

# CSS 2004 — Platform presentations

Thursday, Mar. 18, 2004

**OUTCOME EVALUATION OF OPERATIVE AND NONOPERATIVE TREATMENT FOR LUMBAR DISC PROTRUSION CAUSING RADICULOPATHY.** *Charles Fisher, Kenneth Thomas, Marcel Dvorak, Michael Boyd, Paul Bishop, Peter Wing.* Division of Spine, Department of Orthopaedics, University of British Columbia and the Combined Neurosurgical and Orthopaedic Spine Program, Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Objective:** The primary objective of this study was to document and compare health related quality of life (HRQOL) in patients with lumbar disc protrusion causing radiculopathy treated either operatively or nonoperatively. Secondary objective: determining the influence of baseline variables on HRQOL. **Design:** A prospective cohort design. **Methods:** All patients seen through the Acute Disc Clinic at Vancouver General Hospital were assessed for eligibility. Outcome measures were collected at baseline (clinic visit), 6-month and 1-year time points. **Results:** Five hundred and eighty-eight (588) patients participated in the study. There were 349 patients in the operative treatment group and 239 patients in the nonoperative treatment group. Of the 349 subjects in the operative treatment group, 208 completed 1-year follow-up outcome measures. Of the 239 patients in the nonoperative treatment group, 108 completed 1-year follow-up outcome measures. In total, there were 316 patients with at least 1-year follow-up who formed the sample for this study. Outcome measures were compared between groups and to published normative data.

**PATIENT EXPECTATIONS AND FUNCTIONAL OUTCOME FOLLOWING POSTERIOR LUMBAR SPINAL SURGERY FOR DEGENERATIVE CONDITIONS.** *Joel A. Finkelstein, Albert Yee, Michael Ford, Nana Adjei, Mubarak Al-Gabhtany.* Sunnybrook Spine Program, Toronto, Ont.

**Purpose:** The hypothesis tested was the association between patient expectation for surgery and outcomes as quantified by patient-derived functional outcome measures, patient satisfaction and surgeon perception of patient outcome. **Methods:** One hundred and fifty-five (155) patients undergoing spinal surgery at 1 institution were evaluated. Prospectively collected patient expectation, SF36 and Oswestry measures were recorded preoperatively and serially postoperatively. **Results:** Mean age was 52. Main diagnoses included disc herniation (43%), isthmic or degenerative spondylolistheses (19%), stenosis (30%). Mean preoperative SF36 mental and physical component scores were 41.1 and 22.3. Mean Oswestry was 48.7. Patients reported significant postoperative improvement in SF36 and Oswestry scores. Postop scores were still 1–2 SD below age- and gender-matched country norms. Patients with predominantly leg symptoms reported statistically greater improvement in scores when compared with those with com-

bined leg and back pain symptoms. Overall patient satisfaction was 81%. In 19%, surgery did not meet patient expectations. This was explained in 6 by 2 nonunions, 1 misplaced pedicle screw and 3 with significant medical comorbidity. In the remainder, factors negatively influencing meeting expectations included prior lumbar surgery, worker compensation/litigation and lower preop scores on the VT and GH subscales of the SF36. Surgeon rating of patient outcome correlated poorly with patient reported satisfaction ( $\kappa = .19-.28$ ). **Discussion:** Surgery met patient expectation in the majority of cases. Patient expectation for surgery and factors that influence patient expectation and perception of outcome requires further study. A response shift is hypothesized to contribute to these findings.

**THE RELATIONSHIP BETWEEN SURGICAL APPROACH AND OUTCOME FOR ADULT LOW-GRADE ISTHMIC SPONDYLOLISTHESIS: A SYSTEMATIC REVIEW.** *Brian K. Kwon, Alan S. Hilibrand, Kelly Malloy, Paul Savas, Marco T. Silva, Todd J. Albert, Alexander R. Vaccaro.* Combined Neurosurgical and Orthopaedic Spine Program (CNO SP), Department of Orthopaedics, University of British Columbia, Vancouver, BC; Department of Neurosurgery, Thomas Jefferson University; The Rothman Institute, Department of Orthopaedic Surgery, Thomas Jefferson University, Philadelphia, Pa.

**Introduction:** While numerous reports exist describing the surgical outcomes of adults with isthmic spondylolisthesis, the optimal surgical approach has not been established. The purpose of this study was to systematically review the reported literature on the radiographic and clinical outcomes of adult patients undergoing surgical management for low-grade isthmic spondylolisthesis. We also sought to evaluate the influence of such covariates as a laminectomy, spinal instrumentation, smoking and secondary gain issues on these outcomes. **Methods:** Studies that described the radiographic or clinical outcomes after the surgical management of adult patients with low-grade isthmic spondylolisthesis were reviewed. Patients were pooled, and a  $\chi^2$  analysis was performed to determine the relationship between surgical approach and patient outcome. A covariate analysis was performed to determine the influence of a laminectomy, spinal instrumentation, smoking and secondary gain issues on these outcomes. **Results:** Patients with combined anterior and posterior procedures were most likely to achieve a solid fusion and a successful clinical outcome. The use of spinal instrumentation also increased the chance of fusion and successful clinical outcome. A history of smoking or the presence of secondary gain issues were associated with poor clinical outcomes. **Conclusions:** A pooling of the adult patients reported in the literature who underwent surgical management of low-grade spondylolisthesis indicates that a combined anterior and posterior procedure most reliably achieves fusion and a successful clinical outcome.

**PERIOPERATIVE ADVERSE EVENTS IN IN-PATIENT SPINAL SURGERY: A PROSPECTIVE DATABASE.** *Y.R. Rampersaud, M.A. Neary, E.R.P. Moro, K. White, M.G. Fehlings, S.J. Lewis, E.M. Massicotte.* Division of Orthopaedic and Neurosurgery; Manager, Allied Health; Division of Neurosurgery, Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ont.

**Introduction:** Adverse events (AE) in spinal surgery are not reported with consistency. Accurate documentation of AE is critical for quality assurance and to facilitate improvements in clinical protocols. The purpose of this study was to develop and report on the use of a novel grading system for AE and the implementation of a prospective database for perioperative AE in spinal surgery. **Methods:** From 12/2001 to 06/2003, an AE data sheet (completed by surgical, nursing and allied health personnel) was attached to the chart of all in-patients undergoing a wide variety of spinal procedures. AE were defined as any negative event occurring while in-hospital that was unexpected/undesirable. AE were graded as I (minor: none/minimal treatment, minimal effect on length-of-stay [LOS]), II (moderate: requires treatment, increases LOS 2–3 days, no long term sequelae), III (severe: requires treatment, increases LOS >4 days, long term sequelae) and IV (death). **Results:** Completed data sheets on 837 patients (80% completion rate) revealed an overall adverse event rate (AER) of 26.2% ( $n = 219$ ). The mortality rate was 0.3%. Of the 219, 104 were medical and 115 were surgical. The majority of surgical (Grade: I;  $n = 34$ ; II,  $n = 67$ ; III,  $n = 14$ ) and medical (Grade: I,  $n = 33$ ; II,  $n = 64$ ; III,  $n = 3$ ; IV,  $n = 4$ ) events were mild or moderate (88% and 93%, respectively). **Conclusion:** In conclusion, the results of this study represent a prospective comprehensive look at overall AE in spinal procedures and offer a practical grading system. This approach to the documentation and analysis of AE will enable objective assessment of quality of care and facilitate evidence-based changes in clinical protocols.

**CAUDAL JUNCTIONAL KYPHOSIS AS A CAUSE OF POST-OPERATIVE FLAT-BACK SYNDROME.** *Hossein Elgafy, Marcel Dvorak, Michael Boyd, Charles Fisher.* Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Objective:** The purpose of this study was to describe this previously unreported complication, its treatment, and to identify predictors. **Methods:** We identified 10 patients who experienced early (within 3 months) onset of progressive postoperative lumbar junctional kyphosis following multi-level lumbar arthrodesis. Radiographs were analyzed for: total lumbar lordosis; total lordosis within the instrumented segment; the distance between the sagittal vertical axis and posterior border of the L1 vertebra; and the distance between the distal pedicle screw and the inferior end plate of the corresponding vertebra. **Results:** Six (6) women and 4 men presented with progressive postoperative lumbar kyphosis following initial satisfactory postoperative sagittal plane alignment. Radiographic analyses revealed progressive kyphosis at the caudal end of lumbar segmental instrumentation due to loosening and caudal migration of L5 pedicle screws (4 cases), pedicle and laminar insufficiency fractures (4 cases) and disco-ligamentous kyphosis (2 cases).

All patients reported severe symptoms necessitating surgical revision and all were treated with posterolateral extension (pedicle subtraction) osteotomy to restore lordosis. Common features predisposing to progressive caudal junctional kyphosis included: multiple level lumbar arthrodesis (3 or more motion segments), circumferential (anterior and posterior) fusion, extension of a previous lumbar fusion, major deformity correction (kyphosis or scoliosis) and caudal fixation point at the L5 level. **Discussion:** There are no reports in the literature of postoperative flat-back syndrome that has developed as a result of progressive focal kyphosis at the caudal end of lumbar segmental instrumentation. Surgeons should be aware of this potential complication, particularly in patients with multilevel lumbar circumferential fusions with the caudal fixation level at L5.

