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Abstracts • Résumés

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CLINICAL PRACTICE GUIDELINE-BASED TREATMENT IS NOT EFFECTIVE FOR ALL PATIENTS WITH ACUTE LOWER BACK PAIN. *Paul Bishop, Charles Fisher, Jeff Quon, Marcel Dvorak.* Combined Neurosurgical and Orthopaedic Spine Program, Department of Orthopaedics, Vancouver General Hospital, University of British Columbia, Vancouver, BC.

Background: Clinical practice guideline (CPG) concordant treatment (Ctx) has been shown to be more effective than CPG discordant care (Dtx) in a heterogeneous cohort of patients with acute lower back pain (ALBP). However, patients with underlying spine pathology (e.g., stenosis, disc degeneration, facet joint arthropathy) or without identifiable spine pathology may all present solely with ALBP. At present, it is unknown if underlying spine pathology influences the outcome of Ctx. **Purpose:** To determine if Ctx is more effective than Dtx in patients with differing underlying spine pathology who present with ALBP. **Study design:** Two-arm, randomized controlled trial with stratified analysis. **Patient sample:** Inclusion: ages 19–59 years; Quebec Task Force Spinal Disorders (QTFSD) classification I, II ALBP < 4 weeks. Exclusion: “red flag” conditions, comorbidities contraindicating Ctx. **Outcome measures:** Primary outcome: difference between Ctx and Dtx Roland–Morris disability questionnaire (RDQ) scores at 16 weeks postbaseline between study groups. Secondary outcomes: differences in bodily pain (BP) and physical functioning (PF) SF-36 domain scores at 16 weeks. **Methods:** Patients were assessed by a spine physician and randomized to Ctx or Dtx groups. Patients were stratified on the basis of CT or MRI evidence of: 1) spinal stenosis; 2) disc degeneration; 3) facet joint arthropathy; or 4) no identifiable pathology. Hospital and University Ethics approval were obtained. **Results:** Eighty-eight patients were recruited: 39 in the Ctx group and 38 in Dtx group completed the study. Baseline prognostic variables were evenly distributed between groups. Outcomes: mean difference in 16-week RDQ, BP and PF scores between Ctx and Dtx groups was statistically greatest in group 4 ($p < 0.001$). There was no significant clinical improvement in RDQ, BP or PF scores in either the Ctx or Dtx in group 2. **Conclusion:** Ctx was more effective than Dtx in patients with no identifiable spine pathology and was ineffective or equivalent to Dtx in patients with underlying disc degeneration.

OUTCOMES BASED ON A LOW BACK PAIN CLASSIFICATION SYSTEM. *Greg McIntosh, Hamilton Hall, Christina Boyle.* CBIHealth, Toronto, Ont.

Introduction: One goal of low back pain (LBP) assessment is to direct clinicians to specific subgroups that benefit from particular treatment approaches. The term ‘nonspecific’ LBP does not direct treatment or instill confidence in patients. The purpose of this study was to compare outcomes in a conservative care setting between patients assessed and treated based on a diagnostic system of LBP classification and patients managed

without a classification system. **Methods:** This was an observational cohort study of mechanical LBP cases ($n = 1942$) who started a rehabilitation program at 11 clinics across Canada between February 2006 and August 2007. A group of patients attending 6 clinics with staff specifically trained in the use of an LBP classification system using patterns of pain, not anatomic site or pathological process ($n = 1525$) were compared with patients from 5 clinics using a generic, nonclassification approach ($n = 417$). Patients were categorized into 1 of 5 classifications, each dictating a separate treatment approach. The intertester reliability of the classification system has been previously documented (agreement = 79%, kappa = 0.61). **Results:** The mean age of the cohort was 44.9 (SD 13.5, range 18–92) years with 54.6% males. The mean lag-time from injury to treatment was 114.4 (median 37) days. Treatment based on this classification system resulted in more pain reduction ($p < 0.001$), higher functional improvement ($p < 0.001$), less medication use ($p < 0.001$) and fewer treatment days ($p < 0.001$), compared with a generic approach. The 5 patterns of pain showed statistically significant differences in outcomes. **Discussion:** Outcome differences between the 5 classified groups suggest that LBP is heterogeneous and recognizable by clinical patterns of patient characteristics. The results support the effectiveness of a system that matches treatment to patient presentation and pattern of pain. Classification-based treatment had a positive impact on outcomes.

A SYSTEMATIC REVIEW OF LOW BACK PAIN COST OF ILLNESS STUDIES. *Simon Dagenais,* Jaime Caro,† Scott Haldeman.‡* From the *University of Ottawa, Ottawa, Ont., †McGill University, Montréal, Que., and the ‡University of California, Los Angeles / Irvine, Calif.

Introduction: The economic burden of low back pain is very large and appears to be growing. It is not possible to understand the impact of this burden without understanding the strengths and weaknesses of the research on which these costs are calculated. **Methods:** MEDLINE was searched to uncover studies about the direct or indirect costs of low back pain published in English from 1997 to 2007. Data extracted for each eligible study included study design, population, definition of low back pain, methods of estimating costs, year of data and estimates of direct, indirect or total costs. Results were synthesized descriptively. **Results:** The search yielded 147 studies, of which 27 were deemed relevant. The studies reported on data from Australia, Belgium, Japan, Korea, the Netherlands, Sweden, the UK and the US. Nine studies estimated direct costs only, 9 indirect costs only, and 9 both direct and indirect costs, from a societal ($n = 18$) or private insurer ($n = 9$) perspective. Among studies providing a breakdown on direct costs, the largest proportion of direct medical costs for low back pain was spent on physical therapy (17%) and inpatient services (17%), followed by pharmacy (13%) and primary care (13%). Among studies providing estimates

of total costs, indirect costs due to lost work productivity represented a majority of overall costs associated with low back pain. Three studies reported that estimates with the friction period approach were 56% lower than with the human capital approach. **Discussion:** Estimates of the economic costs in different countries vary greatly depending on study methodology, but by any standards must be considered a substantial burden on society. This review did not identify any studies estimating the total costs of low back pain in the US or Canada from a societal perspective. Such studies may be helpful in determining appropriate allocation of health care resources devoted to this condition.

2008 Debbie Scarlett Award for Best Paper

DIRECT COST EFFECTIVENESS ASSESSMENT OF SURGICAL INTERVENTION FOR FOCAL SPINAL STENOSIS COMPARED WITH PRIMARY HIP AND KNEE REPLACEMENT FOR OSTEOARTHRITIS. *Y. Raja Rampersaud, Stephen J. Lewis, Roderick Davey, Nizar Mahomed.* Toronto Western Hospital, University of Toronto, Toronto, Ont.

Introduction: The primary objective of this study was to determine the estimated, direct cost per quality adjusted life years (cost / QALY) following surgical treatment for spinal stenosis compared with total hip and knee arthroplasty. **Methods:** An age-, sex- and time-of-surgery-matched cohort of patients who had undergone elective primary 1–2 level spinal decompression ($n = 90$) with ($n = 30/90$) or without fusion for spinal stenosis ($n = 40$ with degenerative spondylolisthesis) and elective primary total hip ($n = 90$) and knee ($n = 90$) arthroplasty for osteoarthritis were compared. Detailed, direct hospital case costing (from the operating room, nursing, medical imaging, laboratories, pharmacy and allied health) was determined for each cohort. Health utility was derived using the Brazier conversion of SF-36 to the SF-6D. **Results:** The mean pre- to postoperative change in SF-6D at 2 years after surgery was spine = 0.1098, hip = 0.1037 and knee = 0.0491 ($p = 0.005$ and 0.019 , spine-hip v. knee; spine v. hip, $p = 0.955$). Mean hospital length of stay / direct case costing / and 2-year cost / QALY for each cohort was: stenosis decompression = 3 days / \$4186 / \$19 027; stenosis fusion (cost calculated for a 1-level posterior lumbar interbody fusion) = 5 days / \$10 550 / \$47 954; primary hip replacement = 5 days / \$9035 / \$41 068; and knee replacement = 5 days / \$8210 / \$82 100. **Discussion:** The results of this study show that surgical intervention for focal lumbar spinal stenosis has a cost / QALY that is comparable to primary total hip replacement and is more cost-effective than primary total knee replacement at 2 years postsurgery.

PATIENT CONCERNS IN THE PERIOD POSTREFERRAL AND BEFORE SEEING A SPINE SURGEON. *Biniyam Kidane,* Angela Sarro,† Raja Rampersaud.†* From the *University of Toronto and the †Toronto Western Hospital, Toronto, Ont.

Introduction: Patient satisfaction with clinical encounters is related to the extent to which patients feel their concerns are addressed. The purpose of this study was to assess the concerns of adult spinal patients during the period between being referred to and actually seeing a spine surgeon. **Methods:** A

questionnaire (Likert-scale, semiquantitative, open-ended questions) was administered and completed by 200 patients just before consultation with a spine surgeon. **Results:** The issues reported as causing the most concern were: ongoing pain (39.9% rated this as most concerning), loss of function (23.9%), permanence of the condition (12.3%), inevitability of surgery once referred to a spine surgeon (12.3%), lack of information (5.0%), fear of paralysis (4.3%) and fear of cancer (2.0%). Although only 30% of patients were considered possible surgical candidates, 44% listed surgery as 1 of their top 3 concerns. χ^2 analysis showed that concern about surgery is independent ($p < 0.05$) of whether a person is a possible surgical candidate. The most influential information source regarding patients' spinal conditions were: family doctor (48%), other orthopedic or neurosurgeon (21.7%), nonsurgical specialist (14.9%), allied health (11.1%), family (5.0%), other (3.7%), media (2.5%) and friend (1.2%). Mere referral to a spine surgeon resulted in increased level of concern (LOC) in 55% of patients. Of these, 27% specified fear of surgery as the reason for increased LOC. The effect of waiting for consultation increased LOC in 54% of patients; long wait times, increasing pain and fear of the unknown were the most widely cited reasons. **Discussion:** Although patients did not perceive lack of information to be one of their main concerns, it seems inaccurate information was likely the underlying culprit for many of their major concerns. The provision of timely and accurate information that addresses patients' specific concerns could mitigate many of the major concerns that arise before surgical consultation.

THE POSITIVE PREDICTIVE VALUE OF A REFERRAL FOR SPINAL STENOSIS. *C.S. Bailey,* P. Rosas Arellano,* Nav Chaudhary,† K.R. Gurr,* S.I. Bailey.** From the Divisions of *Orthopaedics and †Neurosurgery, University of Western Ontario, London, Ont.

Purpose: To determine the positive predictive value of the referral to treat degenerative spinal stenosis, in a consecutive patient cohort with a CT or MRI demonstrating spinal stenosis, to actually having clinical spinal stenosis. **Methods:** All patients referred to a tertiary spine centre between March 2006 and October 2007 with a clinical diagnosis of degenerative spinal stenosis and confirmatory imaging (CT or MRI) were approached by written invitation to participate in this study before their consultation. Patients were excluded if they had had previous lumbar surgery, progressive neurologic deficit or were unable to reliably complete the questionnaires. Consenting patients were administered the Oswestry Disability Index (ODI) and SF-36 at the time of both referral and consultation. At consultation, 1 of 4 fellowship-trained orthopedic spine surgeons evaluated the patient to determine the clinical diagnosis. The positive predictive value of these referred patients having degenerative spinal stenosis was determined. The ODI, SF-36 and visual analogue scale score of patients diagnosed with spinal stenosis was compared with those without spinal stenosis at both time intervals. **Results:** Between March 2006 and October 2007, 505 referrals were received: 428 had been invited to participate, and 40 invitations had yet to be mailed. Only 10 have declined participation, and 45 have been lost to follow-up. One-hundred and seventy-four patients are awaiting initial consultation. Of the 254 patients so

far evaluated, 17 satisfied exclusion criteria, leaving 234 patients. One-hundred and twenty-three subjects have a confirmed diagnosis of spinal stenosis, 20 subjects require further investigation before definitive diagnosis, and 84 have a diagnosis other than spinal stenosis. Of those patients for whom the diagnosis of spinal stenosis was excluded, 80% had mechanical back pain. **Conclusion:** The positive predictive value of a referral for spinal stenosis is 59%.

WAITING TO SEE A SPINAL SURGEON. *Mathew Coyle, Simon Dagenais, Garth Johnson, Donald Chow, Richard Moulton, Eugene K. Wai.* University of Ottawa Spine Unit, Ottawa, Ont.

Introduction: Wait times to see a spinal surgeon are perceived to be quite long, and most spinal surgeons often triage the referrals received. There has been little research documenting the wait time for a spinal surgeon consultation, efficacy of the ad hoc triage process and factors relating to this. **Methods:** A random selection of charts and referral letters of patients referred to surgeons at a single centre's spinal unit was independently reviewed. Patients were included for review if they involved a referral for an elective lumbar spinal problem. Referrals for tumours, fractures or infections were excluded. Because wait times were quite skewed, nonparametric analyses were used. **Results:** One-hundred and forty-nine patients were reviewed. The median wait time for consultation with a spinal surgeon was 13 weeks, however there was quite a significant variability with a range of 0 weeks to 3.1 years. Seventy-three percent of patients did not see a spinal surgeon within the recommended 6 weeks from referral. Referrals from specialists, presence of a CT or MRI scan report, and mention of an "acute" problem by the referring physician was associated with significantly shorter wait times. Less than 10% of referrals commented on neurologic findings, severity of symptoms and dominant location of pain. Legibility of referral, sex, radiologic findings and specification of socioeconomic status were not related to wait times. A significant majority of patients that eventually required surgery waited longer than recommended times to be seen in initial consultation. **Conclusions:** There is significant variability in wait times for consultation with a surgeon. Although some surgical candidates may be more rapidly triaged, significant proportions have unacceptable waits. Important clinical features that may help identify appropriate surgical candidates are frequently not specified in referrals. Addressing this may help improve access for appropriate patients.

LOCAL ADMINISTRATION OF MORPHINE FOR ANALGESIA FOLLOWING ILIAC CREST HARVESTING — A RANDOMIZED CONTROLLED TRIAL. *Tom Polis,* Garth Johnson,† Donald Chow,† Joseph O'Neil,† Seyan Sathiaselan,‡ Robin Cardman,§ Eugene K. Wai.†* From the *Department of Anaesthesia, †Spine Unit, ‡Division of Orthopaedic Surgery and §Faculty of Medicine, University of Ottawa, Ottawa, Ont.

