.

SATURDAY, MARCH 3, 2012

3.1.29

Adverse events in emergent oncologic spine surgery: a prospective analysis. ***N. Dea, J. Street, M. Boyd, S. Paquette, B. Kwon, J. Batke, M. Dvorak, C. Fisher.*** **From the Vancouver General Hospital, Vancouver, BC**

Background: Reporting on morbidity and mortality of spine surgery in the literature has been primarily retrospective. Emerging prospective analyses of adverse events (AEs) demonstrate significantly higher rates, suggesting under-reporting in retrospective and prospective studies without AE as a targeted outcome. Emergency oncologic spine surgeries are generally palliative, to improve pain, neurology and health-related quality of life. With limited life expectancy, AEs can have catastrophic implications; therefore, an accurate AE incidence must be considered in the surgical decision-making. Our purpose was to determine the true incidence of AEs in emergent oncologic spine surgery. **Methods:** We conducted a prospective cohort study in a quaternary care referral centre of consecutive patients between Jan. 1, 2009, and Dec. 31, 2010. Inclusion criteria were all patients undergoing emergency surgery for metastatic spine disease. Adverse events data were reported and collected on standardized AE forms (SAVES) at weekly, dedicated morbidity and mortality rounds attended by all house staff. After discharge, AEs were captured at 6- and 12-week follow-up. **Results:** In all, 45 patients met inclusion criteria, 24 males and 21 females. Data are complete in 71% (32 patients): 50% had at least 1 AE, and a total of 43 AEs were noted in 16 patients. Three patients (9.4%) died during admission. Intraoperative surgical AEs were observed in 12.5% of patients (3.1% incidental durotomy, 9.4% major blood loss above 2 L). Neurologic deterioration occurred in 2 patients (6.3%). Cumulative incidence of infectious complications in the patient population was 37.6% (surgical site: 6.3%; systemic: 31.3%). Delirium complicated the postoperative period in 15.6% of cases. **Conclusion:** When evaluated in a rigorous prospective manner, metastatic spine surgery is associated with a higher morbidity than previously reported. This AE incidence must be considered by the patient, oncologist and surgeon in determining appropriate management and preventative strategies to reduce AE in this fragile patient population.

3.1.30

En-bloc resection of primary spinal and paraspinal tumours with critical vascular involvement. ***A. Ranganathan, R. Reddy, R. Rampersaud.*** **From the Toronto Western Hospital, Toronto, Ont.**

Background: Curative resection of primary spinal and paraspinal tumours invading the spine is challenging. Critical vascular involvement is thought to be a relative contraindication. **Methods:** Between 2002 and 2011, a single surgeon series of 44 consecutive en-bloc resections and reconstructions for primary spinal and paraspinal tumours was reviewed. Of these, 11 cases had critical vascular involvement requiring reconstruction for curative intent. **Results:** There were 6 male and 5 female patients, mean age 51.73 (range 38–66) years. There were 4 primary spinal tumours: 2 cervical chordomas, 1 malignant fibrous histiocytoma and 1 chondrosarcoma. The remaining 8 were paraspinal tumours invading the vertebral bodies: 3 lung, 1 neural ectodermal, 1 retrocrural liposarcoma, 1 retroperitoneal haemangiopericytoma, 1 leiomyosarcoma and 1 mediastinal angiosarcoma. One patient had subclavian artery reconstruction (segmental Gore-Tex graft [SGG]), 2 had vertebral artery bypass (saphenous vein), 1 had venacaval and left renal vein reconstruction (SGG), 1 patient had common iliac vein reconstruction (bovine pericardium), 1 primary aortic shortening, 3 had aortic endovascular stenting with surgical skeletonization (adventitial/intimal separation) and 3 had aortic segmental replacement (SGG). Patients had spinal column resections ranging from 1 to 5 levels and reconstructions with cages, allograft or vascularised fibula (Clivus C4 × 2). Ten cases had clear resection margins microscopically (range 0.5–4.5 cm). No major complication (surgical or tumour-related) or mortality occurred due to the vascular component of these cases. Nine patients have had no recurrence at a mean follow-up of 4.3 (range 3–7) years. One patient died 3 months postoperatively from intensive care unit complications, and 1 patient died at 8 months postoperatively from widespread metastasis. **Conclusion:** Critical vascular involvement of localized primary spinal and paraspinal tumours is not a contraindication for en-bloc resection. The development of advanced techniques in spinal and vascular surgery now makes curative resection of these tumours possible using highly specialized multispecialty teams.

3.1.31

The treatment impact of minocycline on quantitative MRI in acute spinal cord injury. ***Y. Zhang, J. Hurlbert, W. Yong, S. Casha.*** **From the University of Calgary, Calgary, Alta.**

Background: The impact of acute spinal cord injury (SCI) remains catastrophic. However, there is no treatment proven to significantly reduce disability following this devastating condition. Minocycline has been shown to reduce injury bulk and improve functional outocmes in mice subjected to SCI. The purpose here was to assess treatment impact of minocycline using quantitative MRI in a pilot, placebo-controlled, randomized clinical trial in human SCI. **Methods:** Fifty-two patients were randomized within 12 hours of injury to either intravenous minocycline or placebo therapy, twice daily, for 1 week. Patients were stratified as cervical or thoracic, motor complete or motor incomplete or central cord injury. Magnetic resonance imaging was performed within 24 hours of injury (day 1), and at days 7, 28 and 365 after injury. Maximum canal compromise (MCC) and maximum spinal cord compression (MSCC) were quantified at injury epicentre. The length and area of inclusive T_2 hyperintensity were computed on the image showing the maximum signal abnormality using a semiautomatic program. Neurological outcomes were evaluated simultaneously. **Results:** Fifty patients were followed by MRI; 25 were treated with minocycline. Thirty-one patients had sequential MRI at each time point (20 with minocycline). Collectively, the minocycline group tended to have less MSCC, indicating less cord expansion, and smaller T_2 lesion length and area than the placebo group ($p > 0.05$). This is more evident in the motor complete and cervical-only subgroups, which formed the majority of this SCI cohort. **Conclusion:** This pilot study showed that minocycline appeared to decrease the severity of

cord swelling during acute injury or myelomalasia at chronic SCI and reduce the territory of T_2 abnormality. These favourable MRI findings are consistent with clinical outcomes demonstrating improved motor recovery in a subset of minocycline group. Quantitative MRI assessment may be useful to evaluate treatment impact in acute SCI.