**ANTERIOR LUMBAR INTERBODY FUSION — 20-YEAR MRI FOLLOW-UP.** *E.K. Wai, E. Santos, R.D. Fraser.* Spinal Unit, Royal Adelaide Hospital, University of Adelaide, Adelaide, Australia

**Introduction:** There are concerns that lumbar fusion leads to increased stress at the adjacent levels. However, the clinical significance of this remains unclear. The objective of this study is to assess the degree of adjacent level degeneration with a minimum of 20 years follow-up. **Methods:** Thirty-nine (39) patients who underwent lower lumbar anterior lumbar interbody fusion and who had normal preoperative discograms at the adjacent level were evaluated with a minimum of 20 years follow-up. MRI scans were performed and independently evaluated for any evidence of degeneration. **Results:** Advanced degeneration was identified in 13 (33%) patients, with 6 (15%) being isolated to the adjacent level. Fifteen (39%) additional patients had early degeneration, of which 5 (16%) were isolated to the adjacent level. There was no relation between function and radiographic degeneration. Three (8%) patients required additional surgery as a result of adjacent level degeneration. **Discussion and conclusion:** The prevalence of degenerative changes is similar to other studies involving normal asymptomatic subjects. After 20 years, only a handful of patients developed advanced adjacent-level degeneration. Furthermore, the majority of degenerative changes seen occurred over multiple levels or at levels not adjacent to the fusion, suggesting that changes seen may be more likely related to constitutional factors as opposed to the increased stresses arising from the fusion.

**A PROSPECTIVE RANDOMIZED CLINICAL STUDY COMPARING INSTRUMENTED LUMBAR FUSION RATES OF RECOMBINANT HUMAN BONE MORPHOGENIC PROTEIN-2 (rhBMP-2) WITH AUTOGENOUS ILIAC CREST BONE GRAFT IN PATIENTS WITH SYMPTOMATIC DEGENERATIVE DISC DISEASE. CALGARY EXPERIENCE.** *I. Assiri, S. du Plessis, J. Hurlbert, R. Hu, P. Salo, T. Whittaker.* University of Calgary Spine Program, Department of Clinical Neurosciences, Division of Neurosurgery, Calgary, Alta.

**Background:** Spinal fusion requires harvesting of a bone graft from iliac crest, or using of a donor bone. The use of autograft has been associated with limited supply and donor site morbidity.

The use of allograft has also been associated with infection and disease transmission. Therefore, an alternative that promotes bone fusion without the associated problems of autograft or allograft is attractive. **Methods:** This prospective, randomized, controlled, multi-centre trial involves posterolateral lumbar fusion in patients with degenerative disc disease. All patients were instrumented with the TSRH<sup>®</sup> spinal system. The patients were randomized into an investigational group receiving rhBMP-2 or a control group receiving autogenous bone. Fusion rates were assessed by radiographs and CT scans and were defined by the presence of continuous bridging trabecular bone bilaterally on both modalities, with absence of motion on flexion-extension radiographs. **Results:** Fifteen (15) patients were recruited in Calgary for this study; 8 in the investigational group and 7 in the control group. The rate of fusion in the investigational group was reported as 6 patients fused at 6 months and 5 patients met the criteria for fusion at 24 months. In the control group, no fusion was reported at 6 months, and 1 patient met the criteria for fusion at 24 months. The mean Oswestry score showed changes in the investigational group from 53.1 preoperatively to 22.0 at 24 months, compared with changes in the control group from 48.8 preoperatively to 31.2 at 24 months. **Conclusion:** rhBMP-2 when used with the TSRH<sup>®</sup> spinal system for posterolateral lumbar fusion showed superior fusion rates when compared with the use of autogenous bone graft harvested from iliac crest.

**MINIMALLY INVASIVE POSTERIOR LUMBAR INSTRUMENTED FUSION (PLIF): PRELIMINARY CLINICAL REPORT.** *Y. Raja Rampersaud.* Division of Orthopaedic and Neurosurgery, Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ont.

**Introduction:** Recently, a number of spinal procedures have attempted to minimize the muscle morbidity associated with posterior spinal approaches. The purpose of this study is to describe the operative technique and early clinical results of minimally invasive PLIF. **Methods:** Retrospective review of prospectively collected data on 14 patients from March 2002 to present. Pre- and postoperative short-form McGill Pain Questionnaires (MPQ) and Oswestry low-back outcome measures were obtained. **Results:** The diagnoses were: isthmic spondylolisthesis (8: grade I [5], grade II [3]), degenerative disc disease/disc herniation (5) and iatrogenic – degenerative spondylolisthesis (1: grade III). A single level procedure was performed at L5–S1 (8), L4–5 (4), L3–4 (1) and 2 levels at L4–5/L5–S1 (2). All procedures were performed using a bilateral 3-cm paramedian muscle splitting approach with the MetRx<sup>™</sup> tubular retractor system, Telamon titanium interbody cages and the Sextant<sup>™</sup> percutaneous pedicle screw system. BMP-2 was used in 5 patients. The average OR time, blood loss and length of hospital stay was 6 hours (4.25–7.5), 340 cc (100–800) and 3.5 days (3–5). There were no perioperative complications. The average pre-, 6-week and most recent (3-month to 1-year) postoperative VAS/MPQ scores were 7.7/17.3, 0.9/3.3 and 1.9/2.3, respectively. Oswestry scores (converted to a scale of 100) were 58.3, 38.9 and 29.6, respectively. All patients reported good or excellent overall

satisfaction and indicated they would undergo the procedure again. **Conclusion:** The early results of minimally invasive PLIF are encouraging and appear to justify the initial steep learning curve and increased operative time.

Friday, Mar. 19, 2004

**SPINAL CORD LEVEL PEDICLE SUBTRACTION OSTEOTOMY FOR THE TREATMENT OF THORACIC KYPHOSIS: EARLY RESULTS AND COMPLICATIONS.** *Stephen J. Lewis, Y. Raja Rampersaud, Manoj D. Singrakhia, Eduardo R.P. Moro, Michael G. Fehlings.* Division of Orthopaedic Surgery; Division of Neurosurgery, Spinal Program, Krembil Neuroscience Centre, Toronto Western Hospital, University Health Network, University of Toronto, Toronto, Ont.

**Purpose:** To determine the results and safety of patients undergoing spinal cord level (SCL) pedicle subtraction osteotomy (PSO) for the treatment of thoracic kyphosis. **Methods:** Retrospective chart and radiographic review of 25 patients. **Results:** The underlying diagnoses were: tumour (8), Scheuermann's kyphosis (4), degenerative/osteoporosis (3), fracture (3), inflammatory (2), neurofibromatosis (2), congenital kyphosis (1), tuberculosis (1) and infected tumour (1). The osteotomy was combined with a lumbar PSO in 5 patients. Three patients were treated with double thoracic osteotomies. Two PSOs were extended transdiscally to debride the infected disc. The mean focal PSO correction was 33.6° (range 9°–73°). The overall thoracic kyphosis measured from T5 to T12 improved from a mean of 58.3° preoperatively to 37.1° postoperatively. Estimated blood loss ranged from 400 cc to 12 500 cc. All patients presenting with preoperative spinal cord dysfunction improved neurologically postoperatively. There were 2 major neurological complications. One patient developed postoperative progressive paraplegia following a prolonged period of intra- and postoperative severe hypotension and coagulopathy. The other developed a pseudoarthrosis 5 months postoperatively, suffering an incomplete spinal cord injury during the subsequent revision. Other complications included: T3 radicular pain (1), resolved; dural tears (2); respiratory failure, prolonged ICU (1); fractures proximal to the thoracic (2) and distal to lumbar (1) instrumentation; incomplete corrections of severe sagittal malalignment despite double osteotomies (2); wound breakdown due to preoperative radiation (1). **Conclusion:** SCL-PSO is a feasible option for severe thoracic kyphosis. This procedure eliminates the need for anterior surgery but requires complex reconstructions with the potential for significant morbidity.

**PATIENT CHARACTERISTICS ASSOCIATED WITH SURGEONS' RATINGS OF PHYSICAL DEFORMITY IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS).** *Sandra Donaldson, Doug Hedden, Derek Stephens, Ben Alman, Andrew Howard, Jim Wright.* The Hospital for Sick Children, Toronto, Ont.