Introduction: Harvesting of iliac crest graft for spinal fusions is associated with a number of patients reporting residual pain at the harvest site. Various interventions, including morphine infiltration, have been proposed to minimize the pain associated with this. **Methods:** A double-blinded, placebo and randomized controlled study was performed comparing intra-

operative infiltration of 5 mg of morphine (treatment) versus saline (placebo) into the iliac crest harvest site for patients undergoing elective spinal surgery. Patients with myelopathy, excessive preoperative opioid use (60 mg equivalent morphine/day or more) or multilevel (greater than 3 levels) spinal surgery were excluded. Postoperative administration of morphine (recovery room and patient controlled analgesia) was standardized. Numeric pain scores specific for the iliac crest site were determined in the immediate postoperative period and at 3, 6 and 12 months. Ad hoc power analysis demonstrated that 36 patients would be able to detect a clinically significant difference of 2 points on a 10-point numerical pain scale ($\alpha = 0.05$, power = 80%). **Results:** Thirty-seven patients were randomized and evaluated with a minimum of 1 year follow-up. The groups were similar in baseline age, sex and comorbidity. There was no significant difference between groups in total use of postoperative morphine during the first 24 hours (treatment: 320 mg \pm 268 mg; placebo: 293mg \pm 182 mg; $p = 0.73$). There was no significant difference in iliac crest activity pain scores at 1 year (treatment: 1.7 \pm 3.0; placebo: 1.1 \pm 2.4; $p = 0.48$) or at any of the earlier time points. The proportion of patients with moderate to severe iliac crest pain at 1-year follow-up was the same between both groups. **Conclusions:** This study has demonstrated that there are no additional benefits for the use of intraoperative infiltration of morphine into the iliac crest harvest site during spinal fusions.

A LONG-TERM RADIOGRAPHIC AND CLINICAL EVALUATION OF A NEW rhBMP-2 FORMULATION IN A PROSPECTIVE RANDOMIZED LUMBAR POSTEROLATERAL SPINE FUSION STUDY. *Edward Abraham, David Alexander, Stewart Bailey, John Hurlbert, Robert McBroom, James Mahood, Charles Fisher.* Atlantic Health Sciences Corporation, Saint John, NB.

Introduction: A government-regulated, Canadian, multicentre study was conducted comparing outcomes using rhBMP-2/BCP as an alternative to iliac crest bone graft (ICBG) in patients undergoing instrumented 1- or 2-level lumbar posterolateral fusions for degenerative disc disorders. **Methods:** Ninety-seven patients were enrolled in this prospective, randomized study. Depending on number of levels treated, rhBMP-2/BCP patients received either 20 or 30 cc ceramic granules consisting of 60% hydroxyapatite/40% tricalcium phosphate administering a concentration of 2 mg rhBMP-2/mL (Medtronic Sofamor Danek). Local bone was not used in either group. Clinical evaluations were done preoperatively, at discharge and at 1.5, 3, 6, 12, 24 and 48 months including Oswestry disability index, SF-36 and back, leg and donor site pain scores. Thin-slice CT scans and x-rays were independently assessed at 6, 12, 24 and 48 months. Fusion criteria including bridging tribecular bone, 3-mm translation, $< 5^\circ$ angulation and no revision for pseudarthrosis. **Results:** Forty-nine patients (32 1-level) received ICBG; 498 patients with comparable demographics (36 1-level) received rhBMP-2/BCP. Operative time, blood loss and hospital stay trended lower in the rhBMP-2/BCP group, without statistically significant difference. Seventy-seven patients were evaluated at 48 months. Two patients died, and 3 patients were lost to follow-up. Both groups exhibited continuous improvement in Oswestry scores, with rhBMP-2/BCP patients averaging a 29.2

improvement compared with 23.1 for ICBG patients. Significant improvements in SF-36, back and leg pain scores were achieved early and maintained for 48 months in both groups. Control patients reported an average donor site pain of 3.3/20 at 48 months, which was reduced slightly from 4/20 at 24 months. At 48 months, 93.9% of rhBMP-2/BCP patients were fused versus 78.1% of ICBG patients. **Discussion:** rhBMP-2/BCP may be a suitable alternative to ICBG and may produce improved fusion success rates while avoiding the long-term morbidity associated with ICBG harvesting.

PROSPECTIVE RANDOMIZED CONTROLLED STUDY COMPARING A DBM-CaSO₄ COMPOSITE GRAFT AND BONE MARROW ASPIRATE WITH AUTOLOGOUS ILIAC CREST BONE GRAFT IN 1-LEVEL AND 2-LEVEL LUMBAR AND LUMBOSACRAL SPINAL FUSIONS. *David Alexander, William Oxner, Alexandra Sorocanu, Adrienne Kelly, Donna Shakespeare.* Department of Orthopaedic Surgery, Dalhousie University, Halifax, NS.

Introduction: The current gold standard for spinal arthrodesis, autologous bone graft harvested from the iliac crest, has several disadvantages including donor site morbidity, blood loss, delayed wound healing and increased operative time. Our study explores a demineralized bone matrix–calcium sulfate (DBM-CaSO₄) composite graft with autologous bone marrow aspirate (BMA), and compares it to autologous iliac crest bone graft in lumbar and lumbosacral spinal fusions with internal fixation. **Methods:** A total of 80 patients were recruited for the study and randomized, via a computer-generated randomization schedule, to autologous iliac crest bone graft (control) or DBM-CaSO₄ composite graft with BMA (study) groups. Patients were evaluated at 3, 6 and 12 months postoperatively with questionnaires to evaluate clinical outcome (Oswestry disability questionnaire, visual analogue pain scales [VAS], validated SF-36 and North American Spine Society [NASS]) and with posteroanterior and lateral x-rays of the spine to evaluate radiologic outcome. **Results:** At 12 months postoperatively, there were no statistical differences seen between the 2 groups based on the clinical outcomes measured. Average Oswestry disability index values were 22.89 for the control group and 22.43 for the study group ($p = 0.892$). The average back VAS pain for the control group was 3.54 cm and 3.38 cm for the study group ($p = 0.759$). There were, however, differences in operative time and blood loss between the 2 groups. The average operative time was 115.7 minutes for the control group versus 104.2 minutes for the study group ($p = 0.014$). Average calculated blood loss was 571.9 mL for the control group versus 438.2 mL for the study group ($p = 0.025$). **Discussion/Conclusions:** At 1-year follow-up, the DBM-CaSO₄ and BMA composite demonstrated functionally equivalent clinical outcomes to autologous iliac crest bone graft in lumbar spinal fusions with internal fixation while offering potential reduction in operative time and blood loss.

MECHANICAL AND BIOLOGICAL INVESTIGATION OF A NOVEL HYALURONAN AND ELASTIN-LIKE POLYPEPTIDE NUCLEUS PULPOSUS SCAFFOLD. *Isaac Moss,* Lyle Gordon,* Kimberly Woodhouse,* Cavi Whyne,*† Albert Yee.*†* From the *University of Toronto and †Sunnybrook Health Sciences Centre, Toronto, Ont.

Purpose: This study was designed to investigate a modified synthetic hyaluronan (HA) and elastin-like polypeptide (EP) composite material as a potential tissue engineering scaffold to reconstitute the nucleus pulposus in early degenerative disc disease. **Methods:** Thiol-modified HA (TMHA) and elastin-like polypeptides (EP) were combined in various concentrations and cross-linked using poly(ethylene glycol) diacrylate. Resulting materials were loaded in confined compression to determine their biphasic material properties. Human intervertebral disc (IVD) cells were then isolated from surgical specimens and seeded into either TMHA-only or composite TMHA/EP scaffolds and cultured for 3 weeks. At 1 and 3 weeks of incubation, constructs were imaged by confocal microscopy to determine cell viability. Reverse transcription polymerase chain reaction (RT-PCR) was employed to evaluate gene expression for aggrecan, types I and II collagen, CD24 and versican. **Results:** Mechanical testing revealed an aggregate modulus of 15.8 KPa (± 4.5) for TMHA-only gels and 25.2 KPa (± 6.3) for TMHA/EP4 gels. The material exhibited biphasic nonlinear viscoelastic behaviour, and, thus, a single measure of hydraulic permeability could not be determined. Human IVD cells were found to be 80% and 83% viable at 1 week, and 78% and 74% viable at 3 weeks in TMHA and HA/EP gels, respectively. RT-PCR revealed that cells seeded in both scaffold formulations expressed aggrecan, collagen I, collagen II and CD24 at 1 and 3 weeks. No versican expression was found in either formulation at either time point. **Conclusions:** TMHA and TMHA/EP scaffolds tested in this study exhibit mechanical properties different from native nucleus pulposus tissue. Addition of EP does result in stiffer constructs. The in vitro experiments demonstrate that TMHA-based hydrogels provide an excellent biologic environment for the culture of human IVD cells, maintaining both viability and apparent phenotype over a 3-week period. The addition of EP did not have a significant effect on IVD cell function in the experiments conducted.

CERVICAL DISC ARTHROPLASTY VERSUS ANTERIOR CERVICAL DISCECTOMY AND FUSION: PROSPECTIVE RANDOMIZED TRIAL. *Najmedden Attabib, Stephan duPlessis, Steven Casha, John Hurlbert.* University of Calgary, Calgary, Alta.

Objectives: To prospectively compare the clinical and radiologic outcomes of patients treated with Bryan disc arthroplasty (BDA) to patients treated with the traditional anterior cervical discectomy and fusion (ACDF). **Methods:** We prospectively randomized 43 patients with cervical disc disease; 28 with radiculopathy, 7 with myelopathy and 8 patients with both. Twenty patients were randomized to the ACDF group and 23 to the BDA group. All patients had preoperative (baseline) clinical evaluation, radiologic assessment (including flexion/extension x-rays) and self-assessment questionnaires (visual analog scale, McGill pain questionnaire, neck disability index, SF-36 health survey). These parameters were repeated on follow-up assessments. Changes in the end plate angle and the range of motion were calculated from pre- and postoperative flexion/extension x-rays. The median period for the current follow-up was 6 months. However, we planned for 10 years' follow-up. **Results:** The mean loss of motion in the fusion group was 4.28° compared with 0.5° for the BDA group.

This difference between the 2 groups was statistically significant ($p = 0.007$). Among the BDA group, 44% of patients exhibited decreased range of motion at the treated level, although this wasn't statistically significant ($p = 0.659$). Among the fusion group, there was statistically significant loss in the range of motion postoperatively compared with preoperatively ($p = 0.001$). Fourteen patients among the BDA group had a kyphotic end plate angle on the extension postoperative films (mean 1.7; 95% confidence interval 0.3–3.8). **Conclusions:** Our preliminary data analysis revealed a better range of motion in BDA group patients with a propensity toward kyphosis. A longer follow-up is required to assess the durability of the prosthesis as well as the progression of adjacent level degeneration.

ONE-YEAR CLINICAL AND RADIOLOGIC COMPARISON OF MACHINED ALLOGRAFT TLIF AND ACTIPORE PLIF INTERVERTEBRAL FUSION. *Peter Jarzem, Asim Al Daberi, Rudy Reindl, Jean Ouellet.* McGill University, Montréal, Que.

Introduction: Intervertebral fusion with intervertebral fusion devices (IVFD) is one of the most frequently performed spinal surgeries. Clinical outcome following fusion depends on many factors, including the fusion rate. Fusion rate may vary with the device employed and with the surgical technique. In this study we compare 2 different devices to determine if there is a difference in fusion rate or a difference in patient outcome at 1-year follow up. **Methods:** Forty patients with porous titanium-nickel (Actipore) and 40 patients with machined allograft spacers (Synthes TPLIF) IVFDs were compared for their clinical and radiologic outcomes. Clinical outcome was measured using the Oswestry disability index, and radiologic fusion was measured from plain films using a radiologic fusion score. **Results:** There were significant differences in baseline factors including insurance status, number of levels fused and age, but not in smoking status, sex, body mass index, blood loss and number of complications. Clinical outcome as measured by the Oswestry questionnaire improved for all 80 patients at every time point in the postoperative period. There were no significant differences for the porous titanium-nickel and the machined allograft patients in their Oswestry scores at any time point. Fusion rates as measured by the radiologic fusion score were different. In the porous titanium-nickel group there was 1 nonunion, and in the machined allograft group there were 5 nonunions ($p = 0.083$). **Conclusions:** Clinical results are no different at 1 year with the 2 devices, while nonunion rates appear to be higher in the machined allograft group.

AGE AND COMORBIDITY INDICES AS POTENTIAL PREDICTORS OF CLINICAL OUTCOMES IN PATIENTS WITH ACUTE SPINE TRAUMA: A RETROSPECTIVE COHORT STUDY OF 261 PATIENTS. *Julio Furlan,* Deepa Kattail,† Michael Feblings.†‡* From the *Toronto Western Hospital, University Health Network, the †Krembil Neuroscience Centre and the ‡Toronto Western Hospital and University of Toronto, Toronto, Ont.

Introduction: This study was undertaken to evaluate whether age at time of injury and comorbidity indices are predictors of in-hospital mortality and length of stay in an acute spinal cord injury (SCI) care facility. **Methods:** All consecutive patients

with acute spine trauma who were admitted to our acute SCI care facility from 1995 to 2000 were included. Severity of injury was classified using the ASIA Impairment Scale (AIS). The Charlson comorbidity index (CCI) and Cumulative Illness Rating Scale (CIRS) were derived from our database. Also, the number of ICD-9 codes (ICD9) was used as another comorbidity index. Data were analyzed using Fisher's exact test, Mann-Whitney U test, and logistic, linear and Cox regression analyses. **Results:** There were 184 male and 77 female patients with a mean age of 49.7 (15–96) years. Most patients had spine trauma without SCI (AIS E: 127/261) or mild SCI (AIS D: 86/261) at cervical (166/261) or lumbar levels (46/261). Falls (127/261) and motor vehicle accident (76/261) were the most frequent injury causes. In-hospital mortality rate was 4.6%. This clinical outcome was significantly associated with age (hazard ratio [HR] = 3.503, $p = 0.0011$), CCI (HR = 1.659, $p < 0.0001$), ICD9 (HR = 1.317, $p = 0.0055$) and CIRS (HR = 1.174, $p = 0.0008$). Mean length of stay (LOS) was 23 (1–852) days. After controlling for potential confounders (sex, AIS, level and cause of injury), LOS was not significantly associated with the patient age ($p = 0.862$), ICD9 ($p = 0.314$) or CIRS ($p = 0.251$), but LOS was directly correlated with CCI ($R^2 = 0.207$, $p = 0.042$). **Discussion:** Our results suggest that age, CCI, ICD9 and CIRS are potential predictors of in-hospital mortality after acute spine trauma. However, only CCI could potentially predict the LOS in the acute care SCI facility.

AIRWAY COMPROMISE SECONDARY TO UPPER CERVICAL SPINE INJURY. *Sami Aeissa, Jeremy Reed, J.B. Kortbeek, Paul Salo.* University of Calgary, Calgary, Alta.