3.1.32

Benefit of minocycline in spinal cord injury — results of a double-blind randomized placebo-controlled study. ***S. Casha, D. Zygun, D. McGowan, I. Bains, V.W. Yong, R.J. Hurlbert.*** **From the Department of Clinical Neurosciences and the Hotchkiss Brain Institute, University of Calgary, Calgary Alta.**

Background: Preclinical studies have attributed several neuroprotective properties to minocycline. Animal studies and early clinical trials support its beneficial role in several neurologic diseases. In spinal cord injury (SCI) models, minocycline improved neurologic and histological outcomes, reduced neuronal and oligodendroglial apoptosis, decreased microglial activation and reduced inflammation. **Methods:** This single-centre, human, double-blind, randomized, placebo-controlled study compared neurologic and functional outcomes between patients administered 7 days of intravenous minocycline (n = 27) or placebo (n = 25) after acute traumatic SCI. The primary outcome was motor recovery through 1 year (ClinicalTrials.gov No. NCT00559494). Serum and cerebrospinal fluid minocycline levels were assayed to establish a dose that mimicked serum levels of prior efficacious animal studies. The only adverse event probably related to minocycline was transient serum liver enzyme elevation in 1 patient. **Results:** Overall, patients treated with minocycline exhibited 6 American Spinal Injury Association motor points greater recovery than those receiving placebo (95% CI –3 to 14, p = 0.20, n = 44). No difference in recovery was seen in thoracic SCI patients (n = 16), but with cervical injury, minocycline conferred a benefit of 14 motor points (95% CI 0–28, p = 0.05, n = 25). Patients with cervical motor-complete injury improved 10 motor points (95% CI –9 to 28, p = 0.29, n = 16), whereas those with motor-incomplete SCI improved 22 points (95% CI –7 to 52, p = 0.12, n = 9). Functional outcomes (Functional Independence Measure, Spinal Cord Independence Measure, London Handicap Score and SF-36) trended toward improvement in patients administered minocycline. **Conclusion:** The minocycline regimen established through serum and cerebrospinal fluid levels in this study exhibited a clinical benefit that warrants further investigation in a larger multicentre phase III trial.

3.2.33

Improvement of magnetic resonance imaging correlation with unilateral motor or sensory deficits using diffusion tensor imaging. ***K. Rajamanickam,* B. Mendis,* S. Chakraborty,† T. Nguyen,† E. Tsai.*†*** **From the *OHRI and †The Ottawa Hospital, Ottawa, Ont.**

Background: Routine magnetic resonance imaging (MRI) has limited correlation with patient symptoms. We investigated whether magnetic resonance diffusion tensor imaging (DTI) and fibre tractography could improve clinical correlation in patients with unilateral motor or sensory deficits. **Methods:** Hospital ethics board approval was obtained, and participant underwent an axial spin-echo single-shot echo-planar generalized autocalibrating partially parallel acquisition diffusion-weighted imaging sequence and routine MRI (1.5-T) between August 2008 and March 2010. Mean diffusivity (MD) and first eigenvector fractional anisotropy maps were computed for all axial sections from mid C2 to C6, and tractography was used to visualize the course of the tracts. MATLAB software was used to generate spinal cord tracking images and fractional anisotropy (FA), and MD values were measured in delineated regions of interest corresponding to the dorsal column (DC), corticospinal tract (CST) and spinothalamic tract (STT) bilaterally. Two patients were excluded owing to movement artifacts during scanning. The remaining 11 patients (8 male, 3 female) had a mean age of 50.8 (17–77) years. Clinical status was obtained from the tractography clinical database. **Results:** There was no statistical difference between the left and right side of the DC, CST and STT for controls (n = 8). In patients, FA mean values differed significantly ($p < 0.05$) between the affected tract compared with the contralateral tract. In 9 of 11 patients, the differences in CST FA measurements correlated with clinical motor deficits. In the remaining 2, there were CST FA differences but no noted motor deficit on physical examination. In patients with sensory deficits, 10 of 11 patients had differences in DC or ST FA measurements that correlated with clinical sensory deficits. In the remaining 1 patient, there were sensory tract FA measurement differences but no noted sensory deficit. **Conclusion:** Magnetic resonance DTI may improve imaging correlation with clinical symptoms and may allow early identification of subclinical deficits.

3.2.34

Comparing care delivery for acute traumatic spinal cord injury in 2 Canadian centres: How do the processes of care differ? ***A. Santos,* A. Chen,* D. Atkins,* V.K. Noonan,† B. Drew,‡ D. Tsui,§ A. Townson,¶ M.F. Dvorak.†*** **From the *Centre for Operations Excellence, Sauder School of Business, University of British Columbia, the †Rick Hansen Institute and Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, the ‡Division of Orthopaedics, McMaster University, the §Hamilton Health Sciences Centre, Hamilton, Ont., and the ¶Division of Physical Medicine and Rehabilitation, University of British Columbia, Vancouver, BC**