**Purpose:** To identify patient characteristics associated with surgeons' ratings of patients' physical deformity in Adolescent Idiopathic Scoliosis (AIS). **Method:** Five (5) surgeons inde-



pendently rated clinical photographs of 40 patients with AIS. Surgeons separately rated the appearance of patients' shoulder blades, shoulder symmetry, waist symmetry and also rated patients' "overall appearance" (in 5 categories from 0 [best] to 5 [worst]). The following clinical and radiographic data was also collected: rib prominence, vertebral rotation, shoulder height, spinal imbalance, Cobb angle, age, sex and body mass index. **Summary of results:** Surgeons' mean rating for "overall appearance" was moderately correlated with rib prominence ( $r = 0.48$ ), vertebral rotation ( $r = 0.44$ ) and Cobb angle ( $r = 0.53$ ). Surgeons' rating of patients' "overall appearance" was affected by each of: shoulder blades ( $p = 0.001$ ), shoulder symmetry ( $p = 0.01$ ) and waist ( $p = 0.001$ ). However, each surgeon weighted the components of patients' appearance differently to arrive at their overall rating of appearance ( $p < 0.006$ ). **Significance:** Because patients' physical appearance is an important element of surgical decision making, differences among surgeons could be contributing to inconsistent recommendations about surgery. **Conclusion:** Surgeons' ratings of overall physical appearance are based on their appraisal of patients' shoulder blades, waist and shoulder symmetry. Surgeons, however, weight these elements differently. **Discussion:** Surgical decision making is complicated. Recommendations for surgery are based on radiographs and subjective assessment. Patient appearance undoubtedly influences surgeons' recommendation for surgery. We need to clarify and improve the criteria for surgical decision making. **Funding:** This trial was funded by (in alphabetical order) The Canadian Institutes of Health Research, DePuyAcroMed-Johnson & Johnson Medical Products and Synthes, Canada.

**POSTEROLATERAL APPROACH FOR SPINE METASTASES.** *Charles Fisher, Joe Sparkes, Marcel Dvorak.* Division of Spine, Department of Orthopaedics, University of British Columbia and the Combined Neurosurgical and Orthopaedic Spine Program, Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Introduction:** The posterolateral approach to the spine allows for complete resection of metastatic spine tumours and both anterior and posterior column reconstructions via a single posterior approach, making this approach a theoretically attractive means of addressing this challenging clinical problem. We report our experience with this approach in a group of patients followed prospectively over a 1-year period. **Materials and methods:** This was a prospective cohort study. A group of 32 patients underwent spine metastasis resection via a posterolateral approach, and these were compared with a simultaneously recruited cohort undergoing spine metastasis surgery via other operative approaches. The primary clinical outcome was the rate of complications observed in the posterolateral group compared with the other surgical group. Secondary outcomes included changes in neurologic status and survival post-surgery. **Results:** Patients undergoing posterolateral surgery had lower rates of complications and comparable survival rates when compared with the other surgical group. **Conclusions:** Figures indicate that the posterolateral approach is a safe and effective means of surgically addressing spine metastases.

**OUTCOMES FOLLOWING SURGERY FOR SPINE METASTASES.** *Charles Fisher, Joe Sparkes, Marcel Dvorak.* Division of Spine, Department of Orthopaedics, University of British Columbia and the Combined Neurosurgical and Orthopaedic Spine Program, Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Objective:** The primary outcome measure was improvement in the specific pain for which they had the procedure at 3 months postoperatively. Secondary outcomes were the influence of selected preoperative variables on the aforementioned outcome measures using regression modelling analysis. **Design:** A prospective cohort study. **Methods:** All patients who underwent surgical treatment for metastatic disease of the spine from February 1995 to July 2003. Patients with previous spine surgery for metastases and primary tumours of the spine were excluded. Seventy (70) patients were included in the study sample. Demographic data, baseline variables and standardized outcome measures were completed preoperatively. Outcome measures were: EORTC-QLQ-30, NASS questionnaire, Visual Analog Pain Score, Health Utility Index and Comorbidity Scale. The assessment time points were pre-surgery and at 6 weeks, 3 months, 6 months and 12 months post-surgery. **Results:** Patients reported significant improvements following surgery in a number of domains including

	Pre-surgery	3 months	p value
Pain	7.86	4.60	<0.0001
Quality of life	3.07	3.8	<0.05
ECOG	2.28	1.84	0.051

**Conclusion:** Surgical intervention in patients with spine metastases can provide significant benefits for the patient.

**DIFFERENCES IN PEDICLE SCREW AUGMENTATION WITH LAMINAR HOOKS, SUBLAMINAR WIRES AND CALCIUM PHOSPHATE CEMENT.** *J.S. Tan, Brian Kwon, Marcel Dvorak, Charles Fisher, Thomas Oxland.* Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Objective:** The purpose of this study was to contrast the mechanical behaviour of pedicle screws augmented with hooks, wires or cement under physiologic loads. **Methods:** Cyclic testing was performed on pedicle screws inserted in overdrilled pedicles by applying a caudad-cephalad compressive force and bending moment. Forty-eight (48) screws were inserted in 24 cadaveric vertebrae (L3-L5) and were augmented with hooks, wires or calcium phosphate cement. Motion at the screw tip and screw head were measured using an optoelectronic camera system and the magnitudes compared in a paired manner using non-parametric statistics. Motion patterns of the screw tips and screw heads were recorded. **Results:** Augmentation with hook, wire or cement decreased screw motion when compared with the screw alone. There were no significant differences between augmentation methods when the magnitude of motion, described as range and offset, were compared. Augmentation with cement resulted in rotation of the screws, while wire and hook

augmentation led to rigid body translation. **Discussion:** This study contrasted pedicle screw motion with different augmentation methods. Correlating the direction and magnitude of motion of the screw head and screw tip was most informative. When the screw head and screw tip moved synchronously, this indicated rigid body translation of the screw, which is probable evidence of loosening. Using simple pull-out tests would not detect such differences. While there was no detected significant difference in motion magnitude of the pedicle screws, the motion pattern of the screws suggested better augmentation with cement.

### SPINAL CORD REACTION TO NITINOL AND TITANIUM PARTICLES: A 1-YEAR STUDY IN RABBITS. *Souad Rhalmi, Sylvie Chavette, Michel Assad, Michel Leroux, Charles-H. Rivard.* Ste-Justine Hospital and Biorthex Inc., Montréal, Que.

Nitinol and titanium alloy particles were implanted into the spinal canal of a rabbit model to simulate the unlikely event of metallic debris release following interbody fusion device failure.

Forty-five (45) white female rabbits were divided into 3 groups: nitinol ( $n = 20$ ), titanium ( $n = 20$ ) and sham operation ( $n = 5$ ). Particles ( $<300 \mu\text{m}$ ) were implanted directly into the spinal canal. The animals were sacrificed after 1, 4, 12, 26 and 52 weeks. All specimens were first examined macroscopically and then fixed in formalin and processed for histology. The spinal cord, dura mater and surrounding soft tissue were examined for inflammatory reaction, necrosis or potential toxicity.

The macroscopic analysis revealed that all particles remained on site, clung to the adipose and soft tissue. No necrosis of the dura mater was observed regardless of material type or implantation time. At 1 week, the histologic analysis showed an inflammatory reaction limited to the soft tissue at the implantation site both with nitinol and titanium particles. Slightly fibrotic tissue with mild inflammatory reaction was limited to the soft tissue at 1 month, while compact fibrotic tissue with minimal inflammatory reaction was shown at 3 months. At 6 and 12 months, a well-organized connective tissue was revealed, while scarce macrophages and lymphocytes surrounded either nitinol or titanium particles. Regardless of material type and implantation time, the dura mater, spinal cord and nerve roots tissues were free of reaction.

Macroscopic and histologic evaluation of exposed spinal cord tissue showed a similar and normal inflammatory reaction in both material types.

### ARE CANADIAN SPINAL SURGEONS READY FOR TELEHEALTH? *Gregory D. Harvey, Roger Cho, Elisia Teixeira, Richard W. Hu.* Royal Hobart Hospital, Tasmania, Australia; University of Calgary, Foothills Medical Centre; "Bone & Joint Telematics" Telehealth Unit, University of Calgary, Calgary, Alta.

Telehealth is the use of advanced telecommunications technologies to exchange health information and provide health care services across geographic, time, social and cultural barriers. Telehealth is a reality in Canada. Vast developments in technology have occurred in the last decade. Canarie has been

a driving force in this process. Research is moving away from investigations into technology provision, towards the application of this technology in health-care delivery. Telehealth remains an innovation to the medical sector destined to use this technology. Integral to the successful application of this technology is the readiness for change within a community. Readiness can be defined by the factors that must be in place before an innovation is introduced. Readiness is an integral and preliminary step in the successful adoption of an innovation. It represents the cognitive precursor to the behaviours of either resistance to, or support for, a change effort. A lack of readiness is a huge, and potentially fatal, obstacle to the adoption of an innovation. Canarie has spent a great deal of time and money in examining the readiness of various communities. They investigated the patient, family practitioner, public and organizational domains. No assessment was made of the urban specialists who will provide some of the services examined in the report. The present study addresses the readiness of Canadian spinal surgeons to accept and potentially use telehealth.