Introduction: Airway compromise secondary to isolated injury at C1 and/or C2 without an associated neurologic injury is a rare but recognized phenomenon that results in significant morbidity and mortality. No previous study in the literature has reported the incidence of this potentially lethal complication of these relatively common fractures. The objective of this study is to determine the incidence of airway compromise following C1 and/or C2 fractures and to ascertain associated risk factors. **Methods:** This is a retrospective cohort study. The medical records for 625 consecutive patients who presented to a level 1 trauma centre with C1 and/or C2 fractures during the years from 1996 to 2005 were reviewed retrospectively. Strict inclusion and exclusion criteria were applied to identify adult patients with isolated fractures. All patients that developed significant airway compromise were identified, and correlations with the patients' demographic features, clinical presentation and radiologic findings were done, to assess the potential risk factors. **Results:** During the 10 years studied, 451 patients with isolated C1 and/or C2 fractures were identified. Of these, 17 patients developed significant airway compromise. This represents a 3.8% incidence of this potentially life-threatening complication. Older age and male sex were found to be risk factors with a statistically significant association ($p < 0.05$). Other notable criteria include prevertebral swelling, the presence of significant degenerative changes and displaced fractures. Twelve patients required intubation and admission to the intensive care unit for an average of 5 days. Four patients died due to apnea or hypoxic encephalopathy.

Discussion: Airway compromise is a potentially catastrophic complication that could follow isolated C1 and/or C2 fractures. The etiology is unclear and could be multifactorial. Patients with these injuries require continuous respiratory monitoring in order to detect developing respiratory obstruction at an early stage.

FRACTURE AT THE END OR ADJACENT LEVEL POST SPINAL FUSION AND INSTRUMENTATION. *Edward Abraham, Neil Manson.* Atlantic Health Sciences Corporation, Saint John, NB.

Introduction: Adjacent segment degeneration (ASD) following instrumented spinal fusion has been well described. Severe collapse or fracture of the proximal or distal instrumented vertebrae or adjacent noninstrumented vertebrae (ASF) remains unreported. Segmental instability or neurologic involvement can necessitate major revision surgery. Etiology and risks factors remain unproven. This study assessed ASF to determine (1) incidence and (2) prognostic factors for recurrence. **Methods:** A prospective database identified posterior instrumented spinal procedures performed between 2005 and 2007. Radiographic review identified and defined cases of ASF. Preoperative diagnosis, spinal alignment, fusion levels, instrumentation, neurologic course, ASF characterization and treatment required were evaluated. **Results:** Two-hundred and seventy-six procedures were performed; 77 (28%) demonstrated ASD and 32 (12%) demonstrated ASF via radiographic assessment. Of the 32 cases, 20 (63%) demonstrated neurologic injury and 22 (69%) required revision surgery. The remaining 10 (31%) did not require revision surgery. Of the 10 treated nonoperatively, neurologic status remained stable, and ASF morphology did not progress. Prognostic factors for ASF included increased age, decreased bone quality and multiple fusion levels. Fracture severity, ligamentous incompetence and spinal alignment correlated with neurologic injury and revision surgery. **Discussion:** The incidence of ASF was 12% and occurred early in the postoperative period. ASF is associated with a very high rate of neurologic injury and revision surgery. Major reconstruction was required in all cases requiring surgery, extending the instrumentation well above or below the fracture area. Adjacent segment severe collapse or fracture is a clinically significant entity requiring further study to aid in its prevention.

THE IMPACT OF PATIENT EXPECTATIONS ON OUTCOME FOLLOWING TREATMENT FOR SPINAL TRAUMA. PART 1: WHAT ARE SPINE SURGEONS TELLING THEIR PATIENTS? *Darin Davidson, Marcel Dvorak, Charles Fisher.* University of British Columbia, Vancouver, BC.

Introduction: Many factors can influence the perception of patient satisfaction following treatment, including patient expectations. The impact of patient expectations on outcome following treatment has been demonstrated in an elective setting in the orthopedic literature. It is reasonable to anticipate that there will be a similar, if not greater, impact on outcome in a trauma setting, however this has not yet been studied. It is the objective of this study to determine the impact of patient expectations on outcome following treatment of spinal trauma by first determining what information is provided by

spine surgeons to their patients. **Methods:** A case-based questionnaire was developed to determine the information provided by spine surgeons to their patients. There were 3 questionnaires which each consisted of 5 cases and were grouped by cervical spine trauma, thoracolumbar spine trauma and spinal cord injury. These questionnaires were distributed to members of the spine trauma study group as well as members of our division. Statistical analysis consisted of rank order correlation for categorical data and intraclass correlation coefficients for continuous data in order to determine agreement among the respondents. **Results:** Questionnaires were sent to 54 surgeons, and 31 responses were received (57%). In each of the 3 categories of cases, the agreement among the responses to the questions was poor, indicating poor agreement among the surgeons regarding the information provided to patients. **Discussion:** This study demonstrated substantial variability in the information provided by spine surgeons to their trauma patients. It is anticipated that the results of this study will provide evidence to improve the quality of information provided to spinal trauma patients, thereby allowing their expectations to be more appropriate, potentially maximizing their outcome.

USE OF QUALITATIVE AND QUANTITATIVE MRI PARAMETERS AS POTENTIAL PREDICTORS OF MOTOR/SENSORY IMPROVEMENT IN PATIENTS WITH ACUTE CERVICAL TRAUMATIC SPINAL CORD INJURY (SCI): A MULTICENTRE PROSPECTIVE STUDY OF 60 PATIENTS. *Julio Furlan,* Bizhan Aarabi,† Michael Feblings.‡* From the *Toronto Western Research Institute, University Health Network, Toronto, Ont., the †University of Maryland, Baltimore, Md., and the ‡Krembil Neuroscience Centre, Toronto Western Research Institute and University of Toronto, Toronto, Ont.

Introduction: This multicentre prospective cohort study examines whether quantitative and qualitative MRI parameters post-SCI are predictors of neurologic recovery at long-term follow-up. **Methods:** Clinical data and MRI studies from consecutive patients with traumatic cervical spinal cord injury (SCI) were collected prospectively. Neurologic improvement was defined as 1-grade conversion in the ASIA Impairment Scale (AIS). An independent observer examined MR images and assessed 6 qualitative and 3 quantitative parameters. The study population was divided into patients who had the same AIS on admission and at follow-up (Group 1) and patients who had at least 1 AIS-grade conversion between admission and latest follow-up (Group 2). **Results:** There were 46 male and 14 female patients with a mean age of 47 (19–79) years. Mean follow-up was 6.7 (1–24) months. Most patients had incomplete SCI (68.3%). Both groups were comparable regarding age ($p = 0.64$), sex ($p = 0.13$) and follow-up ($p = 0.46$). Patients in Group 1 had more severe SCI than patients in Group 2 ($p = 0.007$). Univariate analyses indicated that there was a trend for an association of neurologic improvement with the absence of hemorrhage ($p = 0.09$) and smaller length of lesion ($p = 0.08$). The other qualitative (edema, disc herniation, canal stenosis, swelling, soft tissue injury) and quantitative parameters (maximum spinal cord compression and maximum canal compromise) did not significantly correlate with neurologic improvement. **Discussion:** MRI parameters appear to be useful in prognosticating the potential for

neurologic improvement post-SCI. Smaller length of lesion and the absence of hemorrhage, observed at admission, might be associated with at least 1-grade conversion in the AIS.

A PROSPECTIVE, MULTICENTRE TRIAL TO EVALUATE THE ROLE AND TIMING OF DECOMPRESSION IN PATIENTS WITH CERVICAL SPINAL CORD INJURY: INITIAL 1-YEAR RESULTS OF THE STASCIS STUDY. *Michael Fehlings,* Alexander Vaccaro,† Raja Rampersaud,* Eric Massicotte,* Stephen Lewis,* Bizhan Aarabi,‡ Christopher Shaffrey,§ Marcel Dvorak,¶ Charles Fisher.¶* From the *University of Toronto, Toronto, Ont., †Thomas Jefferson University, Philadelphia, Pa., ‡University of Maryland, Baltimore, Md., §University of Virginia, Charlottesville, Va., and the ¶University of British Columbia, Vancouver, BC.

Introduction: The role and timing of decompression in patients with spinal cord injury (SCI) remains controversial. Systematic literature reviews support a biological rationale for early decompressive surgery to attenuate secondary injury; however, the clinical data to support this approach are preliminary at best. The purpose of this study is to evaluate the role and timing of decompressive surgery on neurologic outcome in a consecutive series of patients with cervical SCI. **Methods:** Patients with a subaxial cervical SCI (ASIA A–D) and CT/MRI evidence of canal/cord compression were entered into prospective, multicentre, cohort study at 10 centres in Canada and the US. Decompression was achieved by either traction and/or surgical decompression. Patients were stratified into “early” (< 24 hours) or “delayed” (> 24 hours) groups based on the time to decompression. All patients underwent postoperative CT/MR imaging to confirm the adequacy of decompression. Outcomes were assessed using the standardized ASIA system at 6 months and 1 year postinjury. **Results:** To date, 151 patients (mean age 41.6 ± 17.3; 78.3% M, 21.7% F) have been entered into the trial. The distribution of SCI severity was as follows: ASIA A (44.1%), B (14.5%), C (20.4%) and D (21.1%). There were no significant differences in age, sex, ASIA level or medical comorbidities between the early and delayed groups. To date, 6-month and 1-year follow-up has been obtained in 95 and 31 cases, respectively. At 1-year follow-up, 25% of the patients in the early decompression group had a ≥ 2 grade improvement in the ASIA score compared with 0% in the delayed group ($p = 0.009$). **Discussion:** These preliminary results from the ongoing STASCIS study suggest that decompression within 24 hours may be associated with improved neurologic recovery at 1-year follow-up. Further recruitment of patients with long-term follow-up is required to validate these initial promising results.

RESULTS OF A PROSPECTIVE, MULTICENTRE PHASE I/IIA CLINICAL TRIAL TO EVALUATE SAFETY AND PRELIMINARY EFFICACY OF A RECOMBINANT RHO INHIBITOR (CETHRIN) IN SEVERE ACUTE SPINAL CORD INJURY. *Michael Fehlings,* Gilles Maurais,* James Harrop,† Nicholas Theodore,‡ Christopher Shaffrey,§ Charles Kuntz,¶ Brian Kwon,** Jens Chapman,†† Albert Yee.** From the *University of Toronto, Toronto, Ont., †Thomas Jefferson University, Philadelphia, Pa., ‡Barrow Neurological Institute, Phoenix, Ariz., §University of Virginia, Char-

lottesville, Va., the ¶Mayfield Clinic, Cincinnati, Ohio, the **University of British Columbia, Vancouver, BC, and the ††University of Washington, Seattle, Wash.

Introduction: Cethrin, a recombinant engineered protein, formulated with a fibrin sealant for epidural administration, inactivates the Rho/ROCK pathway and promotes recovery in animal models of spinal cord injury (SCI). Based on these promising preclinical data, we undertook a prospective phase I/IIa clinical trial to evaluate Cethrin in patients with acute SCI. **Methods:** Thirty-seven subjects with ASIA A complete cervical ($n = 13$) or thoracic ($n = 24$) SCI were enrolled in a phase I/IIa study at 9 sites in Canada and the US to evaluate the safety, tolerability, pharmacokinetics and potential neurologic benefits of Cethrin at doses of 0.3, 1, 3 and 6 mg. **Results:** Nine serious adverse events have been reported — none related to Cethrin. Two events resulted in mortality (1 from acute respiratory distress syndrome; 1 from a recurrent glioblastoma multiforme). Neurologic outcomes were assessed using ASIA standards at 0, 1.5, 3, 6 and 12 months. Data were analyzed using a response definition of improvement by at least 2 grades (AIS C or better). Six months after treatment, a clinically significant improvement (2- or 3-grade improvement in AIS scores) was evident in 38% of cervical subjects. Subjects with thoracic SCI did not improve as rapidly or frequently, with 8% showing a significant improvement after 6 months. Complete 12-month data will be available at the time of the CSS meeting. **Discussion:** Cethrin applied as a single epidural dose during decompression surgery is safe in patients with acute SCI. Rates of neurologic recovery appear promising and appear to justify proceeding with a phase III prospective randomized controlled trial.

EVALUATION OF RISK FACTORS FOR INFECTION FOLLOWING SACRAL TUMOUR RESECTION: A 5-YEAR INSTITUTIONAL EXPERIENCE. *Daniel Sciubba, Clarke Nelson, Joseph Noggle, Greg McLoughlin, Beryl Gok, Jean Paul Wolinsky, Ziya Gokaslan.* Johns Hopkins University, Baltimore, Md.

Background: Surgical treatment for sacral tumours has been shown to improve survival since oncologic prognosis is commonly correlated with extent of local tumour control. However, extensive soft tissue resection close to the rectum may predispose patients to infection. Review of clinical outcomes for sacral tumour resections over the last 5 years at a single institution was completed, paying special attention to procedure-related complications. **Methods:** Between 2002 and 2007, 47 patients with sacral tumours were treated with surgery. Demographic data, details of surgery, tumour type and patient characteristics associated with surgical site infections were collected, including presence of diabetes, obesity, smoking, steroid use, previous surgery, previous radiation, cerebrospinal fluid leak, number of spinal levels exposed, instrumentation, albumin level and combined anterior–posterior approaches. Univariate analysis was implemented to find association of such variables with presence of wound infection. **Results:** A total of 47 patients were treated, 21 male (45%) and 26 female (55%) with an average age of 46 (range 11–83) years. Histopathologies included chordoma in 19 (40%), ependymoma in 6 (13%), rectal adenocarcinoma in 5 (11%),

giant cell tumour (GCT) in 4 (9%) and other in 13 (28%). There were 18 cases of wound infection (38%) and 2 cases of repeat surgery for tumour recurrence (1 chordoma, 1 GCT). Variables associated with a statistically significant increased likelihood of infection included previous lumbo-sacral surgery and increasing age. Perioperative serum albumin and loss of bowel/bladder control were associated with a trend toward increased likelihood of infection. **Conclusions:** Patients undergoing sacral tumour surgery may be at greater risk for developing wound complications due to extensive soft tissue resection, especially with the increased potential for contamination from the neighbouring rectum. In this study, it appears that age, previous lumbo-sacral surgery, albumin level and loss of bowel/bladder control may predict those patients more prone to developing postoperative wound complications.

DEFINING ONCOLOGIC SPINAL INSTABILITY. *Timothy Ryken,* Charles Fisher,† Shane Burch,‡ Mark Bilsky,§ Michael Fehlings,¶ Daryl Fourney,** Frank Vrionis,†† Chris Shaffrey.##* From the *University of Iowa, Iowa City, Iowa, the †Vancouver General Hospital, Vancouver, BC, the ‡University of California, San Francisco, Calif., the §Memorial Sloan-Kettering Cancer Center, New York, NY, the ¶University of Toronto, Toronto, Ont., the **University of Saskatchewan, Saskatoon, Sask., the ††H. Lee Moffitt Cancer Center, Tampa, Fla., and the ##University of Virginia, Charlottesville, Va.