Background: Standards of care for traumatic spinal cord injury (tSCI) do not exist, and as a result, care delivery varies across Canada. To improve care and patient outcomes, existing models need to be compared to identify practices that can improve the effectiveness and efficiency of care. The objective of this study was to use simulation models to compare care delivery in 2 Canadian centres. **Methods:** Patient flow from injury to discharge was mapped for 2 Canadian centres (including acute and rehabilitation) as part of the Access to Care (ACT) project. A discrete event simulation model was developed to evaluate processes of care using data from our prospective registry, expert opinion and the literature. A hypothetical scenario whereby patients in the 2 centres were alternatively treated in the other centre was tested and differences in outcomes were compared. The model controlled for patient characteristics. **Results:** There are differences in existing processes of care between the centres. Time to admission

is 25.4 (SD 1.2) hours and 64.9 (SD 7.3) hours in centres 1 and 2, respectively. Differences also exist in time to surgery (54.0 [SD 1.6] h v. 104.2 [SD 9.9] h), length of stay (acute 42.7 [SD 0.6] d, rehabilitation 94.6 [SD 1.0] d v. acute 34.6 [SD 1.2] d, rehabilitation 68.6 [SD 1.1] d) and percentage of patients admitted to rehabilitation (62% v. 66%) for centres 1 and 2, respectively. When the patients are alternated for the treating centres, the significant differences in time to surgery, acute length of stay and percentage of patients admitted to rehabilitation remain after controlling for patient characteristics. **Conclusion:** Differences in processes of care for patients with tSCI exist in Canada and lead to vast differences in performance measures. Results from this study demonstrate the value of using a simulation model to highlight these differences and can inform the development of tSCI standards in Canada.

3.2.35

Improving access to early surgery: a comparison of 2 centres. ***A. Santos,* A. Chen,* D. Atkins,* V.K. Noonan,† B. Drew,‡ M.F. Dvorak.†* **From the *Centre for Operations Excellence, Sauder School of Business, University of British Columbia, the †Rick Hansen Institute and the Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, and the ‡Division of Orthopaedics, McMaster University, Hamilton, Ont.**

Background: There is emerging evidence that patients with traumatic spinal cord injury (tSCI) should receive surgery within 24 hours following injury. One strategy to achieve this target would be to change how patients are triaged to acute spine centres. The objective of this study was to use a simulation model to determine whether increasing the number of patients routed directly to an acute spine centre would be effective in decreasing the time to surgery. **Methods:** The patient flow from the time of injury to discharge into the community was mapped for 2 Canadian centres. A discrete event simulation model was developed to evaluate processes of care using data from our prospective registry, expert opinion and the literature. A hypothetical policy was tested whereby patients were triaged to be admitted directly to a spine centre if they were injured within 20–30 minutes' driving time and within 350 km from the acute spine centre. **Results:** In centre 1, currently 24% of patients are directly admitted, and the average time to admission is 25.4 hours. In centre 2, 45% of tSCI patients are admitted directly, and the average time to admission is 64.9 hours. The average time to surgery is 54.0 (SD 1.6) hours and 104.2 (SD 9.9) hours in centre 1 and 2, respectively. Implementing the proposed policy would result in a 39% and 31% increase in the number of direct admissions for centres 1 and 2. Centre 2 would benefit with a decrease in time to admission of 34.8 hours and time to surgery of 34.0 hours; however, centre 1 would provide earlier surgery. **Conclusion:** A policy increasing the number of patients taken straight to acute spine centres would not have the same effect in providing access to early surgery. This study highlights the value of simulation models in policy decision-making.

3.3.36

The effects of early surgical decompression on motor recovery after traumatic spinal cord injury: results of a Canadian multicentre study. ***J. Wilson,* C. Craven,† M. Ford,† H. Ahn,† B. Drew,‡ M. Fehlings.** **From the *Division of Neurosurgery and Orthopedic Surgery, Spinal Program, University of Toronto, the †Division of Rehabilitation Medicine, University of Toronto, Toronto, Ont., and the ‡Division of Orthopedic Surgery, McMaster University, Hamilton, Ont.**

Background: We present the results of a multicentre Canadian study to evaluate the impact of early versus late surgical decompression on neurologic recovery after spinal cord injury (SCI). **Methods:** A prospective cohort study of patients within the Ontario Spinal Cord Injury Rehabilitation (OSCIR) program was performed. Eighty-six patients with an American Spinal Injury Association [ASIA] A–D spinal cord injury (SCI), with MRI-confirmed spinal cord compression, from 6 Ontario trauma centres, were enrolled between 2007 and 2009. Patient information was collected preoperatively and at discharge from rehabilitation. A grouped analysis was performed comparing the cohort of patients who received early surgery (< 24 h after SCI). The Fisher exact and Student *t* tests were used to examine for differences in baseline characteristics and outcomes between early versus delayed surgery patients. An adjusted analysis was also completed to account for the effects of confounding variables using linear regression, with change in ASIA motor score from admission to rehabilitation discharge used as the outcome variable. **Results:** Of the 86 patients treated, 35 (41.7%) underwent early surgery and 49 (58.3%) underwent late surgery. There was a trend toward older age and increased number of comorbidities within the late surgery group. More patients had a 2-grade or more improvement in their ASIA Impairment Scale grade from admission to rehabilitation discharge in the early surgery group ($p = 0.01$). The mean improvement in ASIA motor score at rehabilitation discharge was 20 points among early surgery patients and 15 points among late surgery patients ($p = 0.46$). For the adjusted analysis investigating motor recovery, after step-wise backward selection, there was a positive effect estimate for early surgical therapy that was statistically significant ($p = 0.05$). **Conclusion:** The results of this study add further weight to the growing body of literature which supports the principle of early intervention in the setting of spinal trauma and SCI.