The data was obtained using a phenomenological approach (similar to Canarie) and Likert-scale questionnaire. The readiness of this community should be assessed before inappropriate Telehealth investments are made. The information obtained will be used to design an application for remote consultation between patient and spinal surgeon using telehealth.

The majority of respondents were not aware of existing practical applications of this technology for surgical care, although they are aware of what telehealth represents.

Most surgeons professed an average or better computing experience, but only a few have had direct experience with telehealth applications. Eighty percent (80%) of the participants agreed with the statement "I am confident in using computers," 60% with using telecommunication equipment, and 36% with videoconferencing technology.

There was clear evidence that telehealth was thought to be beneficial to potential patients, but concern is raised about the lack of examination and direct contact before surgery. Although respondents ( $n = 27$ ) clearly indicated the need to provide alternative access to remote populations (88%), identifying their own patients as in need of this type of technology is not as clear (48%). However, the majority (56%) agreed with the statement: "I think telehealth can work at a practical level," and 60% would change their practice if an appropriately designed system were available, 68% said to be "curious about telehealth." In terms of telehealth applicability, "giving advice to another doctor" ranked higher with 88.4%, compared with "reviewing investigations" with 73.1% of agreement among participants, "history taking" with 61.6%, "formulating a management plan" (57.7%), screening referrals (53.9%), "communicating with my patient" (50%). "Gaining rapport with my patient" (15.4%) and "performing an examination" (11.5%) were considered problematic applications of telehealth for providing care. The examination would be trusted if carried out by preferably a spine fellow at a proportion of 96.1%, followed by orthopaedic surgeon (84.7%), resident (65.3%). A lower proportion would trust the assessment if carried out by another surgeon (40%) or by a nurse practitioner (30.8%), physiotherapist (30.8%), registered nurse (15.3%) or chiropractor (15.3%).

A large number of concerns were raised regarding the barriers to implementation of this technology into practice.

Respondents indicated to be concerned with “the costs to establish this system in my practice” (76%) and “the extra load this will add to their practice” (73.1%), followed by “the legal implications of telehealth consulting” (65.4%). Issues that must be solved before participants would use the technology included legal implications (84%), followed by data security (70.9%) and online privacy (66.7%).

Currently, this population does not appear ready to adopt this technological approach. Although not ready for full implementation, this novel means of combining existing and new technology and processes will be tested, and we hope this will improve patient care and be adopted in the future. “Personal experience with a trial” would influence the respondents to use this technology at a proportion of 69.2%, compared with “published evidence regarding reliability and success” at 61.6%, “realistic claims about system performance” at 57.7%, “use by colleagues” at 50% and “patient desire” at 38.5%.

**SO YOU WANT TO GET PUBLISHED? A SYSTEMATIC ANALYSIS OF FACTORS ASSOCIATED WITH PEER-REVIEWED PUBLICATION IN THE SPINE LITERATURE.** *Liisa R. Vexler, Robert D. Fraser, Eugene K. Wai, E. Santos.* Ottawa Hospital, University of Ottawa, Ottawa, Ont. and Royal Adelaide Hospital, University of Adelaide, Adelaide, Australia

**Objective:** To identify factors associated with eventual peer-reviewed publication in spinal research presented at national and international meetings. **Methods:** Independent reviewers performed systematic reviews of the abstracts presented at the annual meeting of the International Society for Study of the Lumbar Spine (ISSLS) and the Canadian Spine Society (CSS). All abstracts reviewed were categorized into type of research, and aspects of research quality were identified. A Medline database, blinded to the results of the review, was performed to identify abstracts that went onto peer-reviewed publication. **Results:** Univariate and multivariate analyses reviewed that blinding, use of an experimental design, basic science or biomechanical research, and a statistically significant positive result were significant predictors of eventual publication. Papers employing blinded or independent review of outcome were the strongest predictors of publication, and papers employing this had an adjusted odds ratio of 4.7 for being published compared with those papers that did not. Overall, 23% of ISSLS' abstracts were published within 1 year, and 67% within 2 years. In contrast, 6% and 13% of CSS abstracts were published within 1 and 2 years, respectively. **Discussion:** This review has highlighted factors that are associated with eventual peer-reviewed publication. Although limited numbers of presentations from the CSS precluded statistical conclusions, comparisons between the 2 societies will be presented.

**Saturday, Mar. 19, 2004**

**OCCIPITO-CERVICO-THORACIC FUSIONS IN PATIENTS WITH EXTENSIVE CERVICAL INVOLVEMENT FROM RHEUMATOID ARTHRITIS.** *G. Swamy, R.J. Hurlbert.*

**Background:** A minority of patients with rheumatoid arthritis experience severe cervical involvement with atlanto-axial

subluxation, basilar invagination and subaxial subluxation. We have been performing occipito-cervico-thoracic (OCT) fusions in these patients using a combined anterior/posterior approach in an attempt to treat all 3 pathologies definitively. **Methods:** We reviewed the hospital records and office charts of patients undergoing OCT fusion at our institution from 1997 to 2003. Seven patients were identified, all with severe rheumatoid arthritis. Mean follow-up was 24 months. Preoperatively, 2 patients were classified as Ranawat I neurologic status, 2 patients were Ranawat II, and 3 were Ranawat IIIb. The indications for surgery were progressive neurologic deterioration in 5 and intractable neck pain in 2. **Results:** Surgery involved a staged anterior and posterior approach in all 7 patients. The mean total operative time was 18 hours, with a mean ICU stay of 8 days (range 0–18). Postoperatively, 3 patients were Ranawat I neurologic status, 1 was Ranawat II and 2 remained Ranawat IIIb. Serious complications included CHF, pneumonia, airway obstruction, esophageal dysfunction, DVT, renal insufficiency and temporary weakness. All patients experienced significant pain relief. One patient with non-union died from multi-organ failure following revisional surgery 1 year after the index OCT fusion. Thoracic adjacent segment disease with myelopathy was seen in 1 patient, requiring extensive additional thoracolumbar decompression and fusion. **Conclusions:** OCT fusion is an effective method to definitively treat extensive cervical involvement from rheumatoid arthritis, but surgeons and patients should be aware of the high complication rate in this difficult population.

**MOTOR RECOVERY, FUNCTIONAL STATUS AND HEALTH RELATED QUALITY OF LIFE IN COMPLETE CERVICAL SPINAL CORD INJURIES.** *Charles G. Fisher, Vanessa K. Noonan, Donna E. Smith, Marcel S. Dvorak, Peter C. Wing.* Division of Spine, Department of Orthopaedics, University of British Columbia; Combined Neurosurgical and Orthopaedic Spine Program, Vancouver Hospital and Health Sciences Centre; Vancouver Spine Research Centre, Vancouver, BC

**Objective:** To determine motor recovery in complete traumatic spinal cord injury (SCI) patients. Secondary objectives included: 1) determining which factors predict local recovery; 2) assessing functional status using Functional Independence Measure (FIM); and 3) assessing generic health related quality of life using the Short Form-36 (SF-36). **Design:** Retrospective cohort with cross-sectional follow-up. **Methods:** All patients admitted to Vancouver Hospital with a complete SCI between 1994 and 2000 were identified. Patients were excluded if they were found to have incomplete spinal cord injury following resolution of spinal shock. Minimum 2-year follow-up consisted of an ASIA motor score (AMS), a FIM and the SF-36. Changes in variable measurements from cessation of spinal shock to follow-up were evaluated using the Wilcoxon 2-sample test. Demographic variables were analyzed using descriptive statistics. **Results:** One hundred and thirty-three (133) patients were identified, 95 were eligible and 71 completed follow-up. Thirty (30) had tetraplegia and 41 had paraplegia. For tetraplegics, the average admission AMS was 12 and follow-up 20. This change reflected local recovery only. For paraplegics, the admission AMS was 49 and follow-



up 52. This reflected significant change in 1 patient who was probably misdiagnosed. In tetraplegics, 57% had functional recovery 1 level below injury level, 16% 2 levels below, and 3% 3 levels below. Mechanism of injury appeared associated with local recovery. The SF-36 MCS score was 41 in tetraplegics and 40 in paraplegics. **Conclusions:** Motor recovery does not occur below the zone of injury for complete spinal cord injury patients. Varying degrees of local recovery can be expected in tetraplegics.

**INTEROBSERVER RELIABILITY AND CLINICAL VALUE OF RADIOLOGICAL PARAMETERS TO QUANTITATE SPINAL CANAL COMPROMISE AND CORD COMPRESSION AFTER ACUTE SPINAL CORD INJURY: PRELIMINARY RESULTS OF A PROSPECTIVE VALIDATION STUDY.** *Julio C. Furlan, Nabeel Al Shafai, Eric Massicotte, Michael G. Fehlings.* Krembil Neuroscience Centre, Spinal Program, Toronto Western Hospital Research Institute, University Health Network; Department of Surgery, Division of Neurosurgery, University of Toronto, Toronto, Ont.