Introduction: The purpose of this project was to develop a working definition and classification for oncologic spinal instability. **Methods:** A group of 24 orthopedic and neurosurgical spine surgeons and oncologists with expertise in the area of spinal oncology were asked to list factors relevant to the definition of spinal instability in the oncology setting. The results were used to generate a 4-part survey addressing mechanical instability including: clinical features (12 items), radiographic features (12 items), anatomic location (9 items) and other (open-ended response). All participants then ranked these factors from 0 to 100 (0 indicating nonrelevance and 100 indicating absolute importance). The open-ended responses were compiled and included in the final results. The results were divided based on scoring into 3 groups — highly relevant (> 70), relevant (40–70), less relevant (< 40) — and used for a consensus-based discussion to develop a working definition of oncologic spinal instability and a draft of a classification scheme. **Results:** All 24 physicians ranked the resulting 40 factors. Nine factors scored greater than 70 and 19 scored between 40 and 70. The highest ranked factors included subluxation/translation (86.67 ± 11.95), progression of deformity (86.52 ± 13.60), facet destruction bilateral (78.75 ± 13.85), character of neurologic changes (with motion) (77.71 ± 19.89) and mechanical pain (pain that is worse with movement) (75.4 ± 25.2). The anatomic areas of most concern were occipitocervical junction (70.83 ± 16.33) and cervicothoracic junction (72.29 ± 21.01). **Discussion:** Based on the relative rankings and consensus debate, a working classification scheme was developed to begin reliability and validation testing. Based on the survey results and consensus discussion, oncologic spinal instability was defined as a loss of spinal integrity as a result of a neoplastic process that is associated

with movement-related pain, symptomatic or progressive deformity and/or neural compromise under physiologic loads.

ONCOLOGIC INSTABILITY OF THE CERVICAL SPINE — A SYSTEMATIC REVIEW. *Michael G. Fehlings,* Kenny S. David,* Julio C. Furlan,* Mark A. Bilsky,† Daryl R. Fourney,‡ Frank D. Vrionis,§ Meic H. Schmidt.¶* From the *Toronto Western Hospital Spinal Program, Toronto, Ont. the †Memorial Sloan-Kettering Cancer Center, New York, NY, United States, the ‡University of Saskatchewan, Saskatoon, Sask., the §H. Lee Moffitt Cancer Center, Tampa, Fla., and the ¶University of Utah, Salt Lake City, Utah.

Introduction: Neurological injury may result from neoplastic involvement of the cervical spine either due to direct compression of the spinal cord by tumour tissue, or from of mechanical instability of the cervical vertebral column causing secondary effects on the neural elements, or from a combination of the 2 processes. Defining instability and impending instability is critical to selecting cases for instrumented stabilization before potential neurologic injury may occur. A systematic review was performed to gather evidence-based data toward providing a working definition as well as guidelines for the diagnosis of clinical instability or impending instability. **Methods:** A literature search using standard databases (EMBASE and MEDLINE) and the search terms ‘cervical vertebra’ and ‘neoplasm’ was performed. Two authors independently reviewed all abstracts. Articles meeting predefined criteria were evaluated to assess methodological quality, and relevant data were extracted. Authors gave specific attention to identifying criteria in the literature that have been used to indicate the presence (or absence) of mechanical instability. **Results:** One-thousand, one-hundred and forty-six (1146) articles were identified via the initial literature search. Thirty-eight studies met all predefined inclusion and exclusion criteria. **Discussion:** Although there are no level-1 and level-2 studies which address this issue, information from level-3 studies demonstrates the following consistent themes: tumour size, location (anterior, posterior or combined), bone density (osteolytic or osteoblastic) and radiosensitivity may all be factors in determining the extent of instability caused by a neoplastic lesion. Mechanical (activity-related) neck pain is a consistent feature of oncologic instability. Radiologic involvement of more than 50% of the vertebral body, involvement of the end plates, as well as sagittal plane translation and/or angulation may all represent instability situations. Due to the paucity of level-1 and -2 evidence, there is a clear need for directing clinical research to answer the fundamental question of impending/overt instability in the neoplastic cervical spine.

UNILATERAL PEDICLE SCREW FIXATION WITH TRANSFORAMINAR LUMBAR INTERBODY FUSION: DOES LESS MEAN MORE? *Raphael Lotan, Yigal Bronstein, Rupert Indar, Michael Ford, Albert Yee, Joel Finkelstein.* University of Toronto, Toronto, Ont.

Introduction: Instrumented lumbar fusion is commonly performed for spinal stenosis associated with instability. The advent of interbody fusion (IF) devices has made the necessity of posterolateral fusion unnecessary, and pedicle screw fixation

with IF is necessary to provide initial stability until the anterior construct fuses. Transforaminal lumbar interbody fusion (TLIF) is a technique that avoids the morbidity of an anterior approach and the nerve root manipulation of a posterior interbody fusion. The unilateral TLIF and pedicle fixation procedure limits dissection of the spine to 1 side, is less invasive and has obvious benefits to the patient with less morbidity if the outcome is similar to bilateral surgery. **Methods:** Prospective data were collected in 27 patients undergoing a 1-level TLIF for degenerative lumbar conditions with instability. Ten patients underwent a unilateral TLIF procedure in conjunction with posterior unilateral pedicle screw fixation, while 19 patients underwent unilateral TLIF with bilateral pedicle screw fixation. Outcome measurement was done using the Short Form 36 (SF-36). Average follow-up time was 3 months and 7.6 months, respectively. **Results:** SF-36's physical component average improvement was 13.75 in the unilateral pedicle fixation compared with 9.39 in the bilateral pedicle fixation. SF-36's mental component improvement was 11.01 and 4.38, respectively. These differences were statistically significant. **Discussion:** Unilateral posterior pedicle fixation in combination with a TLIF is a viable treatment option with comparable results in generic health outcome measures. The decreased patient morbidity from the approach likely contributes to this outcome without any compromise in the goals of surgery. We have demonstrated better results at the short-term follow-up, which may indicate quicker rehabilitation potential and early return to normal function. Our results also raise questions regarding the amount of rigidity needed for a successful IF. Longer term follow-up is needed to determine this procedure's efficacy.

OUTCOMES AND FAILURES OF MIS DECOMPRESSION FOR FOCAL LUMBAR SPINAL STENOSIS IN PATIENTS WITH AND WITHOUT DEFORMITY. *Michael Kelleher, Marcus Timilin, Raja Rampersaud.* Toronto Western Hospital, University of Toronto, Toronto, Ont.

Introduction: Minimally invasive, facet-preserving decompression offers a significantly less morbid alternative to fusion in patients with symptomatic degenerative spondylolisthesis and/or scoliosis. The purpose of this study was to evaluate the clinical efficacy of minimally invasive surgery (MIS) decompression for focal lumbar spinal stenosis (FLSS) in patients with and without deformity. **Methods:** A single-surgeon, consecutive series ($n = 78$) was prospectively evaluated over 5 years. All patients had MIS lumbar laminoplasty for FLSS (1–2 level). Patients had leg-dominant, claudicant pain. Patients were divided into 4 groups: (A) stenosis with no deformity, $n = 22$; (B) stenosis with spondylolisthesis only, $n = 25$; (C) stenosis with scoliosis, $n = 16$ and (D) stenosis with spondylolisthesis and scoliosis, $n = 12$. The primary clinical outcome measures were the Oswestry disability index (ODI) and surgical revision rate. Pre- and postoperative standing radiographs were assessed. **Results:** The average age was 68 (74–87) years with a mean time from surgery of 26.5 (10–59) months. Average clinical improvement in ODI was 48.4% to 26.2% (mean of 13.5, 2–55 months). Incidence of preoperative grade 1 slip was 46%. Slip progression (mean 8.4%) occurred in 9 patients; new slips occurred in 2. Revision rate (repeat decompression alone ($n = 2$) and decompression + fusion ($n = 6$) was 10%.

Subgroup analysis of pre- and postoperative ODI and revision rate revealed (A) 48%–19.2%, %0; (B) 48%–28%, 4%; (C) 50.7%–33%; 25% and (D) 48%–27%, 25%, respectively. The revision rate for patient with scoliosis (C+D) was statistically significant ($p = 0.0035$). Six of the 8 revised patients had a lateral listhesis (3 in C and 3 in D). **Discussion:** Day surgery decompression for FLSS is clinically effective in the majority of patients, including those with degenerative spondylolisthesis. However, patients with scoliosis and lateral listhesis have a significantly higher revision rate that needs to be considered in operative decision-making.

POSTERIOR LUMBAR INTERBODY FUSION (PLIF) PROCEDURE FOR DEGENERATIVE LUMBOSACRAL DISEASE VIA A MINIMALLY INVASIVE APPROACH: A RETROSPECTIVE COMPARATIVE STUDY. *Nicolas Marcotte, Michel Lacroix.* Laval University, Québec City, Que.

Introduction: Posterior lumbar interbody fusion (PLIF) is a common surgical procedure for degenerative lumbosacral disease. The classical procedure, which includes the placement of interbody and pedicle devices, necessitates a wide surgical exposure. Recently, multiple systems were developed for the placement of instrumentation by a minimally invasive and transcuteaneous route. The avoidance of extensive muscular dissection confers theoretical advantages for a minimally invasive approach. **Methods:** This is a retrospective analysis of cases comparing the classical 'open' and the 'minimally invasive' instrumentation placement for patients treated at our institution between 2003 and 2006 by 1 surgeon. Variables included: demographics, length of surgery, estimated blood loss, hospital stay, narcotic use, radiologic quality of instrumentation, complications, estimated cost and clinical outcome of patients with lumbar or lumbosacral fusion for degenerative disease of the spine at 1 or 2 segments. **Results:** There were 11 open and 32 minimally invasive surgical procedures by 1 surgeon. Both groups showed comparable demographic variables. The length of surgery was shorter in the minimally invasive group ($p = 0.02$). Estimated blood loss was diminished in the minimally invasive group ($p = 0.01$). Hospital stay was decreased in the minimally invasive group ($p = 0.02$). There was less postoperative narcotic use in the minimally invasive group ($p = 0.01$). Estimated hardware cost, radiologic quality of device placement, complication rate and outcome were comparable in both groups. **Discussion:** Posterior lumbar interbody fusion (PLIF) for patients with degenerative disease of the lumbosacral spine using a minimally invasive technique is an acceptable alternative to the conventional procedure. A minimally invasive procedure seems to provide advantages with respect to surgical time, estimated blood loss, postoperative narcotic use and hospital stay.

OPEN VERSUS MAST LUMBAR INTERBODY FUSION. *Sean Christie,* John Song,† Mathew Kiberd,* Melody Hrubes,‡ Edward Abraham,§ Richard Fessler.‡* From *Dalhousie University, Halifax, NS, †Northwestern University, the ‡University of Chicago, Chicago, Ill., and §Saint John Regional Hospital, Saint John, NB.

Introduction: Minimal access surgical techniques (MAST)

continue to evolve in the surgical management of spinal disorders. It is felt that these approaches minimize tissue damage and allow for a swifter and smoother recovery. To date there has been no published comparison of open versus MAST approaches for lumbar interbody fusion. **Methods:** A nonrandomized comparison of 2 similar cohorts of patients undergoing lumbar interbody fusion was performed. The open group received their interbody graft via a posterior (PLIF) approach. The MAST group underwent a transforaminal approach (TLIF). Both groups had supplemental pedicle screw implants, percutaneous in the MAST group. Immediate surgical outcomes and 1-year functional outcomes were compared between groups (visual analogue scale [VAS] and Oswestry). **Results:** There were 33 patients in the PLIF group compared with 63 in the TLIF group. The mean ages were 45.6 (PLIF) versus 57.4 (TLIF); $p < 0.001$. The PLIF group contained 55% males compared with 41% in the TLIF group. The L4–5 level was the most common level operated followed by L5–S1 in both groups. Grade 1 spondylolisthesis was equally common in both groups (38.7% v. 40.9%, PLIF v. TLIF, respectively). Patients in the TLIF group had a lower operative blood loss (221 ± 109 mL v. 553 ± 407 mL; $p < 0.001$) and a shorter postoperative hospital stay (86 h v. 156 h; $p < 0.0001$). At 1-year follow-up, clinical outcomes both groups were statistically equivalent ($p > 0.5$). **Conclusions:** MAST TLIF can be performed successfully on the same patient population as traditional open fusion procedures. Although the clinical outcomes are the same, the MAST TLIF group had less blood loss and a shorter hospital stay.

THE EFFECT OF A SELECTIVE NERVE ROOT BLOCK ON MOTOR SCORE IN PATIENTS WITH ACUTE SCIATICA SECONDARY TO HERNIATED NUCLEUS PULPOSUS. *Paul Bishop, Charles Fisher, Peter Wing, Marcel Dvorak.* Combined Neurosurgical and Orthopaedic Spine Program, Department of Orthopaedics, Vancouver General Hospital, University of British Columbia, Vancouver, BC.

Background: Selective nerve root block (SNRB) has been demonstrated to reduce pain and obviate the need for surgery in some patients with acute sciatica secondary to herniated disc (AS/HD). However, whether or not SNRB improves an accompanying motor deficit is at present unknown. **Purpose:** To determine if patients with AS/HD and an accompanying motor deficit who receive standardized nonoperative treatment (SNT) and an SNRB have improved motor scores when compared with patients who received SNT without SNRB. **Study design:** A prospective observational 2-arm cohort study. **Patient sample:** Inclusion criteria: ages 19–59 with AS/HD choosing nonoperative care. Lower extremity motor score deficits of 3 or 4/5. Exclusion criteria: “red flag” conditions or prior history of sciatica/lumbar spine surgery. **Outcome measures:** Change in motor score at 8, 16 and 24 weeks postbaseline assessment. **Methods:** All patients were evaluated using a standardized assessment protocol. Motor function scored out of 5 at baseline, 8, 16 and 24 weeks. Group A patients received an SNRB within 2 weeks from baseline and standardized nonoperative therapies (non-narcotic analgesic medication, reassurance and reactivation advice). Group B received the same treatment, but without an

SNRB. Ethics approval was obtained. **Results:** Forty-nine patients were recruited with 24 in Group A and 25 in Group B. Mean baseline motor scores and symptom duration were not significantly different in Groups A and B. At 8 weeks post-baseline, 60% of patients in Group A and 76% in Group B had a 5/5 motor score ($p < 0.01$); at 16 weeks postbaseline, 66% of patients in Group A and 88% in Group B had a 5/5 motor score ($p < 0.001$); and at 24 weeks postbaseline, 100% of patients in Group A and 96% in group B had a 5/5 motor score. **Conclusion:** Motor score improvement may be inhibited by the use of SNRB in patients with AS/HD.

INJECTABLE BIOPOLYMERS FOR SUSTAINED PERINEURAL DRUG RELEASE TO TREAT RADICULOPATHY. *Mohammed Shamji,* Lyman Whitlatch,† Allan Friedman,† William Richardson,† Ashutosh Chilkoti,† Lori Setton.†* From the *Ottawa Hospital, Ottawa, Ont., and †Duke University, Durham, NC.