3.3.37

A clinical prediction model for long-term functional outcome after traumatic spinal cord injury based on acute clinical and imaging factors. ***J. Wilson,* A. Kiss,† A. Vaccaro,‡ J. Harrop,‡ R. Grossman,§ R. Frankowski,¶ J. Guest,** M. Dvorak,†† B. Aarabi,* M. Fehlings.** **From the *Division of Neurosurgery and the †Department of Research Design and Biostatistics, University of Toronto, Toronto, Ont., the ‡Department of Neurosurgery and Orthopedics, Thomas Jefferson University, Philadelphia, Pa., the §Houston Methodist Hospital and the ¶School of Public Health, University of Texas, Houston, Tex., the **Division of Neurosurgery, University of Miami, Miami, Fla., and the ††Division of Orthopedic Surgery, University of British Columbia, Vancouver, BC**

Background: To improve clinicians' ability to predict outcome after spinal cord injury (SCI) and to help classify patients within clinical trials, we have created a novel prediction model relating

acute clinical and imaging information to functional outcome at 1-year follow-up. **Methods:** Data were obtained from 2 large prospective data sets. The primary outcome was Functional Independence Measure (FIM) motor score at 1-year follow-up. Predictor variables were obtained within 3 days of injury and included: American Spinal Injury Association grade, neurologic level, age and MRI intramedullary signal characteristics. These predictors were chosen based on expert opinion and literature support. A linear regression model was created and internally validated using bootstrap resampling, with model performance judged by R^2 values. The FIM motor score was then dichotomized, and logistic modelling was used to classify patients achieving functional independence (score ≥ 6 for all FIM motor items). Model discrimination was judged by the area under receiver operator curves (AUC). **Results:** Of 729 patients, 376 met the inclusion/exclusion criteria. The mean FIM motor score at 1 year was 62.9 (SD 28.6). The linear model demonstrated an R^2 of 0.54 in the original data set and 0.53 across the 200 bootstraps, with mean parameter estimates for each covariate across the bootstraps closely approximating estimates from the original data set. Functional independence was achieved by 148 patients (39.4%). For the logistic model, the AUC was 0.92, indicating excellent predictive discrimination. **Conclusion:** We have created and internally validated the first prediction model that uses acute clinical and imaging data to predict functional status at 1-year follow-up in patients with traumatic SCI. We anticipate that this model will have important clinical impact to guide decision-making and for counselling patients and families.

3.3.38

Effect of motor score on adverse events and quality of life in patients with traumatic spinal cord injury.

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Background: Neurological impairment associated with traumatic spinal cord injury (tSCI) results in significant health care costs and disability. The purpose of this study was to assess the impact of neurologic impairment, specifically motor score on admission, with the incidence of adverse events, length of stay (LOS) and long-term health status in patients with tSCI. **Methods:** Patients with a tSCI discharged from a quaternary acute care centre between 2008 and 2010 were identified from our prospective registry. Adverse event data were prospectively collected using the previously validated Spine Adverse Events Severity instrument. Data related to patients' injury, diagnoses, hospital admission and follow-up SF-36 physical and mental component scores (PCS, MCS) were obtained from the registry. The 5 most common adverse events were identified and multivariate analyses performed to determine whether the initial motor score on admission was significantly associated with adverse events, as well as with LOS and SF-36 scores at 1–2 years postinjury. **Results:** In all, 171 patients with tSCI were included, 81.3% were male and the mean age at injury was 47.2 (SD 20.3) years. A lower motor score on admission was significantly associated with having pneumonia, pressure ulcers and urinary tract infections ($p < 0.05$); no association was found with delirium or neuropathic pain. There was also a significant association between motor score and the incidence of adverse events and LOS ($p < 0.0001$). For each 10-point decrease in motor score, LOS increased by 20%. In patients with a motor score over 50, the SF-36 PCS increased by 3.8% for each 10-point increase in motor score. There was no effect on the SF-36 MCS. **Conclusion:** The initial motor score can predict important outcomes such as incidence and type of adverse events, LOS and long-term health status. Patients with low motor scores should be identified on admission to maximize their health outcomes.

3.4.39

The impact of facet dislocation on neurologic recovery after cervical spinal cord injury: an analysis of data on 325 patients from the Surgical Trial in Acute Spinal Cord Injury Study (STASCIS).

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Background: We have undertaken a subanalysis of a large prospective data set to define differences in demographics, injury characteristics and neurologic outcomes between cervical spinal cord injury (SCI) patients with and without facet dislocation (FD). **Methods:** A multicentre, North American prospective cohort study of early (< 24 h) versus late (≥ 24 h) spinal cord decompression following cervical SCI was performed. Patients were classified into FD and non-FD groups depending on the results of imaging investigations performed at admission (radiography or CT). Patients with FD underwent closed or open reduction at the earliest opportunity following injury, and time to reduction was noted. Neurologic outcome assessments were performed at 6 and 12 months postinjury. Baseline characteristics and outcomes between the FD and non-FD groups were compared using univariate statistics. Multivariate linear regression was also used to evaluate the independent effects of FD on neurologic outcomes at follow-up by adjusting for initial injury severity. **Results:** Of the 325 patients enrolled, 112 (34%) had an FD and 213 (66%) had no FD. Patients in the FD group had significantly worse presenting American Spinal Injury Association (ASIA) Impairment Scale (AIS) grade as compared with those in the non-FD group ($p < 0.01$). Fifty-six of the 67 FD patients (84%) who were placed in traction successfully achieved closed reduction. There were no differences in baseline sex, age or injury velocity/mechanism between the 2 groups. At 1-year follow-up, FD patients experienced a mean ASIA motor score improvement of 18 points, whereas non-FD patients experienced a significantly larger improvement of 29 points ($p = 0.01$). After adjusting for initial AIS grade, patients with FD continued to demonstrate a smaller degree of ASIA motor score recovery as compared with the non-FD patients ($p = 0.01$). **Conclusion:** As compared with those without FD, cervical SCI patients with FD tend to present with a more severe degree of initial injury and seem to display a smaller potential for neurologic recovery over time.