**Objective:** To evaluate the interobserver reliability and to verify whether neurological evaluation is correlated with maximum canal compromise (MCC) and maximum spinal cord compression (MSCC) in individuals with acute spinal cord injury (SCI). **Methods:** We included all individuals with acute traumatic cervical SCI admitted to the TWH who were enrolled in the STASCIS prospective study. Using ASIA scores, neurological status was assessed at admission. MCC was measured from preop/postop CT scans and MRIs. MSCC was obtained from preop/postop MRIs. Two observers performed blinded radiologic measurements. Data were analyzed using paired *t*-test and linear regression. **Results:** There were 16 individuals (2F, 14M; ages 18–63 years; mean 39) who underwent surgery for SCI. Most individuals had incomplete motor/sensory impairments (ASIA B4, C3, D4), but 3 subjects showed ASIA A and 2 E at admission. Decompression of spinal cord was achieved from 9–236 hours (mean 49) after SCI. Variability of radiologic measurements between both observers was not significant for preop/postop-CT-MCC, preop/postop-MRI-MSCC and postop-MRI-MCC. The interobserver differences for preop-MRI-MCC ( $p = 0.024$ ) were minimized with standardization of measurements ( $p = 0.151$ ). There was no correlation between ASIA score and preop CT-MCC or MRI-MSCC. A trend for an association between ASIA score and preop-MRI-MCC ( $p = 0.078$ ) was observed. Differences between preop/postop measurements were correlated with timing of decompression only for MRI-MCC ( $p = 0.045$ ). **Conclusions:** The interobserver variability was acceptable for all 3 radiologic parameters. MRI-MCC was the only radiologic parameter that was associated with ASIA score. Correlation between MRI-MCC and timing of decompression suggests that early decompression may improve neurological outcome.

**EARLY VERSUS LATE ENTERAL FEEDING IN PATIENTS WITH ACUTE CERVICAL SPINAL CORD INJURY: A PILOT STUDY.** *Marcel Dvorak, Vanessa K. Noonan, Birthe Bruun, Lise Bélanger, Charles Fisher.* Vancouver Hospital and Health Sciences Centre, Vancouver, BC

**Purpose:** To compare the incidence of infections in patients with acute spinal cord injury (ASCI) who received early versus late enteral feeding. Secondary objectives included assessing nutritional status, feeding tolerance, ventilator hours and acute hospital length of stay (LOS). **Background data:** Early nutritional support has been found to be beneficial in critically ill patients, however, the same benefits may not be realized in patients with ASCI due to their unique nutritional challenges. **Methods:** Eligible patients were randomized to early (<72 h) and late feeding (>120 h following injury). Patients were stratified based on their neurological level. Patients were assessed daily for the first 15 days, after which time infections, ventilator hours and LOS were tracked. **Results:** Twenty-three (23) patients met the eligibility criteria, and 17 patients were included in the analysis. There were 7 patients in the early group and 10 in the late group. The early group had a mean of  $2.4 \pm 1.5$  infections compared with the late group, which had a mean of  $1.7 \pm 1.1$  infections. Secondary outcomes were not substantially different between the 2 groups. **Conclusions:** This pilot study failed to detect any differences in the incidence of infection, nutritional status, feeding complications, number of ventilator hours or LOS between patients receiving early versus late initiation of enteral feeding. This data will assist in the determination of an adequate sample size for future studies. **Significance:** Despite lacking statistical power, this study questions the effectiveness and feasibility of early enteral feeding in the metabolically unique spinal cord injured patient.

**SURGICAL TRIAL IN ACUTE SPINAL CORD INJURY STUDY (STASCIS): RATIONALE, DESIGN AND PRELIMINARY RESULTS.** *Michael G. Fehlings, Alexander Vaccaro, Eric Massicotte, Raja Rampersaud, Steve Lewis, Gwen Schwartz, Nabeel Al Shafai, Yuriy Petrenko.* Spinal Program, Krembil Neuroscience Centre, University Health Network and Department of Surgery, University of Toronto, Toronto Ont.; Department of Orthopedic Surgery, Thomas Jefferson University, Philadelphia Pa.; Spine Trauma Study Group

**Objective:** The role and timing of decompression in acute spinal cord injury (SCI) remains controversial. Although there is a strong biological rationale for early decompression to minimize secondary injury, questions exist around the efficacy, safety and practicality of such an approach. The Surgical Trial in Acute Spinal Cord Injury Study (STASCIS) has been designed to address these critical questions. **Design:** STASCIS is a prospective, multi-centre, observational study in which neurological recovery will be correlated with the timing to decompression in patients with acute cervical SCI. All patients will be managed by standard acute care protocols with CT and MR imaging. The main outcomes to be examined will include recovery of neurological function (ASIA assessment) and measures of quality of life (SF-36) and functional independence (FIM). **Participants/methods:** The lead centres are University of Toronto and Thomas Jefferson University. Currently, 15 sites are included in the trial. Planned enrolment will be 800 cases. **Results:** To date 29 patients (24M, 5F; mean age 38.6) have been enrolled at UT and TJU (ASIA A:  $n = 7$ ; ASIA A-D:  $n = 22$ ). The leading causes of injury included

MVA ( $n = 9$ ) and falls ( $n = 14$ ). All patients underwent either anterior ( $n = 10$ ), posterior ( $n = 9$ ) or combined anterior/posterior decompression/reconstruction ( $n = 10$ ). The median time to decompression was 24 hours (range 7–48 h). There were no cases of neurological deterioration. Postoperative follow-up neurological evaluations are currently underway. **Conclusions:** The STASCIS trial will provide valuable data to guide clinicians regarding the optimum surgical protocols for the timing and application of decompressive interventions.

**C1–C2 FACET SCREWS IN PEDIATRIC PATIENTS.** *Chris Reilly, Kishore Mulpuri.* British Columbia's Children's Hospital, University of British Columbia, Vancouver, BC

C1–C2 facet screws have been utilized in 9 patients at the author's institution. The youngest patient treated was 5 years of age with a mean age for the group of 12. The group consisted of 3 Down's syndrome patients and 6 with os odontoidium, 2 of which failed previous C1–C2 fusion. Two (2) patients presented with an acute spinal cord injury. Pre-op CT or MR imaging was used in all patients. Screw placement was unacceptable in 1 case. Halo immobilization was used in 7 patients postoperatively. Post-op complications included 1 wound infection and 4 halo pin infections requiring treatment. No further surgery has been required at a mean follow-up of 4 years in all patients. C1–C2 facet screws are an important adjunct in a pediatric spine practice. Although vertebral size and congenital anomalies may make screw positioning challenging, the technique provides a great advantage in the Down's patients who have a high rate of C1 arch defects and os odontoidium.

**VERTEBRAL ARTERY ECTASIA AND POSTERIOR C1–C2 TRANSARTICULAR SCREW FIXATION: REAL OR PERCEIVED LIMITATIONS?** *J.F. Chevalier, S. Casha, J. Bouchard, R. Cho, P. Salo, S. Du Plessis, R.J. Hurlbert.* University of Calgary Spine Program, Calgary, Alta.

**Background:** Posterior C1–C2 transarticular screw fixation is an effective method for atlanto-axial arthrodesis. However, reports suggest restriction of screw insertion due to vertebral artery ectasia (VAE) in 15%–20% of trauma patients and in up to 50% patients with rheumatoid arthritis (RA), arguing for intraoperative navigation. We review our experience in light of these observations. **Methods:** Retrospective case series. Patients undergoing isolated C1–C2 arthrodesis between 1996 and 2003 at our institution were identified and their charts reviewed. **Results:** Eighty-seven (87) patients underwent C1–C2 arthrodesis over the 7 year period ( $n = 23$  RA,  $n = 64$  non-RA). Indications for surgery included ligamentous laxity and post-traumatic or congenital instability. In the RA group, 44 of 46 possible C1–C2 transarticular screws were placed

uneventfully (96%). One screw was not attempted because of preoperatively defined VAE; 1 was removed secondary to malposition. In the non-RA group, 124 of 128 possible screws were inserted uneventfully (97%). Two screws could not be inserted because of marked kyphosis, 1 was removed because of malposition, and 1 fractured the pars interarticularis without clinical consequence. There were no excluded attempts due to VAE among non-RA patients, nor known vertebral artery lacerations. **Conclusions:** Surgeons may be overly sensitive to perceived VAE. In our experience, safe bilateral transarticular screw fixation is possible in over 95% of RA and in up to 100% of non-RA patients without vertebral artery laceration or the need for intraoperative navigation.

**A CASE CONTROL STUDY COMPARING POSTERIOR CERVICAL MICRO-ENDOSCOPIC DISCECTOMY WITH ANTERIOR CERVICAL DISCECTOMY AND FUSION FOR CERVICAL RADICULOPATHY.** *Ibrahim Assiri, Tara Whittaker, Stephan du Plessis.* University of Calgary Spine Program, Department of Clinical Neurosciences, Division of Neurosurgery, Calgary, Alta.