Background: Systemic anticytokine treatment for lumbar radiculopathy offers clinical improvement but exposes patients to untoward systemic effects of immunosuppression. Elastin-like polypeptides (ELPs) are environmentally responsive polypeptides that aggregate upon heating to physiologic temperature, creating in situ forming depots from which therapeutic monomers are slowly resolubilized. This study evaluated how ELP aggregation affects protein residence time after perineural delivery to the dorsal root ganglion (DRG). **Methods:** Radiolabelled ELPs (aggregating or soluble) were injected to overlie the right L5 DRG in a rat model ($n = 48$). Animals were sacrificed at 6 time points, and radioactivity in the injected segment, serum and other tissues was evaluated. Half-lives of protein residence were computed for each group and compared by Student's t test. **Results:** The aggregating ELP exhibited a substantially longer perineural half-life (39 ± 5 h) than the soluble ELP (5.5 ± 0.5 h, $p < 0.01$). This suggests that the ELP aggregate depot slowly resolubilizes providing for sustained, local protein release. Furthermore, radioactivity in the serum reached lower peak values for the aggregating group ($1.6 \pm 0.3\%$ injected dose) compared with the control ($23 \pm 5\%$ injected dose), demonstrating slower absorption into the systemic circulation. **Conclusions:** These results suggest that ELP aggregation behaviour prolongs perineural compartment residence of an injected protein depot. ELP fusions to anti-IL1 and anti-TNF α molecules retain bioactivity, and perineural delivery of such agents may sustain immunomodulating activity to treat local neuroinflammatory conditions. Such delivery may achieve high local doses and protect the body from systemic toxicity, with future investigation anticipated in evaluating bioactivity in an animal radiculopathy model.

LUMBAR SPINAL STENOSIS: PHYSICAL ACTIVITY, PAIN, QUALITY OF LIFE AND DISABILITY. *Michael Johnson, Michael Goytan, Dean Kriellaars.* University of Manitoba, Winnipeg, Man.

Introduction: Pain reduction and functional restoration is a goal of treatment in people with spinal stenosis, yet little is known regarding their physical activity patterns. This study examined the physical activity patterns of people with spinal stenosis. **Methods:** Twenty subjects (mean [and SD] age 65.6

[8.9] y, weight 81.8 [19.3] kg, height 1.67 [0.09] m, and body mass index 27.7 [4.3]) with lumbar spinal stenosis (MRI- or CT-verified, leg > back activity related pain) were recruited. Surgery consisted of decompression ± single or multiple fusion (no complications). Physical activity was monitored by biaxial accelerometry (Biotrainer Pro; IM Systems Inc.: 5 days, 1 minute epoch). Mean total daily energy-expenditure-form physical activity was calculated. Physical activity was assessed in relation to pain (visual analogue scale [VAS] of leg, VAS of back), disability indices (Oswestry disability index [ODI], Disability of the Arm, Shoulder and Hand scale [DASH], Roland-Morris disability questionnaire [RMDQ]) and a general-health measure (SF-36). These measures were obtained presurgically and postsurgically at 3-month intervals up to 1 year postoperatively. **Results:** After surgery (3 and 6 months combined), pain reduced (53 to 16 mm, $p < 0.001$), RMDQ improved (12 to 3.6, $p < 0.01$) and DASH and ODI improved ($p < 0.05$). Similar to VAS pain data, the body pain dimension of SF-36 improved (38 to 61, $p < 0.05$), however the general health, physical function and vitality dimensions did not change. Presurgical physical activity was low (3 kcal/kg/d) and remained low (2.4 kcal/kg/d) after surgery (3- and 6-month data combined). **Discussion:** Despite the substantial reduction in pain, and reduction in the subjective level of disability, objective data of physical activity concurred with the lack of subjective improvement in physical functioning (SF-36). Early postsurgical lifestyle and exercise intervention programs may be necessary to enable a greater degree of functional restoration.

MECHANISMS OF BACK INSTABILITY REVEALED THROUGH A FATIGUING TASK IN ELITE ATHLETES. *Kari Schneider, Michael Johnson, Dean Kriellaars.* University of Manitoba, Winnipeg, Man.

Introduction: The exact mechanisms responsible for back injury remain elusive. Changes in back stability during repetition of a task are postulated to contribute to back injury. This study was designed to examine lumbar kinematics during execution of a trunk stabilization task to fatigue failure in elite athletes. **Methods:** Ten subjects (mean [and standard deviation, SD] age 24.8 [3.1] y, height 190.2 [11.3] cm, weight 85.4 [11.6] kg, body mass index 23.5 [1.7]) were recruited from Canada's national volleyball teams. Subjects wore calibrated uniaxial accelerometers (EGAX 2 g; Entran Devices, Fairfield, NJ) over the spinous processes of L1 and L4 vertebrae. Subjects performed a front plank on an exercise ball with range of motion-limited elbow flexion/extensions to fatigue. **Results:** Mean number of repetitions was 54.4, range 20–148; mean time to fatigue was 74.8 seconds. The average repetition duration was 1601 (540) milliseconds. When controlling for repetition duration, the correlation between repetitions and time to fatigue was 0.95 ($p < 0.05$). Moderate negative correlations between repetition duration and height ($r = -0.66$) and mass ($r = -0.74$) consistent with fatiguing exercise, lumbar (L1 and L4) mechanomyograms revealed positive correlations ($p < 0.01$) with repetitions. Lumbar orientation was derived from differential low-frequency lumbar acceleration, revealing 7 of 10 subjects with enhanced lordosis with repetitions through concurrent L1 and L4 inclination shifts (2 subjects underwent kyphotic shifts). Movement-related acceleration

magnitude increased with repetitions at both L1 and L4 ($p < 0.05$). L1 and L4 accelerations were not completely correlated ($r = 0.76$, $p < 0.01$). **Discussion:** Motion control strategies were body size dependent. Increased lumbar acceleration magnitude along with progressive dissociation between L1 and L4 motion control teamed with a compromised lumbar orientation and fatigue would increase risk of motor control error with an injury consequence.

OBJECTIVE FUNCTIONAL ASSESSMENTS IN THE SURGICAL MANAGEMENT OF CERVICAL SPONDYLOTIC MYELOPATHY (CSM) — ARE WE RVALUATING MEANINGFUL OUTCOMES? *Sukhvinder Kalsi-Ryan,* Eric Massicotte,† Michael Fehlings.** From the *Toronto Western Hospital, Krembil Neuroscience Centre, and the †University of Toronto, Toronto, Ont.

Introduction: Cervical spondylotic myelopathy (CSM) is a common cause of spinal cord impairment. Despite improved surgical treatments, objective evidence for improved recovery in CSM with surgery remains scarce. **Purpose:** To determine a standard assessment of functional outcomes for individuals undergoing surgical management of CSM. **Methods:** A prospective study of consecutive individuals ($n = 93$ enrolled, 70 with 6-month follow-up and 35 with 1-year follow-up to date) who underwent either anterior or posterior cervical decompression/reconstruction for CSM was undertaken. Nurick grading, modified Japanese Orthopaedic Assessment (mJOA), Berg Balance Scale (BBS), 30-metre walk test (30MWT) and grip and pinch Dynamometry (GPD) were administered pre-operatively and postoperatively at 6 months and 1 year. Paired t tests were conducted to determine the amount of change. A subgroup of subjects presenting with only a 0–1 grade change on the Nurick and a 0–3 score change on the mJOA was analyzed separately. **Results:** The Nurick grade and mJOA had a mean difference in improvement of 1 and 2.8, respectively ($p < 0.05$). The BBS, GPD and 30MWT showed mean improvements of 5.5, 6.4 kg/F and 16.2 seconds respectively ($p < 0.05$) at 6 months and 1 year. In cases with milder levels of impairment, the Nurick and mJOA showed little or no change after surgery, whereas the BBS, dynamometry and 30MWT did reflect improved function. **Conclusions:** Surgical interventions for symptomatic CSM show improved functional outcomes postoperatively at 6 months that are sustained at 1 year. Milder forms of CSM show benefits with decompression, which are more accurately reflected in quantitative assessments of gait, hand function and balance.

ASSESSMENT OF AGE, SEX, DURATION OF SYMPTOMS AND COMORBIDITIES AS POTENTIAL PREDICTORS OF FUNCTIONAL OUTCOMES AND COMPLICATIONS FOLLOWING SURGICAL TREATMENT OF PATIENTS WITH CERVICAL SPONDYLOTIC MYELOPATHY: A PROSPECTIVE STUDY IN 81 PATIENTS. *Julio Furlan,* Sukhvinder Kalsi-Ryan,† Eric Massicotte,† Abhlan Kailaya-Vasan,‡ Michael Fehlings.*†* From the *Toronto Western Research Institute, University Health Network, the †Krembil Neuroscience Centre and University of Toronto, Toronto, Ont., and the ‡University College London, London, UK.

Introduction: This prospective study examines the potential

confounding effects of age, sex, duration of symptoms and comorbidities on the functional outcomes and postoperative complications in patients who underwent cervical decompressive surgery for cervical spondylotic myelopathy (CSM). **Methods:** We included all consecutive patients who underwent surgery from December 2005 to October 2007. Functional outcomes were assessed using Nurick, modified Japanese Orthopedic Association (mJOA) and Berg balance scales. Comorbidity indices included Charlson Comorbidity Index (CCI) and the number of ICD-9 codes (nICD-9). **Results:** There were 57 male and 24 female patients with a mean age of 57 (32–88 years). Mean duration of symptoms was 25.2 (1–120) months. After a mean follow-up time of 9.2 (6–12) months, the functional improvement was not significantly associated with age, sex, duration of symptoms or comorbidity indices. Postoperative complications occurred in 18.5%. The occurrence of complications was not associated with sex or duration of symptoms. However, patients who developed complications were significantly older than patients who had no complications (66.3 v. 54.9 y; $p = 0.006$). Patients with complications and patients without complications significantly differed regarding nICD-9 (0.35 v. 0.8; $p = 0.03$). Patients with complications showed a trend for a greater CCI in comparison with patients without complications (0.17 v. 0.33; $p = 0.09$). Logistic regression analyses indicated that the odds on developing a postoperative complication in a given person-year increase with age (7%/y). Comorbidity indices were not significantly associated with complications, and no interaction between age and comorbidity was found. **Discussion:** Our results suggest that older age and greater comorbidity indices are potential predictors of postoperative complications after cervical decompressive surgery for CSM. Age, sex, duration of symptoms and comorbidity indices were not associated with functional improvement in this cohort of patients.

CLINICAL VALUE OF MAGNETIC FIBRE TRACT TRACING IN THE SPINAL CORD. *Eve C. Tsai,* Fahad Alkherayf,† John Sinclair.†* From the Ottawa Hospital, *OHRI, and the †University of Ottawa, Ottawa, Ont.

Introduction: Fibre tract tracing allows delineation of specific white matter (WM) tracts using magnetic resonance imaging (MRI). While it has been studied extensively within the brain, its use within the spinal cord (SC) has been limited due to image acquisition artifact and algorithm processing limitations. Recently, these limitations have been overcome, and our group has used fibre tract tracing to study several SC lesions. **Methods:** Healthy volunteers and patients with SC lesions, scheduled to receive MRI for clinical reasons, underwent the fibre tracking sequence. Imaging was performed on a 1.5T Siemens MR imager, and the protocol began with the acquisition of a sagittal T_2 -weighted fast spin echo sequence with a subsequent axial diffusion-weighted single-shot echo planar imaging sequence using Grappa and 12 noncollinear gradient directions. Three-dimensional WM fibre tracts were created using the principal diffusion directions method where the eigenvector corresponding to the largest eigenvalue is extracted from the diffusion tensor generated from the diffusion tensor imaging data sets in the region where the diffusion was linear. Typical values for the fractional anisotropy threshold

and the angulation threshold were 0.17° and 45°, respectively. MEDINRIA version 1.0.30 and DTI-Studio Version 2.02 software were used to generate the fibre tracking images. **Results:** SC tract tracing in healthy volunteers corresponded to normal anatomic tracts and allowed visualization of tracts as they entered and exited the SC. Spinal cord lesions in patients included cervical stenosis, multiple sclerosis, astrocytoma, spinal cord vascular malformations and syringomyelia. Tractography improved visualization of tracts and allowed a better understanding of how tracts were disrupted by the lesions. **Discussion:** Although further clinical correlation for validation of this technique is required, MRI fibre tract tracing holds promise in allowing improved detection of SC abnormalities and improved operative management of SC lesions.

SURGICAL TREATMENT IS EFFECTIVE IN CERVICAL SPONDYLOTIC MYELOPATHY — INITIAL RESULTS OF A PROSPECTIVE MULTICENTRE STUDY INVOLVING 316 PATIENTS. *Michael Fehlings,* Branko Kopjar,† Eric Massicotte,* Tim Yoon,‡ Arnold Paul,§ Darrel Brodke,¶ Eric Woodard,** Christopher Shaffrey,†† Alexander Vaccaro,‡‡ Michael Janssen.§§* From the *University of Toronto, Toronto, Ont., the †University of Washington, Seattle, Wash., the ‡University of Atlanta, Atlanta, Ga., the §University of Kansas, Kansas City, Kan., the ¶University of Utah, Salt Lake City, Utah, the **Boston Spine Group, Boston, Mass., the ††University of Virginia, Charlottesville, Va., the ‡‡Thomas Jefferson University, Philadelphia, Pa., and the §§Spine Education and Research Institute, Denver, Colo.

Introduction: Cervical spondylotic myelopathy (CSM) is a common cause of neurologic disability. However, the literature supporting the use of surgery for this condition is limited. To clarify the effectiveness of surgical treatment of CSM, we conducted a large, multicentre, prospective cohort study to assess the outcomes of surgery in CSM. **Methods:** A total of 316 cases of CSM have been enrolled. Of these, 117 have reached 6 months follow-up and 58 have reached 1-year follow-up. All patients underwent preoperative and postoperative MRI. Neurological recovery was assessed by the modified JOA (mJOA), Nurick scale and Neck Disability Index (NDI). Gait was quantified by a 30-metre walk and timed up and go tests. One-year follow-up results will be available in a large cohort of patients at the time of the CSS meeting. **Results:** The average age was 53 years; 53% were male; 64% of patients underwent anterior surgery (discectomy/corpectomy with fusion); 36% of the patients underwent posterior surgery (laminectomy and fusion or laminoplasty). Baseline mJOA was 13.0 and NDI 41. Subjects treated with anterior surgery were younger (53 v. 65 y, $p < 0.01$) and had better baseline mJOA scores (13.8 v. 11.6, $p < 0.01$) when compared with those treated posteriorly. There were no differences in sex, baseline SF-36 scores and NDI between the anterior and posterior cohorts. At 6 months all outcome parameters improved statistically significantly from the baseline values. Average improvements were: mJOA 2.2 points; NDI 14.7 points; 30-metre walk test 5.1 seconds; SF-36 physical component score 4.6 points; SF-36 mental component score 7.0 points, Nurick 1 grade. In the subjects with 1-year follow-up, the improvement in outcome parameters have been maintained. **Discussion:**

The initial results of this study indicate that the operative treatment of CSM significantly improves all relevant clinical, functional and quality of life outcomes.