3.4.40

Toward a more precise understanding of the epidemiology of traumatic spinal cord injury in Canada. ***R. Lewis,[*] L. Marais,[*] V.K. Noonan,[†] M. Queyranne,[*] M.G. Fehlings,[‡] M.F. Dvorak,[†] D. Atkins.[*]*** **From the *Centre for Operations Excellence, Sauder School of Business, University of British Columbia, the †Rick Hansen Institute and the Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, and the ‡Krembil Neuroscience Centre, Spinal Program, Toronto Western, University Health Network, University of Toronto, Toronto, Ont.**

Background: The incidence of traumatic spinal cord injury (tSCI) in Canada is not well understood. To date, the most comprehensive empirical study uses data from only 1 province over 2 years. The objective of this study was to use data from the Canadian Institute of Health Information's National Trauma Registry (NTR) Minimum Data Set to empirically estimate the incidence rates of tSCI in Canada and forecast future incidence. **Methods:** The NTR data set included 18 537 records for all institutions in Canada (excluding Quebec) for 1994–2009. International Classification of Disease (ICD)-9 and -10 codes for tSCI were identified based on a literature search. To account for the data being record-level (admission) and not patient-level, a probabilistic model was developed to identify readmissions. The patient-level injury data estimates were then combined with population estimates from Statistics Canada to calculate injury rates for particular ages, sexes, regions and years. **Results:** Out of 18 537 records, there are at least 1600 readmissions (identified by matching age, sex, urban/rural residence, injury place, level of injury and time of discharge/readmission); if less stringent conditions are used, the count of readmissions could be as high as 7000. The proportion of possible readmissions varies by province and by year. The estimated range for provincial tSCI incidence rates by age and sex will be presented based on the different mapping criteria for the period 1994–2034. Eliminating readmissions from the data affects the observed time trend in injury rates but does not explain all of the regional variation in injury rates. **Conclusion:** The NTR record-level data provide the first empirical estimate of tSCI incidence rates in Canada (excluding Quebec). Future work with patient-level data will refine these estimates; nevertheless, this estimate is valuable for planning future SCI services and provides insight into using NTR data.

3.4.41

Access to care (ACT) for traumatic SCI: a survey of acute Canadian spine centres. ***V.K. Noonan,[*] R.J. Hurlbert,[†] R. Fox,[‡] D. Fourney,[§] M. Johnson,[¶] M.G. Fehlings,[**] H. Ahn,[**] M. Ford,[**] A. Yee,[**] J. Finkelstein,[**] E. Tsai,[††] C. Bailey,[‡‡] B. Drew,[§§] J. Paquet,[¶¶] S. Parent,[***] S. Christie,[†††] M.F. Dvorak.[*]*** **From the *Rick Hansen Institute and the Division of Spine, Department of Orthopaedics, University of British Columbia, Vancouver, BC, the †Spine Program and Division of Neurosurgery, University of Calgary, Calgary, the ‡Division of Neurosurgery, University of Alberta, Edmonton, Alta., the §Division of Neurosurgery, University of Saskatchewan, Saskatoon, Sask., the ¶Department of Surgery Section of Orthopaedics and Neurosurgery, University of Manitoba, Winnipeg, Man., the **Department of Surgery and Spinal Program, University of Toronto, Toronto, Ont., the ††Division of Neurosurgery, University of Ottawa, Ottawa, the ‡‡Division of Orthopaedics, University of Western Ontario, London, the §§Division of Orthopaedics, McMaster University, Hamilton, Ont., the ¶¶Département des sciences neurologiques, Hôpital de l'Enfant-Jésus, Laval University, Quebec City, the ***Division of Orthopaedics, University of Montreal, Montreal, Que., and the †††Division of Neurosurgery, Dalhousie University, Halifax, NS**

Background: The ideal system of health care delivery for persons with traumatic spinal cord injury (tSCI) has not been defined. The Trauma Association of Canada developed standards for trauma patients, but there are no standards specific to SCI. The objective of this study was to describe the prehospital, acute and rehabilitation care delivery in Canada to understand current systems of delivery of care. **Methods:** A standardized survey was sent to all acute and rehabilitation facilities participating in the larger Access to Care (ACT) study. The survey included questions about number of admissions/discharges, service availability (e.g., triage criteria) and the relationship among acute and rehabilitation facilities (e.g., admission criteria). Data from the local SCI Registry in each facility and other hospital databases were used to estimate number of patient admissions. **Results:** Twenty-five facilities were contacted, and surveys were completed by 23 (92% completion rate). The sample covers 6 provinces and includes 12 acute facilities, 9 rehabilitation facilities and 2 acute/rehabilitation facilities. There was tremendous variation in the processes of care. The number of tSCI patients admitted to the 14 acute centres ranged between 24 and 102 (median 38) in 2010. Three acute centres reported the inability to admit all referred patients with tSCI. Cohorting of patients (all tSCI regardless of level of injury are treated on spine-specific units) occurs in only 4 of 14 acute care centres. The majority of centres reported that patients receive rehabilitation during acute care, but the criteria for admission to formal rehabilitation varied among facilities. **Conclusion:** Results from this study highlight similarities and differences in delivery of care for patients with tSCI in Canada. The differences will be further examined in the ACT health service models. The long-term goal is to develop standards of care for tSCI that can be implemented by Accreditation Canada.

3.4.42

Use of the Spine Adverse Events Severity (SAVES) instrument for traumatic spinal cord injury. ***J. Street,[*] V.K. Noonan,[*†] A. Cheung,[†] B. Sun,[†] M.F. Dvorak.[*†]*** **From the *Division of Spine, Department of Orthopaedics, University of British Columbia, and the †Rick Hansen Institute, Vancouver, BC**

Background: Adverse events are common during acute care in patients with traumatic spinal cord injury (tSCI). Administrative data are often used to report adverse events, however these data may not reflect patient complexity and outcome. The Spine Adverse Events Severity (SAVES) instrument has previously been validated for adverse event recording in the spine. The objective of this study was to determine if SAVES was superior to ICD-10 codes in measuring adverse events in patients with tSCI.