**Background:** Cervical disc herniation with radiculopathy is a commonly encountered problem. Anterior Cervical Discectomy and Fusion (ACDF) has become the standard of care in managing this problem. Complications seen with this procedure include donor site morbidity and long-term effect of fusion on the adjacent segment. Avoidance of these complications can be obtained through a posterior approach by Posterior Cervical Micro-endoscopic Discectomy (PCD). **Methods:** This is a retrospective case-control study in which patients who had undergone PCD (cases) were compared with randomly selected patients, from the same time period, who underwent ACDF (control). We compared technical aspects of both procedures. The inclusion criteria include unilateral radiculopathy, absence of myelopathy and single-level involvement. PCD is done through a small paramedian skin incision utilizing a muscle splitting technique with tubular dilators under fluoroscopy. A microscope is used to perform the decompression. **Results:** Twelve (12) patients underwent PCD; their results were compared with 12 patients who underwent ACDF. It was shown that the mean blood loss was 64 ml for the PCD group and was 179 ml for the ACDF group. The mean operative time was 102 minutes (1:42 h) for the PCD group compared with 143 minutes (2:23 h) for the ACDF group. The mean hospital stay was 1 day and 6 hours for the PCD group compared with 2 days and 17 hours for the ACDF group. **Conclusions:** PCD is an excellent alternative to ACDF in selected patients. It reduces the length of hospital stay, the length of operative time as well as substantially decreases total blood loss. It eliminates donor site morbidity and the long-term effects on the adjacent segments.



## CSS 2004 — Poster Presentations

**THE SIEMANS C-ARM MOUNTED X-RAY IMAGE INTENSIFIER FOR EVALUATION OF ATLANTOAXIAL DISORDERS.** *Doron Rabin, David McErlain, Hristo Nikolov, Chris J.D. Norley, David W. Holdsworth, Ramesh Sahjapaul, Neil Duggal.* Division of Neurosurgery, University of Western Ontario; Imaging Research Laboratories, Robarts Research Institute, London, Ont.

**Background:** Accurate imaging is essential to patient selection, preoperative planning and operative management for C1/C2 transarticular screw and odontoid screw fixation. We describe our initial results using the Siemans Multistar Image Intensifier (XRII) based CT system for the evaluation of patients with disorders of the atlantoaxial complex. **Methods:** Patients presenting with C1/C2 instability or a Type II odontoid fracture were given a traditional helical CT and managed with internal fixation under conventional fluoroscopic guidance. Additional preoperative and postoperative imaging using the Siemans Multistar XRII was obtained for comparison with traditional CT images. **Results:** Two (2) odontoid screws and 6 transarticular screws were placed amongst 6 patients. Patients were exposed to a mean dose of 0.049 mSv (SD 0.026 mSv) for preoperative imaging and 0.098 mSv (SD 0.026 mSv) for postoperative imaging. Preoperative XRII CT was used to evaluate the fracture, relevant anatomy and operative planning for screw placement while postoperative XRII CT demonstrated acceptable screw placement. **Conclusions:** Three-dimensional fluoroscopic images produced by the Siemans Multistar XRII CT were comparable in quality to those obtained with traditional helical CT while exposing the patient to a comparable radiation dose. We hope to present our experience with real-time neuronavigation of the rostral cervical spine using intraoperative XRII CT imaging.

**PREDICTION MODEL FOR FINAL KYPHOSIS IN THORACOLUMBAR BURST FRACTURES.** *Joel A. Finkelstein, Albert Yee, Michael Ford, Fahad Al-Khalifah, Nana Adjei.* Sunnybrook Spine Program, Toronto, Ont.

**Study design:** Retrospective radiographic analysis of 60 patients treated conservatively for traumatic thoracolumbar burst fracture. **Objectives:** To develop a prediction model for determining maximum final kyphosis in thoracolumbar burst fractures from the initial supine trauma plain radiograph. A secondary objective was to determine if there is differential behaviour in anatomically distinct regions of the spine. **Summary of background data:** Functional outcomes of neurologically intact patients with burst fractures are dependant on final kyphosis at the end of treatment. Conservative treatment is indicated if an acceptable sagittal alignment of the spine can be anticipated. In cases where the delineation between “stable” and “unstable” is difficult to determine, the ability to predict final kyphosis at the

end of treatment may provide the surgeon with clinical data to help guide treatment in considering the need for surgery. **Methods:** Conservatively treated thoracolumbar burst fractures in intact patients were reviewed for progression of deformity. Initial trauma supine radiographs were measured for initial kyphosis (Ki). Final kyphosis (Kf) in the upright patient was measured at the end of treatment. The Ki and Kf were plotted on a scatter graph, and, using linear regression analysis, a mathematical model was created for purposes of a prediction model equation. **Results:** The thoracolumbar spine behaved in 2 independent patterns with respect to final kyphosis. Kf at the TL junction (T11–L1) could be predicted most accurately with the equation  $Kf = Ki + .5Ki$ . At the L2–L3 level, a best-fit model was  $Kf = Ki + 4^\circ$ . **Conclusions:** Treatment of TL burst fractures needs to be individualized based on clinical, radiological and anatomical levels of the spine. We have developed a prediction model that may be useful in those fractures considered stable in order to predict final radiological outcome. Furthermore, we have shown the unique patterns of behaviour of the spine at the TL junction and at the L2–L3 level. If the final kyphosis is predicted to be above a threshold, the surgeon may want to consider surgery from the outset.

**DELTA VERSUS PLIF FIXATION IN THE TREATMENT OF GRADE II ISTHMIC SPONDYLOLISTHESIS: A BIOMECHANICAL STUDY.** *Paul Morin, Rudolf Reindl, Thomas Steffen, Jean Ouellet, Max Aebi.* Montréal, Que.

Isthmic spondylolisthesis of L4–L5 is managed at our centre with posterior lumbar interbody fusion (PLIF). This procedure requires manipulation of the cauda equina and the use of 2 interbody cages that account for 50% of the hardware expense.

“Delta fixation” has been developed to provide stable fixation with less nerve manipulation and without interbody cages. This fixation involves trans-sacral pedicle screws that exit the end plate of S1 and enter the inferior endplate of L5.

Our objective is to demonstrate that Delta fixation is as stable as PLIF fixation in the operative treatment of grade II isthmic spondylolisthesis.

Eight fresh frozen human spines were used. Matched pairs were created and block randomization used to create 2 groups: PLIF fixation and Delta fixation groups. The specimens were instrumented with a grade II spondylolisthesis of L5–S1, tested and then re-instrumented with the alternative fixation and tested again.

Vertical displacement, axial rotation, flexion–extension and side bending were tested using an MTS machine.

When comparing Delta fixation with PLIF fixation, the only statistically significant difference was found in axial rotation. Delta fixation had 2.05° less ROM and 0.90° less NZ compared with PLIF fixation with *p* values of 0.0052 and 0.0104,

respectively. This demonstrates that the delta fixation is more stable than PLIF fixation.

Delta fixation provides better initial stability, requires less nerve manipulation and is more cost effective than PLIF fixation and, therefore, is an acceptable alternative to PLIF for the treatment of grade II isthmic spondylolisthesis of L5–S1.

**PERIODONTOID TUMORAL PSEUDOGOUT AND CERVICAL SPINE MYELOPATHY.** *Mohammed F. Shamji, Eric Belanger, Jagadish Prasad, John Woulfe.* Division of Neurosurgery, Division of Radiology and Division of Pathology, Ottawa Hospital, Civic Campus, Ottawa, Ont.

Calcium pyrophosphate dihydrate (CPPD) crystals rarely cause compressive myelopathy by deposition in cartilaginous structures. We report a case of symptomatic periodontoid tumoral pseudogout compressing the cervical spine and present a literature review of the presentation, radiology and treatment of this condition. There is not yet sufficient experience to describe optimal surgical management for pseudogout compressing the spinal cord, with few previously described treating via a posterior approach.

Our patient was an elderly woman presenting with 5 months of progressive cervical spinal stenosis, initially with dorsal column symptoms progressing to include quadriparesis. Metastatic, metabolic and inflammatory workup were non-contributory. CT demonstrated a hyperdense, epidural lesion with speckled calcifications extending from the clivus to C2, causing odontoid remodelling with intact cortex; the initial differential was of chondroid tumour or meningioma. Evaluation with MRI demonstrated severe cord compression and myelomalacia from a mass consistently isointense with muscle and hypointense to neural tissue on T2, expanding the differential to include inflammatory lesions and away from most neoplasms.

The patient became hemodynamically unstable following posterior decompression from lower occiput to C3, and a C2 laminectomy provided access for biopsy of the anterior mass, but time did not permit for excision. Histopathological analysis was consistent with CPPD with no evidence of neoplastic change or inflammatory rheumatoid pathology. Our patient has made excellent motor and sensory recovery in follow-up.