INTRAOPERATIVE MOTOR EVOKED POTENTIAL CHANGES IN CHILDREN TREATED WITH INTRAOPERATIVE SKULL-SKELETAL TRACTION FOR SEVERE CORONAL PLANE DEFORMITIES. *Stephen Lewis, Laura Holmes, Sam Strantzas, Harsha Malempati, Christian Zarour, Janet Abier, Reinhard Zeller.* Hospital for Sick Children, Toronto, Ont.

Introduction: Intraoperative skull-skeletal traction has been used to facilitate correction of large scoliotic deformities. Traction and subsequent correction of the spinal deformity may cause ischemic changes to the spinal cord. Monitoring the motor pathways of the anterior cord would show these changes and alert the surgeon of potential spinal cord injury. The purpose was to determine and quantify motor evoked potential (MEP) changes seen with intraoperative traction. **Methods:** A retrospective review of prospectively collected data of 41 consecutive patients undergoing scoliosis correction with the use of intraoperative traction was performed. Approximately 50% of the body weight was applied through the legs, with 20%–25% countertraction applied through the skull. Baseline MEP data were obtained in 40 of 41 cases. **Results:** There were 28 patients with adolescent idiopathic scoliosis (AIS), 9 with neuromuscular (NMS) and 4 syndromic scoliosis. Twelve (12) of 28 AIS, 1 of 8 NMS and 4 of 4 syndromic demonstrated traction-related changes in the MEP monitoring for a total of 17 of 40. Two further had transient instrumentation-related changes. All traction-related changes were seen in thoracic curves with a mean curve magnitude of 84.9° (range 56°–112°). Unilateral MEP changes were seen in 7 patients, with 3 responding to decreasing the weight; in the remaining 4, no action was taken. Bilateral MEP changes were seen in 10 cases, with 8 of 10 responding to decreasing traction weight. The rods were removed in 2 cases: 1 patient tolerating reinsertion of the rod following return of the MEPs, the other returning 1 week later for rod insertion. There were no somatosensory evoked potential changes in any of the cases. There were no postoperative neurologic deficits. The mean major curve correction was 58%. **Discussion:** Significant MEP changes occur with the use of skull-skeletal traction in the treatment of high magnitude thoracic scoliosis. We recommend the use of MEP monitoring when skeletal traction is used in this manner.

INTRAOPERATIVE STIMULUS-TRIGGERED ELECTROMYOGRAPHIC MONITORING (ISTEM) FOR EVALUATION OF PEDICLE TRACT INTEGRITY IN PAEDIATRIC SPINAL DEFORMITY. *Paolo Punsalan, Alberto Nettel Aguirre, Leanne Alfaro, David Parsons, Lorie Hamiwka, Jason Howard.* University of Calgary, Alberta Children's Hospital, Calgary, Alta.

Introduction: Though the use of segmental pedicle screw fixation for posterior scoliosis corrective surgery is becoming more widespread, the potential for significant neurologic injury is still a concern. Utilization of a device that more accurately detects a loss of pedicle tract integrity during pedicle tract preparation may improve the safety profile for pedicle

screw insertion. The purpose of this study was to evaluate the effectiveness of ISTEM in detecting a cortical breach during pedicle tract preparation. **Methods:** A retrospective review of hospital, operative, electrophysiologic and radiographic records for all pediatric patients who underwent segmental pedicle screw fixation at a single institution from May 2006 to July 2007 was performed. Intraoperative use of ISTEM during pedicle screw insertion involved the use of an electrified pedicle access needle in detecting cortical breaches as compared with direct palpation. Sensitivity, specificity, positive (PPV) and negative predictive values (NPV) for ISTEM were calculated using descriptive statistical methods. **Results:** A total of 397 pedicles in 30 patients were included in the analysis. The sensitivity, specificity, PPV and NPV of ISTEM were 57.1% (95% confidence interval [CI] 39.5%–73.2%), 98.6% (95% CI 96.6%–99.4%), 80.0% (95% CI 58.7%–92.4%) and 95.9% (95% CI 93.3%–97.6%), respectively. Assessment of nonconcordant proportions (ISTEM v. palpation, McNemar's χ^2 test) determined that both methods are significantly different in assessing cortical integrity ($p = 0.044$). **Conclusion:** ISTEM has been shown to have excellent specificity and negative predictive value such that a negative result is very suggestive of an intact pedicle before screw insertion. The low sensitivity may result from electric stimulus conduction through thin cortical walls in dysplastic pedicles and suggests the use of ISTEM as an adjunct rather than a stand-alone device for insuring pedicle integrity during pedicle screw insertion.

INTRAOPERATIVE SPINAL CORD AND NERVE ROOT MONITORING: A SURVEY OF CANADIAN SPINE SURGEONS. *Lissa Ogieglo,* Stephen Hentschel,* Richard Fox,† Daryl Fourney.** From the *University of Saskatchewan, Sask., and the †University of Alberta, Edmonton, Alta.

Introduction: Intraoperative spinal cord and nerve root monitoring is used in spinal surgery to identify emerging insult to the underlying neurologic structures in an attempt to prevent irreversible injury. There are 3 major types of monitoring: somatosensory evoked potentials (SSEP), motor evoked potentials (MEP) and electromyography (EMG). The indications for use vary widely. At present there is no standard of care in Canada in regards to the use of monitoring. This study addresses the current practice pattern and opinions on intraoperative monitoring and its use in Canada. **Method:** A survey concerning the availability, use, indications and opinions regarding the standard of care in Canada was distributed to the members of the Canadian Spine Society. **Results:** One-hundred and five (105) surveys were distributed, with 90 total responses received. The prevalence of spinal cord monitoring was 61.1% mostly performed by electrophysiologists. Surgeons in either full-time or part-time academic practice used monitoring more frequently than private practice surgeons ($p < 0.0008$). Years of practice and training background did not influence the usage of monitoring. The availability at the institution significantly correlated to use ($p < 0.0001$). A majority of respondents (77.7%) felt monitoring should be a standard of care for select cases, most specifically for correction of major deformity (97%) and resection of spinal cord tumours (65%). **Discussion:** There is much controversy regarding the indications of spinal cord and nerve root monitoring. Availability is

not universal in spine care practice. This survey shows use is prevalent, and a majority of surgeons believe spinal cord and monitoring should be a standard of care for selected cases.

SCORE DISTRIBUTION OF THE SCOLIOSIS RESEARCH SOCIETY-22 QUESTIONNAIRE IN PATIENTS WITH IDIOPATHIC SCOLIOSIS. *Douglas Hedden, Douglas Hill, James Mahood, Rohan Dang, Marc Moreau.* Capital Health, Edmonton, Alta.

Introduction: The SRS-22 has been validated in adult patients and those having undergone scoliosis surgery. The high ceiling effects observed when assessing younger patients or those with mild severity may limit the usefulness of the SRS-22 in measuring quality of life in those groups. **Methods:** The SRS-22 questionnaire was used in a retrospective cross-sectional study to analyze the score distribution for female patients with idiopathic scoliosis. The SRS-22 was completed by 202 female patients (age 25 ± 12 y; $38^\circ \pm 16^\circ$ Cobb angle) with idiopathic scoliosis. Subgroups of age, treatment, curve severity and Lenke curve type were assessed. Ceiling and floor effects were calculated, and the score distribution analyzed through the use of box plots and by calculating the proportion of patients scoring at least 4 out of 5 for each domain and each item. **Results:** Ceiling effects were less prevalent in older patients, while floor effects were more prevalent. Pain and satisfaction domains showed the greatest proportion of ceiling effects, while function showed the least. However, function showed the highest proportions of patients scoring at least 4 out of 5 over most subgroups. Ceiling effects were generally quite high, especially in younger patients or those with less aggressive treatment. Scores were generally highest for those in the observation (3.9 ± 0.5) and past brace (3.8 ± 0.3) subgroups and those prescribed exercises or chiropractic care (3.7 ± 0.6), or who had had surgery within the last 10 years (3.7 ± 0.6), and lowest by far for those patients planning surgery (3.2 ± 0.7). **Discussion:** Patients planning surgery score the lowest on the SRS-22, but surgery significantly ($p = 0.02$) improves quality of life.

EFFECT OF INTRAOPERATIVE SKELETAL TRACTION ON APICAL VERTEBRAL ROTATION IN SCOLIOSIS. *Stephen Lewis, Subir Jhaveri, Stephen Miller, Reinhard Zeller.* Hospital for Sick Children, Toronto, Ont.

Introduction: Intraoperative skeletal traction has been used for the correction of large magnitude idiopathic and neuromuscular scoliosis. The ability of skeletal traction to correct the rotational deformity of the spine has not been characterized. **Methods:** Following Research Ethics Board approval, retrospective analysis of 22 (adolescent idiopathic scoliosis = 14, neuromuscular = 8) consecutive pediatric patients having surgical posterior instrumented correction and fusion for their scoliosis was performed. Intraoperative skeletal traction with approximately 50% body weight was achieved with smooth distal femoral pins. Counter-traction up to 25 lbs was used through Gardner-Wells tongs. The apical vertebral rotation (AVR) of the major curve was assessed using the Nash-Moe grading system by a radiologist and a senior spine surgeon not involved in the treatment of these cases. Statistical analysis was performed to determine significance. **Results:** Overall mean

AVR of the major structural curve was 2.9 and reduced to 2.1 ($p = 0.001$) following traction. The AVR decreased by 1 or more Nash-Moe grades with traction in 14 of 22 (64%) patients. The Cobb angle corrected from a mean of 88.2° to 48.2° (45.3%, $p = 0.00001$) with traction. The decrease in AVR correlated with the higher magnitude Cobb angles (correlation 0.53, $p = 0.014$). Patients with pretraction AVR ≥ 3 showed the largest change with traction (3.4 to 2.2, $p = 0.000004$). There was excellent correlation between the radiologist and the spine surgeon: 0.82 (standing films) and 0.68 (traction films). The minor structural curve corrected from a mean Cobb of 53.5° to 33.8° (37.8%) with AVR decreasing from a mean of 1.9 to 1.4 ($p = 0.014$). **Discussion:** Significant apical derotation occurs with the use of intraoperative skull-skeletal traction in the correction of high magnitude scoliotic curves. This derotation can facilitate spinal exposure, placement of pedicle screws and final correction in these patients.

RESULTS OF THE CANADIAN PEDIATRIC SPINAL DEFORMITY STUDY GROUP OF SURGICAL TECHNIQUES AND PERIOPERATIVE CARE FOR ADOLESCENT IDIOPATHIC SCOLIOSIS. *Sarah Bacon,* Reinhard Zeller,* Ron El-Hawary,† Peter Jarzem,‡ Nizar Mahomed,§ Stephen Lewis.** From the *Hospital for Sick Children, Toronto, Ont., †Dalhousie University, Halifax, NS, ‡McGill University, Montréal, Que., and the §Toronto Western Hospital, Toronto, Ont.

Introduction: Significant variation exists in techniques and philosophies in care of pediatric adolescent idiopathic scoliosis (AIS). A questionnaire was sent to members of the CPSDS to determine individual practices and areas of controversy (AOC) amenable to Canada-wide research studies. **Methods:** A comprehensive questionnaire was completed by 17 surgeon-members of the CPSDS. Answers were graded from 0 to 3 (never = 0, rare = 1, frequent = 2, always = 3). "Standard of care" (SOC) was defined as $> 88\%$ (15/17) always or frequent use (2+3), or $> 88\%$ (15/17) never or rare use (0+1) as long as 0 or 3 were $\geq 65\%$. AOC were defined as users (1+2+3) or occasional users (1+2) between 35% and 65%, and not meeting criteria for SOC. **Results:** Bone graft technique: SOC included use of local autograft, facet, lamina and thoracic transverse process decortication, and not using bone morphogenetic proteins, iliac crest bone graft (ICBG) or rib graft. AOC included use of allograft and graft extenders. Blood conservation: SOC included use of cell saver, and not using erthropoietin. AOC included blood donation and tranexamic acid. Instrumentation: use of stainless steel, titanium, rod diameter and crosslinks are AOC. Lumbar pedicle screws are SOC; thoracic pedicle screws are AOC. The role of anterior releases for curves $> 70^\circ$ and anterior-only procedures for thoracolumbar curves was AOC. Perioperative care: use of somatosensory evoked potentials was SOC, while motor evoked potentials and electromyography were AOC. Only 17% of respondents performed wake-up tests. The use of drains and time to return of full activities were AOC. Eighteen percent (18%) did not use postoperative antibiotics. Preoperative standing anteroposterior, lateral and side-benders and postoperative radiographs at 3, 6 and 12 months were SOC. Intraoperative and early postoperative radiographs were AOC. **Discussion:** This questionnaire provides useful information in

the practices of surgeons treating pediatric spinal deformity. While it is useful to know the country's SOC, highlighted AOC provide potentials for country-wide multicentred research.

A MATCHED-COHORT STUDY OF SEVERELY POLYTRAUMATIZED PATIENTS WITH AND WITHOUT SPINAL INJURY PRESENTING TO A LEVEL I TRAUMA INSTITUTION. *Olivia Murnaghan, Edward Lansang, Iris Weller, Yigal Bronstein, Michael Ford, Joel Finkelstein, Albert Yee.* The Spine Program, Division of Orthopaedic Surgery, Sunnybrook Health Sciences Centre and Department of Surgery, University of Toronto, Toronto, Ont.

Purpose: We aimed primarily to evaluate early hospital morbidity/mortality and secondarily to characterize the demographics and treatment of the spine cohort. **Methods:** The institutional trauma registry identified consecutive (1998–2005) polytraumatized patients with spinal injury and an Injury Severity Score (ISS) > 14. A matched cohort (age, sex, mean ISS, injury year) without spinal injury was assembled. A review was conducted on prospectively collected data. **Results:** Two hundred and ninety (290) patients were identified (151 spinal, 139 control). Spine-injured patients spent more days ventilated (5.1 d v. 2.4 d) and experienced both a longer intensive care unit (ICU) (10.4 d v. 5.4 d) and acute hospital stay (25.7 d v. 16.2 d); $p < 0.05$. There was a trend toward greater mortality (15% v. 9%) in the control group ($p = 0.06$). Within the spine cohort, cause of injury included falls (25.2%), pedestrian (9.3%), industrial/recreational accidents (7.9%), motor vehicle collision (55.6%), gunshot (1.3%) and other (0.7%). Multilevel spine injury occurred in 23%. Neurologic injury occurred in 31% (Frankel grade A, 17.9%; B, 6.0%; C, 2.0%; D, 4.6%; E, 69.5%). Fracture severity by AO grade was A (43.7%), B (29.1%) and C (27.22%). Thirty-five percent (35%) of patients were treated surgically (76% posterior, 15% anterior, 9% combined). A higher AO grade was associated with greater neurologic dysfunction, higher surgical rate and longer hospital stay ($p < 0.05$). Neither Frankel grade (A–E) nor AO grade (A, B, C) correlated with early acute hospital mortality. **Conclusions:** Patients presenting with spinal trauma in the face of severe polytrauma have a greater ICU stay and longer requirement for ventilation when compared with those patients without spinal injury. Although the early mortality rate was not significantly different between groups, the trend toward higher early mortality in the control group warrants additional study. The incidence of neurologic injury and multilevel injuries in the spine cohort could be anticipated in the context of severely polytraumatized patients. As such, a high index of suspicion in the evaluation of noncontiguous spinal injury and in clearance of the spine in patients presenting with an ISS > 14 is warranted.