Methods: Patients discharged between 2006 and 2010 were identified from our prospective registry. Two cohorts were created based on the method used to record adverse events; cohort 1 used ICD-10 codes, and cohort 2 used SAVES data. The ICD-10 codes were mapped to adverse events in SAVES. The 5 most common adverse events were examined: neuropathic pain, urinary tract infections (UTI), pneumonia, pressure ulcers and delirium. There were 212 patients in cohort 1 and 173 patients in cohort 2. Analyses were adjusted to account for the different sample sizes, and the 2 cohorts were comparable based on age, sex, mechanism of injury and motor score. **Results:** There was an 18% increase in the number of patients diagnosed as having 1 or more adverse events using SAVES (76%) compared with ICD-10 codes (58%). The number of adverse events recorded per person was doubled using SAVES (1.3 v. 2.7), and SAVES reported greater incidence of neuropathic pain (× 32), UTI (× 1.4), pneumonia (× 1.2), pressure ulcers (× 2.9) and delirium (× 1.2). The number of intraoperative adverse events identified was 2.3 times greater using SAVES (7.5% v. 17.3%). **Conclusion:** The implementation of the SAVES system for patients with tSCI captured more patients experiencing adverse events and more adverse events per person compared with using ICD-10 codes. This study demonstrates the utility of prospectively collecting data on adverse events using validated tools.

3.5.17

Does the type of distraction-based growing system for early onset scoliosis affect postoperative sagittal alignment? ***R. El-Hawary,*† P. Sturm,† P. Cahill,† A. Samdani,† M. Vitale,† P. Gabos,† N. Bodin,† C. d'Amato,† C. Harris,† J. Smith.†*** **From the *IWK Health Centre, Halifax, NS, and the †Chest Wall and Spine Deformity Study Group, Layton, Utah**

Background: Rib-based (RB) and spine-based (SB) posterior distraction growing systems are commonly used for the treatment of early onset scoliosis (EOS). The purpose of this study was to determine if the type of growing system affects postoperative sagittal-plane alignment. **Methods:** A multicentre, retrospective, institutional review board–approved radiographic comparison was performed. Preoperative and minimum 2-year follow-up radiographs were analyzed for a group of 79 children with EOS who were treated with posterior distraction-based implants. **Results:** There were 56 patients treated with rib-based and 23 patients treated with spine-based systems. Mean preoperative values for rib- versus spine-based systems were: age (4.4 v. 6.3 yr, $p < 0.05$),, thoracic scoliosis (70.4° v. 74.8°), lumbar scoliosis (34.6° v. 40.1°), thoracic kyphosis (36.6° v. 40.0°) and lumbar lordosis (45.7° v. 54.9°, $p < 0.05$). Other than sacral slope (34.9° v. 39.7°, $p < 0.05$), sagittal spinal and pelvic parameters were similar between groups. At minimum 2-year follow-up (3.5 y RB v. 2.1 y SB, $p < 0.05$), curve correction was less for the rib-based group: 20.9% versus 47.5% thoracic and 19.3% versus 48.9% lumbar (both $p < 0.05$). The rib-based group had greater cervical lordosis (36.4° v. 21.4°, $p < 0.05$), greater thoracic kyphosis (46.2° v. 26.0°, $p < 0.05$), less lumbar lordosis (46.4° v. 53.5°), less sacral slope (34.8° v. 40.0°, $p < 0.05$), greater pelvic tilt (18.0° v. 11.1°, $p < 0.05$) and less pelvic radius angle (49.8° v. 66.4°, $p < 0.05$). Pelvic incidence was not different between groups. **Conclusion:** Although longer follow-up for the rib-based group is a potential confounding variable, at final follow-up, patients treated with rib-based implants had greater cervical lordosis, greater thoracic kyphosis, less lumbar lordosis, less sacral slope, greater pelvic tilt and less pelvic radius angle as compared with those treated with spine-based implants. The patient's preoperative sagittal alignment should be considered when deciding upon which type of distraction-based growing system to use for an individual patient with EOS.

3.5.18

Comparison of radiation exposure during thoracolumbar fusion using fluoroscopic guidance versus anatomic placement of pedicle screws. ***N. Egge, J. Lange, C. DiPaola, A. Lapinsky, P. Connolly, J. Eck.*** **From the University of Massachusetts, Worcester, Mass.**

Background: There are multiple accepted surgical techniques for placing thoracolumbar pedicle screws. Some surgeons use fluoroscopy to aid in placement of instrumentation, whereas others use fluoroscopy as confirmation of positioning after anatomic placement of screws. Depending on the method used, there is a potential for a significant difference in radiation exposure. The purpose of this study is to evaluate the difference in radiation exposure imparted using a fluoroscopic-guided technique versus anatomic placement of pedicle screws during typical posterior thoracolumbar instrumented fusions. **Methods:** A retrospective study evaluated patients who underwent a posterior thoracolumbar fusion over a 4-year time period. Adult patients with nonpercutaneous, posterior instrumented fusions and an available fluoroscopy report were included. The method of fluoroscopy utilization and specific operation were ascertained from the patient's operative report. Average fluoroscopy time in seconds per screw inserted for each method was compared using a Student *t* test. **Results:** A total of 82 patients underwent thoracolumbar fusion by an anatomic technique. The average number of pedicle screws placed was 5.72 screws (range 2–26). The average fluoroscopy time was 11.85 seconds, with a median time of 6 seconds. For placement of a single pedicle screw, the average fluoroscopy time was 2.65 seconds. There were 103 patients who underwent thoracolumbar fusion using a fluoroscopic-guided technique. The average number of pedicle screws placed was 5.1 screws (range 2–12). Fluoroscopy time averaged 83.26 seconds per surgery, with a median of 78 seconds. The average fluoroscopy time for placement of a single pedicle screw was 17.08 seconds. **Conclusion:** Patients undergoing thoracolumbar spinal fusion using the fluoroscopic-guided technique have increased radiation exposure, reaching 6.5 times the amount imparted using an anatomic technique, which is statistically significant ($p < 0.01$). Surgeons performing a large number of fluoroscopic-guided operations may have the potential to exceed annual radiation dose limits.