**TRAUMATIC DISRUPTION OF KNOWN OSTEOPOROTIC THORACIC VERTEBRAL FRACTURE CAUSING MASSIVE HEMOTHORAX.** *Mohammed F. Shamji, Charles Agbi.* Division of Neurosurgery, Ottawa Hospital, Civic Campus, Ottawa, Ont.

While hemothorax often complicates acute major trauma from parenchymal laceration or vessel disruption, isolated vertebral fracture has only rarely been reported causative of this condition. We report a case of massive hemothorax complicating traumatic disruption of a previously diagnosed osteoporotic wedge compression fracture of T12 in an elderly woman presenting for knee fusion.

Hemodynamic instability during an arthrodesis procedure was refractory to transfusion and inotropes with workup in the intensive care unit yielding diagnosis of massive, right hemothorax. Tube thoracostomy and emergent sternotomy

removed more than 3 litres of blood and identified a palpable fracture–dislocation of T12 as the source. While a T12 compression deformity was known, preoperative collapse of the patient's bed or perioperative positioning before arthrodesis may have caused destabilization. Imaging studies showed a complete disruption and marked displacement of this fracture.

Hemothorax from isolated vertebral fracture has been reported, but our case illustrates that wedge compression fracture may be vulnerable to reinjury. Transthoracic T12 corpectomy with instrumented T11 to L1 fusion followed by posterior instrumented fusion from T8 to L3 provided our patient with satisfactory result.

**ACUTE NONTRAUMATIC QUADRIPLÉGIA SECONDARY TO CERVICAL DISC HERNIATION: CASE REPORT AND REVIEW OF THE LITERATURE.** *V. Sadanand, M. Kelly, G. Varughese, D.R. Fourney.*

**Objective:** To describe an exceedingly rare case of acute nontraumatic cervical disc herniation resulting in quadriplegia. We also review the literature on non-traumatic cervical disc herniation. **Methods:** A previously healthy 42-year-old man developed weakness and numbness in his arms and legs immediately following a sneeze. On physical examination, he had signs of myelopathy that progressed over a few hours to a complete C5 quadriplegia. An emergent magnetic resonance imaging study of the cervical spine revealed a massive C4/5 disc herniation. He underwent urgent anterior cervical microdiscectomy and fusion. **Results:** Postoperatively, he remained a C5 quadriplegic. Eighteen days postoperatively, while receiving rehabilitation therapy, he developed a pulmonary embolus and died. There are 5 previous case reports of paraplegia secondary to nontraumatic cervical disc herniation. In most cases, progressive myelopathy was due to enlargement of the disc herniation coupled with pre-existing spinal canal stenosis. **Conclusions:** Non-traumatic acute cervical disc herniation resulting in quadriplegia is exceedingly rare. Prompt diagnosis and emergent decompressive surgery is the key to prevention of severe myelopathy.

**DELAYED PRESENTATION AND DIAGNOSIS OF CERVICAL SPINE INJURIES IN ANKYLOSING SPONDYLITIS.** *G. Joseph, M.V. Jigajinni, R.A. Johnston, M.H. Fraser, A.N. McLean.* Queen Elizabeth National Spinal Injuries Unit, Glasgow, Scotland.

**Aim:** To describe the incidence of delayed diagnosis and treatment of cervical spine injuries in ankylosing spondylitis (AS). **Background:** Patients with AS are vulnerable to fractures due to spinal rigidity. The fracture symptoms may be overlooked by the patient or physician due to the chronic pain that the patient suffers. We were aware of the delays in presentation and diagnosis of cervical spine injuries in patients with AS and set out to examine the extent of the problem. **Methods:** Retrospective study at the national spinal injuries unit of patients with AS who sustained a cervical fracture. We obtained patient details from our database and reviewed the case notes and imaging from the referring hospital and the spinal unit. **Results:** Twenty-six (26) patients, 23 male. Age range 36–86 years with mean 61 years. Forty-two percent (42%) presented 48 hours after the injury. In 50%, plain radiographs did not show an injury, and further investigations

were required. Fourteen patients were initially neurologically intact, but 2 of these patients developed cord damage between admission and eventual diagnosis. **Conclusion:** Clinicians should maintain a high level of suspicion for patients with AS presenting with neck pain after a minor injury. We suggest that clinicians should have a low threshold for carrying out further imaging of these patients even if the initial radiographs are apparently clear. There may be a role for patient education in alerting them to the danger of even minor trauma.

### **C1–C2 FUSIONS WITH A MODIFICATION OF THE MAGERL TECHNIQUE. A RETROSPECTIVE STUDY OF 45 PATIENTS. J.F. Roy. Laval University, Quebec City, Que.**

Magerl's technique of C1–C2 fixation is the most rigid fixation available at the C1–C2 level.

This technique is especially useful in rheumatoid and multidirectional instabilities.

However, the shape of the c-spine and the changes in position of the spine between the drilling and the screw application complicate this technique. This study utilizes a filleted k-wire for fixation as a quick 1-step procedure.

Results after 10 years of application.

### **DEEP FREEZE ARGON CRYOTHERAPY OF THE LUMBAR FACET JOINT. THREE YEAR FOLLOW-UP. J.F. Roy. Laval University, Quebec City, Que.**

The facet joint syndrome is the cause of chronic back pain in 20%–30% of the chronic low-back pain population. Even with medication and a good rehabilitation protocol, most of these patients will remain with considerable pain. Radiofrequency denervation has been proven inefficient, and fusion is disappointing. Local facet denervation with Argon cryotherapy is simple, efficient and with low morbidity. After 3 years of treatment in 145 patients, results seem conclusive with the pure facet joint syndrome and close to placebo in the fusion and degenerated disc group.

### **PLIF USING ACTIPORE™ PLF: RADIOLOGICAL OUTCOMES. D. Noriega, J.J. Noriega, M. Leroux, M. Assad, S. Moreau, J. Badeaux. Hospital Clínico Universitario, Department Orthopaedics and Traumatology, Valladolid, Spain; Biorthex Inc., R&D Department, Montréal, Que.**

In a prospective study, radiological outcomes of patients suffering from degenerative disc diseases and instrumented with Actipore™ PLF devices were evaluated. These porous nitinol cylindrical devices did not require any additional bone graft or bone substitutes.

Twenty-five patients with severe chronic low-back pain were instrumented at 1 level using a PLIF approach while preserving most posterior structures. L4/L5 disk was instrumented for 12 patients and L5/S1 disk in 13 cases. All patients were treated without supplemental posterior fixation. Average follow-up was 14.2 months, ranging from 6 to 24 months. Disc height variations (lateral), migration (lateral) and fusion (flexion/extension) were evaluated radiologically.

One implant was broken during the surgical procedure,

without subsequent complication. Non-fusion has been detected for 2 patients (12 and 14 months postoperative). The first one (L4/L5) is also associated to some subsidence while the second one (L5/S1) showed solely unexpected mobility. Two light migrations were observed, 1 at each level, before fusion took place. A total of 7 decreases in disc height were observed at follow-up when compared with immediate postoperative visit. Two of them showed some subsidence, while the remaining 5 are associated to the setting of the implant in the disc space. All patients showed good clinical outcomes.

Actipore™ PLF devices represent an excellent alternative to existing interbody fusion devices. Since the Actipore™ PLF devices are used stand-alone and without bone graft, the surgery should require less time and be less invasive.

### **ACTIPORE CERVICAL INTERBODY FUSION CAGES: COMPARATIVE RESISTANCE TO LOAD-INDUCED SUBSIDENCE. S. Moreau, M-A. Thébault, M.A. Leroux, M. Assad. Biorthex Inc., R&D Department, Montréal, Que.**

**Introduction:** Cervical interbody fusion devices (CIFDs) are inserted between cervical vertebrae to restore the intervertebral height and should eventually lead to bone fusion. In this study, mechanical testing was performed to evaluate and compare the performance of 5 different CIFDs in load-induced subsidence. **Materials and methods:** Cervical implants were placed between 2 grade-15 polyurethane blocks with flat surfaces and submitted to uniaxial compressive strength (ASTM F-2077-01) until a loss of 2 mm of the inter-block height was obtained (50% of the intervertebral height). Force (N) and displacement (mm) were measured using an Instron 8521. Actipore™ ACF (Biorthex) is made out of a porous bulk structural material. It presents a flat bottom surface, a slight double dome-shaped top surface and no windows. Cifec (Proconcept) represents a threaded cylindrical hollow cage with large windows (2 cages are recommended in the surgical technique). Syncage-C (Synthes-Stratec) has a dome-shaped top and flat bottom surface; it shows a hollow pattern with teeth on each side and many windows. Hedrocel (Implex) device is made out of porous material and presents flat surfaces with a waved (or ribbed) pattern. C-Varlock (Kiscomedica) presents flat surfaces with a wave-like pattern and an important window on each side. **Results and discussion:** The ANOVA revealed a significant difference in the degree of subsidence between Actipore™ ACF and all the other devices. In fact, all other CIFDs allowed more subsidence than Actipore™ ACF. It is hypothesized that these superior results in the case of Actipore™ ACF are related to the design of the device and the elasticity of the material. The other cages present less contact area between the implant and the vertebral endplates. **Conclusion:** Actipore™ ACF device seems to present a better resistance to subsidence and should improve the outcomes of the surgical treatment.