A QUALITATIVE EVALUATION OF PATIENTS' EXPERIENCE WITH NONSURGICAL MANAGEMENT OF RADICULAR PAIN. *Raleen Murphy, Ginette Thibault-Halman, Sean Christie.* Dalhousie University, Halifax, NS.

Introduction: There are no specific Canadian guidelines to direct the conservative management of patients with back and leg pain in the community, and approaches to their manage-

ment vary greatly. There exist a number of treatment modalities for the management of back and leg pain that can be tried before seeking surgical opinion, yet research aimed at investigating this population's experience with these treatments is scarce. **Methods:** A retrospective chart review was conducted on 100 patients with back and leg pain who presented to an academic spine clinic between 2005 and 2007. Clinic notes were reviewed to ascertain the nonsurgical treatment modalities attempted to manage pain before subspecialist referral. Data collected included basic demographics, type of pain, diagnosis and conservative modalities employed, including medications used. **Results:** The charts of 48 female and 52 male patients (mean age 48.73 ± 13.32 y) were reviewed. All patients had radicular pain; 97% had concomitant back pain. No consistent pattern was found for treatment before referral. Of all patients reviewed, 16% had not attempted any therapies before referral. Furthermore, 33% of patients had not tried exercise or physiotherapy. A difference was identified in the prescribing patterns used by specialists versus general practitioners; specifically, patients were less likely to be on narcotics (33% v. 58%, $p = 0.05$) and more likely to have been prescribed pregabalin or gabapentin (43% v. 9%, $p = 0.002$) if they were referred by a specialist. No significant difference was noted in usage of nonsteroidal anti-inflammatories, antispasmodics, tricyclic antidepressants, chiropractic care or physiotherapy. **Discussion:** This study demonstrates a lack of consistency in conservative measures instituted before subspecialist referral for low back and leg pain. These findings will aid future efforts to standardize conservative management for this patient population.

A RELIABLE DOSAGE METRE TO TRACK HOW SCOLIOSIS PATIENTS USE THEIR BRACES. *Edmond Lou, Marc Moreau, James Mahood, Douglas Hedden, Douglas Hill, James Raso.* Capital Health, Edmonton, Alta.

Introduction: Brace treatment is the most commonly nonsurgical treatment for adolescent idiopathic scoliosis (AIS). However, questions regarding how much wear time per day is needed for an optimum treatment outcome, how much brace tightness is optimal and what is the best weaning protocol are still not understood. **Methods:** A reliable brace dosage metre was developed and has been used to monitor brace usage during activities without requiring patient involvement. The dosage metre consists of a data logger and a force sensor. A single AAA battery provides enough power for 4 months data storage. This device measures how tightly and how long the patient uses her brace per day. Six subjects who met the Scoliosis Research Society Brace Study inclusion criteria have been recruited to date for this ongoing study. All subjects were new to brace treatment and have been monitored from 2 months up to 8 months. **Results:** All 6 subjects used a TLSO (thoraco-lumbo-sacral-orthosis brace) to treat their scoliosis. The dosage metre was light (25 g) and small ($4 \times 6 \times 1.7$ cm), which was easy to install and to hide under clothing. To date, 3 subjects with 4 months of data have been assessed. The average brace usage was 13 ± 1.2 hours per day. The tightness level relative to the prescribed level recommended by the orthotist was divided into 3 categories (< 80%, 80%–120% and > 120%) and was 17%, 61% and 22%, respectively. **Discussion:**

This preliminary study demonstrated that the dosage metre was reliable to monitor brace usage during daily activities. No subject has dropped out from this study. Although no conclusive statement can be made at this stage, data collected from this study may be able to further the scientific basis behind brace treatment.

AN ASSESSMENT OF THE RELIABILITY OF THE ENNEKING AND WEINSTEIN-BORIANI-BIAGINI (WBB) CLASSIFICATIONS FOR STAGING OF PRIMARY SPINAL TUMOURS. *Patrick Chan,* Stefano Boriani,† Daryl Fourney,‡ Michael Feblings,§ Roberto Biagini,¶ Mark Dekutoski,** Timothy Ryken,††, Frank Vrionis,‡‡ James Harrop,§§ Meic Schmidt,¶¶ Luis Vialle,*** Peter Gerszten,††† Laurence Rhines,‡‡‡ Stephen Ondra,§§§ Ziya Gokaslan,¶¶¶ Stuart Pratt,**** Charles Fisher.** From the *Vancouver General Hospital, Vancouver, BC, the †Ospedale Maggiore, Bologna, Italy, the ‡University of Saskatchewan, Saskatoon, Sask., the §University of Toronto, Toronto, Ont., the ¶Istituto Regina Elena, Rome, Italy, the **Mayo Clinic, Rochester, Minn., the ††University of Iowa, Iowa City, Iowa, the ‡‡H. Lee Moffitt Cancer Center, Tampa, Fla., the §§Thomas Jefferson University Hospital, Philadelphia, Pa., the ¶¶University of Utah, Salt Lake City, Utah, the ***Catholic University of Parana, Curitiba, Brazil, the †††University of Pittsburgh, Pittsburgh, Pa., the ‡‡‡MD Anderson Cancer Center, Houston, Tex., §§§Northwestern University, Chicago, Ill., ¶¶¶Johns Hopkins University, Baltimore, Md., and ****Medtronic Spinal and Biologics, Memphis, Tenn.

Introduction: The Enneking and Weinstein-Boriani-Biagini (WBB) classifications were developed to stage and facilitate treatment planning in patients with primary spine tumours. To date, their interobserver and intraobserver reliability has not been assessed, a fundamental step in facilitating broader clinical and research use. **Methods:** To assess the reliability of these systems, clinical information, imaging studies and biopsy results were compiled from 15 selected patients with primary spinal tumours. Eighteen spine surgeons independently estimated and scored the cases for Enneking grade, tumour and metastasis categories, Enneking stage, Enneking recommended surgical margin, WBB zones and layers, and WBB recommended surgical procedures, with a second assessment performed after random resorting of cases. Interobserver and intraobserver reliability of each category were assessed by percent agreement or proportional overlap. The Fleiss, Cohen and Mezzich kappa statistics (κ) were then applied, determined by the type of variable analyzed. **Results:** The kappa statistics for interobserver reliability were 0.82, 0.22, 0.00, 0.57, 0.47, 0.31, 0.58 and 0.5 for the fields of Enneking grade, tumour and metastasis categories, Enneking stage, Enneking recommended surgical margin, WBB zones and layers, and WBB recommended surgical procedures, respectively. The kappa statistics for intraobserver reliability were 0.97, 0.53, 0.47, 0.82, 0.67, 0.63, 0.79 and 0.79 for the same respective fields. According to Landis and Koch, the ranges of kappa values of 0.00–0.20, 0.21–0.40, 0.41–0.60, 0.61–0.80 and > 0.80 imply slight, fair, moderate, substantial and near perfect agreement, respectively. **Discussion:** Results indicate

moderate interobserver reliability and substantial and near-perfect intraobserver reliability for both the Enneking and WBB classification in terms of staging and guidance for treatment, despite a less than moderate interobserver reliability in interpreting the Enneking local tumour extension and WBB sector. Prior to incorporating the classifications in the clinical practice and research studies, further work is required to investigate the validity of the classifications.

ATLANTOAXIAL STABILIZATION WITH PARS SCREWS AND CONTOURED ROD PROVIDES A SIMPLE AND EFFECTIVE ALTERNATIVE TO TRANSARTICULAR SCREW FIXATION WHEN ATLAS ARCH IS INTACT. *Karolyn Au, Robert Broad, Michel Lavoie, Frank B. Kortbeek, Keith Aronyk, Richard Fox.* University of Alberta, Edmonton, Alta.

Atlantoaxial instability can be corrected surgically using a variety of techniques, including transarticular screw fixation and C1–C2 screw-rod constructs. Such rigid fixation is immediately effective and provides excellent rates of fusion with acceptably small risks, but is technically challenging in some patients due to body habitus or anatomic variations of vertebrae and vertebral artery. A series of 10 patients, aged 4 to 65 years, with atlantoaxial instability due to trauma ($n = 3$), rheumatoid arthritis ($n = 4$) or os odontoideum ($n = 3$) underwent posterior stabilization and fusion with a construct composed of C2 polyaxial pars screws, a U-shaped rod contoured to the C1 posterior arch, specialized rod clamps and braided cable. The procedure was uniformly well-tolerated, and early follow-up of 4–11 months shows consistent fusion. This construct offers another option to the spine surgeon when the posterior arch of the atlas is intact, and is simple, safe and solid. The construct is compared with C1–C2 screw-rod and transarticular screw constructs, with potential advantages and disadvantages of each reviewed.

CLINICAL AND RADIOGRAPHIC CORRELATION OF POSTEROLATERAL LUMBAR SPINAL FUSION AUGMENTED BY rhBMP-2. *Nauman Akhtar, Marc Underhill, Julia Carp, Joseph Craigh, Stephen Bartol.* Henry Ford Health System, Detroit, Mich.

Introduction: The use of bone morphogenetic protein-2 (rhBMP-2) in spinal fusion has increased dramatically since an FDA approval for its use in anterior lumbar fusion with the LT-CAGE (Medtronic, Minneapolis, Minn.). While there are studies that report historic norms for posterolateral fusion rates with and without instrumentation, this study focuses on evaluating both the clinical and radiographic effects of rhBMP-2 on fusion rates in the posterolateral lumbar spine. **Methods:** An Institutional Review Board–approved retrospective study was conducted on 63 patients undergoing posterolateral lumbar fusion and instrumentation with the inclusion of rhBMP-2. Patients filled out Oswestry functional and pain score questionnaires and had radiographs postoperatively as well as consecutively at each office visit for up to 2 years of follow-up. The patients were also stratified according to major risks factors, including renal failure, diabetes, body mass index, number of levels fused and smoking. These clinical factors were correlated with radiographs and CT scans examined by a single board-certified musculoskeletal radiologist for fusion

assessment. **Results:** Preliminary results found that only 4 of 63 patients treated with rhBMP-2 had radiographic evidence of pseudoarthrosis. Oswestry scores (functional and pain) as well as major risk factors were correlated with these findings. Our fusion rate with the use of rhBMP-2 in posterolateral lumbar fusion was found to be 94.4%, compared with historical norms of 88%. **Discussion:** Conclusions indicate use of rhBMP-2 leads to increased fusion rates and time to fusion. Comorbidities and increase in levels fused increase pseudoarthrosis risk. Imaging correlates with clinical evaluation for pseudoarthrosis.

COMPARING THE FIXATION OF A NOVEL HOLLOW SCREW VERSUS A CONVENTIONAL SOLID SCREW IN HUMAN SACRA UNDER CYCLIC LOADING. *S.D. McLachlin,* B.J.B. Beaton,* M.T. Sabo,† K.R. Gurr,† S.I. Bailey,† C.S. Bailey,† C.E. Dunning.** From the *Department of Mechanical and Materials Engineering and the †Division of Orthopaedics, Department of Surgery, the University of Western Ontario, London, Ont.

Purpose: The purpose of this study was to determine if this hollow screw would be more resistant to loosening than a solid pedicle screw when placed into the S1 pedicles from the standard posterior approach and tested under stair-cased cyclic loading. **Methods:** Six fresh-frozen cadaveric sacra (mean age 72, standard deviation [SD] 4 y) were used. A 7.5 × 35 mm Xia monoaxial screw was placed in one S1 pedicle and a 10 × 34 mm Aesculap MACS HMS screw was inserted contralaterally. Each sacrum was potted in a custom-designed fixture, and a materials testing machine applied alternating flexion and extension bending moments at 1 Hz to each screw independently. Flexion moments started at 0.5 Nm for the first 1000 cycles and increased by 0.5 Nm of flexion every 1000 cycle steps until the screw had visibly failed. Extension moments were maintained at 0.5 Nm. Screw rotation (flexion) relative to the sacrum was recorded using a custom optical tracking system. The magnitude of screw rotation versus both the applied flexion moment and the number of loading cycles were compared using 2-way repeated-measures analysis of variance and post-hoc Newman-Keuls tests ($\alpha = 0.05$). **Results:** Screw rotation tended to gradually increase to 6°, after which point the screw was grossly loose. Overall, the hollow screw required fewer loading cycles ($p = 0.004$) and less applied moment ($p = 0.003$) to achieve the same magnitude of screw rotation as the solid screw. For example, to achieve 6°, the number of loading cycles were 6301 (SD 2161) and 11151 (SD 4221) for hollow and solid screws, respectively. The corresponding applied moments were 3.5 (SD 1.0) Nm and 5.8 (SD 2.0) Nm. **Conclusion:** The novel hollow screw was less resistant to loosening when compared with a conventional solid pedicle screw in this sacral model under cyclic loading.

CONSTRUCT SURVIVAL OF CD HORIZON LEGACY 5.5 POSTERIOR SPINAL INSTRUMENTATION SYSTEM: RADIOGRAPHIC EVALUATION OF THE THORACOLUMBAR SPINE. *Edward Abraham, Neil Manson.* Atlantic Health Sciences Corporation, Saint John, NB.

Introduction: Numerous instrumentation systems have been

developed and used over the years to address multiple pathological conditions of the thoracolumbar spine via a posterior approach. The CD Horizon Legacy 5.5 system (Medtronic Spine, Memphis, Tenn.) was developed as an improvement on preexisting constructs to help address some of their deficiencies. It is a low-profile, flexible and biomechanically sound titanium construct composed of a 5.5-mm rod, polyaxial screws or hooks using a top-loading set-screw locking mechanism. The purpose of this study was to evaluate the Legacy system to determine: (1) radiographic success: absence of construct failure and absence of adjacent segment degeneration (ASD); (2) factors affecting radiographic success: perioperative diagnosis, fusion levels, spinal alignment, etc.; and (3) clinical success: improvement in Oswestry disability index (ODI) and SF-36 scores. **Methods:** This is a prospective evaluation of all cases performed in a single centre requiring the Legacy system for posterior thoracolumbar fusion since the time of product inception, 2004. Radiographic parameters, ODI and SF-36 were evaluated preoperatively and postoperatively at specified intervals up to 2 years. **Results:** One-hundred and twenty-five (125) cases were evaluated with minimum 2-year follow-up for 61%. Average number of levels fused was 4.2. Instrument failure occurred in 13%: rod (5), screw (5) or crosslink (1). Average number of levels fused in the failure group was 7.3. ASD occurred in 14%: predominantly degenerative disc disease (8), kyphosis (7) or scoliosis (4). Average number of levels fused in the ASD group was 3.8. Clinical scores correlated poorly with radiographic abnormalities. **Discussion:** The CD Horizon Legacy 5.5 system maintained construct stability in 87% of cases. Construct failure was associated with a greater number of levels fused, reflecting the demanding pathology and construct complexity in the failure group. Overall, this system proved effective in all types of pathologies evaluated. Neither instrumentation failure, nor ASD, correlated well with clinical results.