3.5.19

Skeletal traction for intraoperative reduction in adolescent idiopathic scoliosis. ***C. Lin, D. Rabin, R. Zeller, S. Lewis.*** **From the Spine Program, Toronto Western Hospital, Toronto, Ont.**

Background: Intraoperative skeletal traction (T) facilitates curve correction in adolescent idiopathic scoliosis (AIS). The aim of this

study is to compare the radiographic results and safety of different traction weights. **Methods:** We conducted a retrospective study of 3 AIS cohorts (high-T, low-T, no-T). High-T (10–15 lbs cranial traction and 50% body weight femoral traction) was used for curves greater than 70°, lumbar curves requiring correction and cases with type C and D pedicles. Low-T consisted of 13 lbs cranial traction and 26 lbs femoral traction. No osteotomies or anterior releases were performed. Primary outcome measure was change in Cobb angle between the 3 cohorts. Secondary outcome measures were flexibility and traction indices and electrophysiological (EP) changes. **Results:** In all, 44 high-T, 41 low-T and 36 no-T patients were analyzed, with mean preoperative curves of 76.6° (44°–112°), 69.3° (50°–85°) and 57.3° (42°–75°), respectively (p = 0.02). Flexibility index was stiffer in the high-T group than low-T group (0.19 v. 0.3, p = 0.05). Intraoperative curve correction in traction was greater in the high-T group (47% v. 34%, p = 0.001). Postoperative curve correction was 64.7%, 60.8% and 68.4% for the high-T, low-T and no-T groups, respectively. Lumbar curves had significantly better final correction with high-T (p = 0.019) than the low-T group. High-T was more likely to produce EP changes compared with low-T (odds ratio 3.8, p = 0.006), though this was not significant when adjusting for curve severity (odds ratio 3.6, p = 0.27). There were no EP changes in the no-T group. **Conclusion:** High skull–skeletal traction facilitates intraoperative curve correction and postoperative lumbar curve correction over low skull–skeletal traction. Furthermore, it achieves correction similar to smaller curves with no traction. However, high-T does introduce a higher risk of EP changes with larger curves, and is not recommended without reliable intraoperative EP monitoring.

3.5.20

Utility of intraoperative cone-beam computed tomography (O-ARM) and stereotactic navigation in acute spinal trauma surgery. ***R. Schouten, R. Lee, M. Boyd, M. Dvorak, C. Fisher, B. Kwon, S. Paquette, C. DiPaola, J. Street.*** **From the Combined Neurosurgical and Orthopedic Spine Program, Vancouver, BC**

Background: The purpose of this study is to describe the emerging role of intraoperative cone-beam computed tomography (O-ARM), frequently coupled with stereotactic navigation, in the surgical management of acute spinal trauma. **Methods:** Our study design used an ambispective cohort. All surgical cases that used O-ARM with/without stereotactic navigation between May 2009 and May 2011 were identified from a prospective spine database. Cases performed for acute spine trauma were identified and retrospectively analyzed to characterize indications and outcomes. Cases with or without O-ARM support were compared for their rates of implant malposition requiring revision surgery. Technical factors associated with successful application of this technology were examined. **Results:** Over the 2-year period examined, O-ARM was used in 183 spinal operations; 27 of these (15%) involved acute spine trauma. Within the trauma cohort, 14 injuries were in the cervical spine, 9 at the cervicothoracic junction and 4 in the thoracolumbar spine. In 12 (44%) cases, pre-existing aberrant and challenging anatomy, commonly ankylosing conditions, were present. Surgical techniques included transarticular atlantoaxial fixation and direct osteosynthesis of a Hangman fracture performed entirely percutaneously (via 2 stab incisions) by using O-ARM assisted stereotactic navigation. None of the trauma cases using O-ARM assisted navigation had iatrogenic neurovascular injury and 0 required subsequent revision surgery for implant malposition, compared with a revision rate of 1.2% of non-navigated acute spinal trauma cases during the same interval. Keys to successful use of O-ARM include: meticulous preoperative planning and proper set-up. Continuous assessment of the accuracy of the navigation is imperative to control for inevitable movement in these unstable injuries. **Conclusion:** O-ARM assisted navigation can overcome anatomic challenges and broaden the available stabilization options in the management of acute spinal trauma. Other advantages include protecting the surgical team from cumulative fluoroscopic radiation exposure and patients from repeat surgery due to implant malposition.

3.5.21

Use of a central compression rod to reduce thoracic level spinal osteotomies. ***C. Lin, A. Bodrogi, S. Goldstein, M. Sofia, S. Lewis.*** **From the Spine Program, Toronto Western Hospital, Toronto, Ont.**

Background: Closing thoracic spinal osteotomies often requires significant forces causing excessive strain on thoracic pedicle screws. We review the results of osteotomy closure with the use of a posterior central hook-based compression rod. **Methods:** Retrospective chart and radiograph review of 19 thoracic-level osteotomies closed with a central compression rod. Data on number and type of osteotomy, curve correction and postoperative complications were collected. **Results:** In all, 19 patients, mean age of 50.3 (18–76) years, underwent thoracic-level osteotomies for kyphosis or kypho-scoliotic deformities. There were 2 vertebral column resections (VCR), 14 pedicle subtraction osteotomies (PSO) and 7 Smith-Peterson osteotomies (SPO), including 4 cases of combined osteotomies (2-level PSO or PSO/SPO combination). Mean levels instrumented was 11.9 (4–16), mean operative time 7.3 (4–13) hours, mean blood loss 3272 (500–12620) mL, and mean hospital stay 16.7 (5–46) days. The central rod was left in place in 9 patients. The mean correction with the osteotomy was 20.0 (7°–52°). Sagittal plumb line corrected from 31.5 (–42 to 247) mm to 13.9 (–40 to 138) mm. Complications included 4 dural tears, 5 pleural tears and 9 postoperative medical complications. There were 2 pseudarthroses, 4 proximal junctional failures and 2 loss of correction in patients where the central rods were removed after undergoing SPO for proximal thoracic deformities. **Conclusion:** The central rod facilitated correction of rigid thoracic deformities following osteotomy while protecting the remaining fixation points. The use of a central rod to close spinal osteotomies provides powerful compression across an osteotomy site while sparing unnecessary forces on the pedicle screws. Removing the rod can be associated with loss of correction in proximal thoracic corrections.

3.5.22

ICD-10 coding accuracy for spinal cord injured patients. ***A. Kim, J. Shin, K. Tung, H. Ahn.*** **From St. Michael's Hospital, Toronto, Ont.**

Background: Administrative databases such as the Canadian Institute of Health Information Discharge Abstract Database (CIHI-DAD) are frequently used in health services research to

assess regional variations in care and to assess morbidity and mortality of treatment. The purpose of this study was to determine the accuracy of diagnostic coding for surgical cases of spinal cord injury using ICD-10-CA codes in an administrative database, along with an optimal search strategy. **Methods:** All 1110 spinal surgery cases performed at St. Michael's Hospital, an urban level 1 trauma centre, from June 2006 to June 2008, were identified through a surgical registry database. Diagnosis obtained via health record review was used as the gold standard. We calculated for sensitivity, specificity, positive likelihood ratio and positive predictive value of CIHI-DAD coding compared with the health record. **Results:** Of the 1110 spinal surgery cases, 82 cases were for acute traumatic spinal cord injuries. Fifteen different diagnostic codes for acute traumatic spinal cord injury were used. Combining all 15 codes using a Boolean "OR" function, sensitivity was determined to be 47.6%, specificity was 99.4%, positive predictive value was 86.6% and positive likelihood ratio was 79.33. In contrast, within this same cohort of surgical cases, coding for myelopathy (cervical and thoracic) had a higher sensitivity of 81.6%. **Conclusion:** Ascertainment of surgical cases of acute traumatic spinal cord injured patients from administrative databases using only ICD-10 diagnostic codes is poor. A potential source of error occurs owing to missed coding of the cord injury in polytrauma patients with numerous injuries (many times over 15 diagnoses in the clinical records). In contrast, surgical cases involving myelopathy, with typically a single diagnosis in the surgical records, are coded with significantly improved sensitivity compared with coding for acute spinal cord injured patients.

3.5.23

Feasibility of patient recruitment in acute SCI trials. ***B. Kwon, R. Lee, J. Batke, R. Ghag, V. Noonan, M. Dvorak.*** **From the University of British Columbia, Vancouver, BC**

Background: Clinical trials of acute spinal cord injuries (SCI) typically require large numbers of patients for sufficient statistical power. In planning such trials, it is crucial to understand how many patients can realistically be enrolled (and hence, how long the trial will take to complete). This study was conducted to define the fraction of SCI patients that would theoretically satisfy standard inclusion criteria of an acute clinical trial. **Methods:** Using local databases, we reviewed patients with acute SCI admitted to our level 1 trauma centre from 2005 to 2009. We then determined how many of the total number of SCI patients would be eligible for enrolment into a hypothetical acute clinical trial that required a valid baseline assessment of neurologic impairment, and an enrolment window of either 12, 24 or 48 hours. **Results:** In all, 405 acute traumatic SCI patients were admitted over 4 years; 258 of 408 (64%) presented within 12 hours of injury, 51 (13%) between 12 and 24 hours and 30 (7%) between 24 and 48 hours. Patient injuries were graded according to the American Spinal Injury Association (ASIA) Impairment Scale (AIS), with 39% AIS A, 11% B, 17% C and 28% D. The number of patients with penetrating injuries or who were intoxicated from drug or alcohol usage was 30%. Individuals presenting with cervical AIS A injuries within 12 hours postinjury comprised only 16% of the total number of patients. **Conclusion:** Out of a total of 405 patients admitted over 4 years, the number who would have been optimistically eligible for an acute neuroprotective trial was disappointingly small. Given that additional inclusion/exclusion criteria would also be applicable in a real clinical trial, the true number of "eligible" or "recruitable" patients is conservatively even lower. This study is the first to quantify this challenging aspect of conducting acute SCI clinical trials, and provides valuable information for those planning such initiatives.

3.5.24

Treatment of adult degenerative scoliosis with DLIF approaches. ***E. Huang, T. Goyal, J. Littlewood, I. Bains, R. Cho, K. Thomas, G. Swamy.*** **From the University of Calgary, Calgary, Alta.**

Background: Adult degenerative thoracolumbar scoliosis can be severely debilitating, causing axial back and neurogenic leg pain. Traditional operative management entails prolonged operative times, high blood loss and a corresponding high immediate-term complication rate ranging from 11% to 33%. Recent reports describe use of less-invasive transpsoas lateral approaches to partially correct the deformity, indirectly decompress neural elements and "loosen" the interspace, allowing for easier definitive deformity correction. Our hypothesis was that less invasive surgery results in a lower immediate-term complication rate. **Methods:** A retrospective chart review was performed on patients undergoing surgery for adult degenerative scoliosis with a cephalad fusion level of T10/11/12 and a caudad level of S1/ilium in the last 3 years. The selection of operation was chronological, with the less invasive approach being employed more recently. Patients with histories of congenital or adolescent idiopathic scoliosis were excluded. Seven patients underwent traditional scoliosis correction techniques, employing open posterior decompression with or without Smith-Peterson osteotomies with L5–S1 transforaminal or anterior lumbar interbody fusion (TLIF/ALIF) and pedicle screw–rod constructs. Eight patients underwent a 2-stage procedure, with transposas direct lateral interbody fusions (DLIF) followed by posterior instrumentation/L5–S1 TLIF. Demographics, comorbidities, surgical data and adverse events were collected. Parametric and nonparametric analyses were performed. **Results:** Demographics were similar in both groups. Patients treated with open techniques had significantly more intraoperative blood loss compared with patients treated with DLIF (4282 mL v. 1169 mL, respectively, $p = 0.02$). Four out of 7 patients in the traditional group experienced major complications immediately postoperatively. These included 3 cases of cardiac ischemia/arrest and 2 deep wound infections. In the DLIF group, there were no major complications, and 2 out of 8 patients experienced minor complications. **Conclusion:** Our preliminary data strongly suggest that a 2-stage DLIF technique results in significantly less blood loss and fewer complications than traditional open techniques.

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