EMG MONITORING PROVIDES A USEFUL ADJUNCT IN THE RESECTION OF SPINAL CORD TUMOURS. *Jonathan Norton, Richard Fox.* University of Alberta, Edmonton, Alta.

Introduction: The surgical resection of intradural spinal tumours is a high-risk procedure. The patient may develop significant neurologic deficits as a result of surgical insult to the cord. Intraoperative monitoring of spinal cord pathways is becoming increasingly common during both spinal cord and spine surgery and is rapidly reaching standard-of-care status. Sensory evoked potentials (SEPs) monitor dorsal column function and require comparatively little change in anesthetic protocol. Importantly, they do not result in a movement of the surgical field, but do not provide instant feedback to the surgeon since many responses need to be averaged to observe the evoked response. Motor evoked potentials (MEPs) provide instant feedback, but require that the patient be, at most, only partly paralysed pharmacologically. MEPs may result in a movement of the surgical field since large currents may be needed to elicit MEPs in the legs. **Methods:** Muscle activity can be recorded from the same electrodes that are used to record the MEPs. The electromyography (EMG) can be either free-running or triggered by a stimulus. Surgeons can use the stimulus-triggered EMG responses to determine the neural

structures in the surgical field. Motor nerve roots have a lower threshold for eliciting a response than sensory roots, and the distribution of the evoked response can be used by the neurophysiologist to identify the root level or the peripheral neural structure. Manipulation of the spinal cord may lead to bursts of EMG activity. Persistent or large amplitude bursts of EMG can provide real time information to the surgical team of potential spinal cord damage. **Results:** We show EMG changes associated with manipulation of the spinal cord and removal of intradural tumours. **Discussion:** Free-running EMG is a useful adjunct in surgical decision-making intraoperatively when removing intradural tumours

GIANT CELL EPENDYMOMA OF THE SPINE: CASE REPORT OF A THORACIC SPINE LESION AND REVIEW OF THE LITERATURE. *Mohammed Shamji,* Arie Perry,† Gerard Jansen,* Brien Benoit.** From the *Ottawa Hospital, Ottawa, Ont., and †Washington University, St. Louis, Mo.

Introduction: Spinal ependymomas are slow-growing lesions that comprise the majority of primary spinal cord neoplasms. When surgical treatment is offered, the extent of tumour removal is the most significant prognostic factor for long-term survival. Unusual histological subtypes can make intraoperative diagnosis spurious, possibly altering surgical approach from gross-total resection for ependymoma to debulking for high-grade astrocytomas. **Methods:** We describe a 67-year-old woman with a thoracic spine intramedullary giant cell ependymoma. She initially presented with decreased lower extremity sensation leading to unsteadiness and an eventual fall. Physical examination revealed lower extremity hyperreflexia, ankle clonus, but no clear sensory level. Magnetic resonance imaging demonstrated an intramedullary T_1 and T_2 hypointense, homogeneously-enhancing lesion at T8 with extensive cephalad and caudal edema. **Results:** Laminectomy at T8–9 afforded gross total resection of the lesion that had a clear cleavage plane with normal spinal cord. Intraoperative pathology suggested high-grade glioblastoma, but final section showed sporadic giant cells with marked pleomorphism, uniform immunofluorescence staining with both GFAP and CD99, and high MIB-1 index. Electron microscopy showed “zipper-like” junctions. There were no detected genomic abnormalities consistent with glioblastoma. **Conclusions:** We present this first reported case of thoracic spine giant cell ependymoma, alongside scant literature yielding 1 case in the cervical spine and 2 cases in at the filum terminale. While those cases had benign courses, ours demonstrates a high degree of proliferation, making the malignant potential difficult to assess.

INSTABILITY AND IMPENDING INSTABILITY OF THE THORACOLUMBAR SPINE IN PATIENTS WITH SPINAL METASTASES: A SYSTEMATIC REVIEW. *Michael Weber,* Shane Burch,† Charles Fisher.** From the *Vancouver General Hospital, Vancouver, BC, and the †University of California, San Francisco, Calif.

Introduction: The majority of metastatic disease is found in the spine, which is likely to increase secondary to the improved survival rates of patients with many cancer types. Despite published research on instability of the patient with metastatic disease to the thoracolumbar spine, controversy still

exists regarding the specific risks and/or variables to justify surgical stabilization. The objective of this the systematic review was to identify what defines instability and impending instability in the patient with metastatic disease of the thoracic and lumbar spine. **Methods:** The authors identified all possible relevant studies concerning patients with metastatic involvement of T1–L5, biomechanics, epidemiology, clinical issues, radiographic parameters pertaining to the thoracolumbar spine, and instability. Two independent observers performed study selection, methodological quality assessment and data extraction in a blinded and objective manner for all papers identified during the search. In a synthesis of the literature, the authors obtained evidence for what defines instability of the metastatic spine. **Results:** A literature search identified 39 papers of potential relevance. Seven additional papers were identified from the reference lists of these selected papers. The study selection process supported a total of 14 relevant papers for inclusion in this systematic review. Common deficiencies among studies included a lack of a specific research question, no description of the study population, no comments on eligible patients who did not participate, and lack of blinded or objective outcome assessment. **Discussion:** There is a lack of evidence to make definitive conclusions; however, the authors recommend variables such as tumour size, magnitude of spinal loading, bone density, tumour location both within the vertebrae and spine and tumour type to be risk factors for instability in spinal metastases. The authors found that there is strong need for improved clinical research methodology to be applied to this patient population.

PREOPERATIVE CROSS-SECTIONAL LUMBAR PARASPINAL MUSCLE AREA MAY PREDICT CLINICAL OUTCOMES FOLLOWING LUMBAR LAMINECTOMY. *Maurice TomPack,* Lynn Ashdown,† Parham Danshevar,* Simon Dagenais,‡ Donald Chow,‡ Joseph O’Neil,‡ Garth Johnson,‡ Eugene Wai.‡* From the *Division of Orthopaedic Surgery, †Faculty of Medicine and ‡Spine Unit, University of Ottawa, Ottawa, Ont.

Introduction: The goal of laminectomy is to relieve spinal stenosis and improve claudicant/radicular pain. Back pain related to poor trunk muscular conditioning may negatively affect postoperative outcomes. A better understanding of this relationship is important to improve the selection of appropriate surgical candidates. The purpose of this study was to assess the association between cross-sectional lumbar paraspinal muscle area as measured by CT and outcomes following laminectomy. **Methods:** A prospective observational study of 23 patients undergoing primary elective lumbar laminectomy without fusion who were assessed with preoperative CT scans was performed. Clinical outcomes were measured with Numerical Pain Scale (NPS) for back and leg pain and the Oswestry disability index (ODI) at baseline and follow-up at a minimum of 1 year. The lumbar paraspinal muscle cross-sectional area was measured using digital imaging software and adjusted for percent fat infiltration on preoperative CT scans; evaluations were blinded to clinical outcomes. **Results:** There were significant improvements in clinical outcomes following laminectomy. ODI decreased from mean 53.9 (standard deviation [SD] 11.8) at baseline to 27.3 (SD 20.6) after a follow-up of 15.2 (SD 3.5) months. A strong correlation existed

between cross-sectional lumbar paraspinal muscle area, after adjusting for infiltrating fat content, and improvement in ODI ($r = 0.51$, $p < 0.02$) or back pain NPS ($r = 0.55$, $p < 0.02$). These relationships remained statistically significant after adjusting for age and body mass index. **Conclusions:** This study suggests a possible relationship between the cross-sectional lumbar paraspinal muscle area and outcomes following laminectomy. This raises important questions regarding the role of trunk muscular conditioning in the etiology of back pain and success of surgery. Further research is required to refine this measurement as a tool to improve patient selection for surgery.

RANGE OF MOTION LOSS IS RELATED TO DISC HEIGHT LOSS IN THE CERVICAL SPINE: A CLINICAL X-RAY STUDY OF ELDERLY SUBJECTS. James Boak,* Dina Popovic,† Eyal Itshayek,† Lyne Koenig,‡ Marcel Dvorak,†§ Peter Crompton.*§ From the *Injury Biomechanics Laboratory, Department of Mechanical Engineering, the †Department of Orthopaedic Surgery, University of British Columbia, the ‡Synaptic Analysis Consulting Group, and the §International Collaboration on Repair Discoveries, Vancouver, BC.

Introduction: The average age of people suffering spinal cord injuries in Canada is shifting toward an older population, with a disproportionate number of injuries occurring in the spondylotic cervical spine. The biomechanics of the spondylotic cervical spine are not well understood. The objective of this study is to investigate how the range of motion of the geriatric cervical spine is related to a quantifiable measure of degeneration: disc height loss. **Methods:** Sagittal plane radiographs of 6 geriatric subjects in full active flexion and extension were analyzed using custom image analysis software (developed in Matlab V7.0.4) to measure the range of motion and degenerative features of each vertebral motion segment from C1 to C7. Range of motion was then compared with healthy adult population values. Intervertebral disc height was normalized to the anterior-posterior diameter of each segment's inferior vertebral body and then compared with healthy adult population values. Analysis is continuing currently with more subjects. **Results:** In general, levels C4–C7 showed a significant positive relationship between negative disc height change (disc height loss) and negative angular range of motion change (range of motion loss). **Discussion:** This data will contribute to an improved understanding of the relationship between geriatric cervical spine kinematics and disc degeneration. This relationship may be useful to identify patterns of spinal degeneration in the elderly that may predispose an individual to cervical spondylotic myelopathy or spinal cord injury. This may lead to an improved ability to identify spinal segments that will benefit from surgical and nonsurgical interventions.

REFINEMENTS TO THE SIMULTANEOUS ANTERIOR-POSTERIOR APPROACH TO THE THORACOLUMBAR SPINE. Lissa Ogiieglo, Evan Frangou, Stephen Hentschel, Daryl Fourney. University of Saskatchewan, Saskatoon, Sask.

Introduction: The treatment of complex spinal disorders occasionally requires approaches both anteriorly and posteriorly.

This case study illustrates a number of modifications to the previously described simultaneous anterior-posterior approach to the thoracolumbar spine. **Methods:** The details of this refined procedure, the benefits it offers and the indications are illustrated by 3 cases. **Discussion:** By altering the incision slightly, the risk of wound breakdown and infection has been reduced. The use of newly available positioning devices has allowed easier incorporation of fluoroscopy to guide the placement of spinal instrumentation. The authors have expanded the use of the approach beyond the original oncologic indications.

THE CLINICAL OUTCOMES OF LUMBAR DISC HERNIATION TREATED WITH AND WITHOUT DISCECTOMY. Edward Vasarhelyi, David Yen. Queen's University, Kingston, Ont.

Purpose: To define the natural history of lumbar disc herniation treated with and without discectomy using a patient-oriented outcome measure with 2-year follow-up. **Methods:** Eighty-eight (76 operative, 12 nonoperative) patients were prospectively enrolled. All patients had disc herniation with radicular symptoms consistent with their imaging. All operative patients were treated with lumbar discectomy. Nonoperative patients were included provided they elected not to undergo surgery, did not have a cauda equina syndrome or a progressive neurologic deficit. The modified Roland-Morris (RM) questionnaire was administered preoperatively, 6 weeks, 1 and 2 years following surgery. **Results:** There was a significant improvement ($p < 0.001$) between preoperative RM scores and 6-week, 1-year and 2-year follow up. There were no significant differences between the postoperative scores. The nonoperative cohort had significant improvement ($p = 0.002$) between the initial RM scores and 6-week, 1-year and 2-year follow up. There were no significant differences between the follow-up scores in the nonoperative group. **Discussion:** Our rate of operative patients with a successful outcome was consistent with those found by the moderate success group reported in the literature. This indicates that a surgical cure is not automatic and supports the importance of patient selection. There was a significant improvement in postoperative RM scores by 6 weeks, with no differences between 6-week and 2-year follow-up scores. This suggests that functional and vocational assessment if needed can be done at 6 weeks after surgery. Nonoperative patients showed improvement over the first 6 weeks following their initial presentation in clinic. This confirms the favourable natural history of disc herniation. There was no significant change in their symptoms beyond 6 weeks, which supports offering surgery after 6 weeks.

THE EFFECT OF MULTIMODALITY METHODS ON TRANSFUSION REQUIREMENTS IN PEDIATRIC SPINAL SURGERY. Janet Abier, Sarah Bacon, Christian Zaarour, Stephen Lewis. Hospital for Sick Children, Toronto, Ont.

Introduction: The purpose of this study was to determine factors that predict children at increased risk of blood loss during elective spinal surgery and methods of blood conservation strategies that reduce the need for nonautologous transfusions. **Methods:** Charts of 1 surgeon's patients 4–18 years of age undergoing posterior instrumentation and fusion for correction of spinal deformity from 2005–2007 were reviewed.

Sixty-nine patients were divided into 3 subgroups: Group A = idiopathic scoliosis, Group B = neuromuscular (NM) scoliosis, and Group C = other. Consistent anesthesia was maintained. Iron supplements were recommended to all patients. Preoperatively, patients were offered autologous blood donation (ABD), directed donation and erythropoietin (Eprex). Data collected included patient's weight, comorbidity, type of surgery, instrumentation levels, duration of surgery, use of tranexamic acid, ferritin levels, estimated blood loss, cell saver (CS), hemovac drainage and preoperative and day 1 hemoglobin. **Results:** Group A: 41/44 (93%) required no blood transfusion during or after surgery; 19/44 (43%) received erythropoietin preoperatively; 6/44 (13%) received intraoperative CS; 3/44 (6.9%) received 1 unit of predonated autologous blood

postoperatively and all 3 (38%) had a thoracoplasty (2/3 had Eprex preoperatively); 1/44 received 1 unit donor-directed blood. Group B: 7/12 (58%) received allogeneic transfusions; 8/12 (66%) received CS; 1/11 (0.09%) received erythropoietin (1 unit) preoperatively. Group C: 5/13 (38%) received CS; 4/13 (30%) had allogeneic transfusions; 3/13 (23%) received no blood product; 6/13 (46%) had Eprex preoperatively. **Discussion:** In this series, AIS patients not undergoing thoracoplasty did not require any blood products. Erythropoietin did not affect need for blood products. NM patients and those undergoing osteotomies had a higher incidence of requiring blood products. We therefore recommend use of preoperative blood conservation strategies in AIS patients undergoing thoracoplasty and in neuromuscular and osteotomy patients.