**POROUS NITINOL FOR CERVICAL FUSION. S. Moreau, M.A. Leroux, M. Assad, P. Jarzem, N. Fomichev. Biorthex Inc., R&D Department; Santa Cabrini Hospital, Orthopaedics Department, Montréal, Que.; Research Institute of Traumatology and Orthopaedics, Novosibirsk, Russia**



**Introduction:** The objective of this study was to examine patients instrumented with porous nitinol IFD in the cervical spine. **Material and methods:** The preoperative medical records of 39 patients were reviewed individually. Instability ( $n = 38$ , 97.4%) and herniated nucleus pulposus ( $n = 24$ , 61.5%) were observed in a majority of cases. Patients were instrumented at 1 level ( $n = 23$ , 59%), 2 levels ( $n = 13$ , 33.3%), or 3 levels ( $n = 3$ , 7.7%) using an anterior cervical fusion technique. No bone graft or supplemental fixation was used. The standard radiological evaluation consisted in flexion/extension radiographs. Fusion was considered successful if the angle difference between the adjacent vertebrae was less than  $5.0^\circ$ . Neck pain was quantified using a 6-point scale: 0 representing no pain and 5 corresponding to unbearable pain. The average postoperative follow-up was 29.5 months (SD 18.8 months). **Results:** Thirty-eight (38) patients (97.4%) showed fusion. Patients' retrospective evaluation of preoperative pain was relatively high: 3.1 points (SD 0.7 points) on a maximum of 5. The postoperative score was low: 1.1 (SD 1.0) for an average pain reduction of 2.0 points. On the 6-point scale, a 1-, 2-, 3- and 4-point improvement of condition was obtained in 11, 17, 6 and 4 patients, respectively. No patient showed an improvement of 5 points. Additionally, 2 patients claimed a complete recovery, 15 others demonstrated a marked improvement, and the condition was mildly improved in 11 cases. **Discussion:** Porous nitinol cervical IFDs allow osseointegration and bone bridging phenomena without using bone graft or bone substitutes. Furthermore, pain relief was obtained in a majority of patients without the requirement for supplemental fixation procedures. Therefore, porous nitinol cervical IFDs represent an excellent alternative to existing cervical interbody fusion devices.

**ANTERIOR INSTRUMENTATION OF DOUBLE MAJOR IDIOPATHIC SCOLIOTIC DEFORMITIES.** *Chris Reilly.* British Columbia's Children's Hospital, University of British Columbia, Vancouver, BC

A number of surgical options exist for management of double major scoliotic deformities. Anterior instrumentation has been completed in 5 patients at BCCH. The technique allows for 1 incision instrumentation of double major curves to the lower end vertebra, preserving the L3-4 motion segment. Patients requiring thoracic and lumbar instrumentation were considered for the technique. Mean pre-op curve sizes were  $53^\circ$  and  $59^\circ$  for the thoracic and lumbar curves, respectively. The described operative technique utilizes a modified lumbar anterior rod placement followed by an overlapped thoracic rod placed in the concavity of the thoracic curve. Thoracic vessels are preserved in this technique. Mean operative time was 7 3/4 hours. Obliquity of L3 was corrected from a mean of  $29^\circ$  pre-op to  $5^\circ$  post-op. No patients had significant decompensation or required any further procedure. No post-op complications occurred.

This new technique may have a significant role in the management of a subset of idiopathic scoliosis patients.

**NONOPERATIVE TREATMENT OF STABLE THORACOLUMBAR BURST FRACTURES — A COMPARATIVE STUDY OF BRACING VERSUS NO BRACING.** *Darryl Young, Eric Belanger, Robert*

*D. Fraser, Liisa R. Vexler, Eugene K. Wai.* Study Performed at the Ottawa Hospital, University of Ottawa, Ottawa, Ont.; Royal Adelaide Hospital and the University of Adelaide, Adelaide, Australia

**Summary of background data:** External bracing is considered the preferred treatment of stable thoracolumbar burst fractures. However, some surgeons have reported success using early mobilization without a brace, arguing that a brace inhibits development of adequate trunk control. To date, a comparative study has not been performed. **Methods:** Patients treated for stable thoracolumbar burst fractures at 2 major academic medical centres were identified. One centre routinely braced patients while the other one did not. Medical records, radiographs and CT scans were independently reviewed. Kyphotic angulation, percentage of anterior vertebral collapse and amount of retropulsion/canal compromise were measured before treatment and at 3 months follow-up. **Results:** Seventeen patients were reviewed. There was no significant difference between the groups in regards to pre-treatment kyphosis or loss of anterior vertebral height, however, the no-brace group (mean = 42% canal compromise) had significantly more pre-treatment retropulsion compared with the braced group (mean = 28% canal compromise). At 3 months follow-up, the progression in kyphosis and anterior collapse averaged  $4.8^\circ$  and  $5.4\%$  respectively for the no-brace group and  $5.8^\circ$  and  $4.7\%$  respectively for the brace group. There were no significant differences in the progression of deformity between the 2 groups ( $p > 0.4$ ). **Conclusions:** This study suggests that the use of a brace in the treatment of stable thoracolumbar burst fractures does not affect radiological outcome. Further prospective research would be required to determine if there are any functional benefits.

**ADVANTAGES OF LUMBAR MICRO-ENDOSCOPIC DISCECTOMY.** *Maher Al-Hejji, Stephan du Plessis, Tara Whittaker.* Department of Clinical Neurosciences, Division of Neurosurgery, Calgary, Alta.

**Introduction:** Minimally invasive surgery has pervaded all branches of surgery with remarkable result. Surgery of the spine is no exception. Microscopic discectomy was first performed in 1968. A muscle splitting technique with endoscopic discectomy was introduced in 1997, and, since then, it's been used in other indications. The purpose of the study is to compare the technical aspects of micro-endoscopic discectomy (MED) with the aid of the microscope to conventional microdiscectomy. **Methods:** In this cohort study, we retrospectively compared 26 patients who had MED with 15 patients who had standard conventional microdiscectomy during the same time period. Through a small paramedian skin incision, a muscle splitting technique is utilized under fluoroscopy to place a tubular retractor system. A standard discectomy technique is then used to remove the disc. **Results:** We evaluated surgical time (skin-to-skin) and blood loss. When comparing MED with conventional microdiscectomy, we demonstrated a 57% reduction in mean blood loss (66 ml v. 154 ml). We noted a 16% decrease in surgical time (1 h 28 min v. 1 h 45 min). **Conclusion:** The use of a mus-

cle dilating technique to access the disc space has significant technical advantages for the patient and the surgeon. However, the ultimate end result for the patient is the same for both discectomy techniques. These technical advantages have the potential to impact positively on the utilization of healthcare resources.

**COUPLING INTRAOPERATIVE MRI WITH NEURONAVIGATION FOR TRANSORAL ODONTOID RESECTION.** *John J. Kelly, Steve Casha, Stefan J. DuPlessis, R. John Hurlbert.*

**Introduction:** The transoral approach is difficult due to spatial confinements of the surgical corridor. The surgical goals of odontoid resection and decompression of the cervicomedullary junction are achieved by adequate exposure and appropriate surgical direction. Benefits of neuronavigation and intraoperative magnetic resonance imaging (iMRI) during transoral odontoid resection have been demonstrated individually. Alone, both image guidance methods have limitations. The authors describe their preliminary experience coupling neuronavigation with iMRI during transoral approaches for surgical problems involving the craniocervical junction. **Methods:** Since 2002, 7 patients have undergone transoral odontoidectomy using iMRI and neuronavigation. Preoperative MR imaging was performed following induction of anesthesia. Navigation using the BrainLab Vector Vision system was based on surgical planning images and used for placement of the Crockard retractor system and planning the surgical trajectory. Interdissection images were obtained to assess the decompression and to update the navigation system. Postoperative quality assurance imaging was performed to confirm complete odontoid resection, full decompression and to demonstrate complications. **Results:** Successful transoral odontoid resection guided by neuronavigation and iMRI was performed in 7 patients. Procedures included resection of a synovial cyst, 4 procedures for basilar invagination (2 degenerative, 2 rheumatoid arthritis) and 2 chordoma resections. The 2 image guidance techniques were valuable for surgical planning and evaluation of decompression in all cases. An immediate benefit to iMRI was obtained in 2 of 7 cases where need for further resection and decompression was evident. Quality assurance imaging demonstrated complete resection in all cases and confirmed 1 complication: a high cervical spinal cord injury. **Conclusions:** Coupling iMRI and neuronavigation in order to enhance transoral resection of the odontoid process is safe and feasible. Benefits of using these image guidance techniques together include retractor placement, determination of the surgical corridor, evaluating extent of resection and updating the navigation system. Neuronavigation and iMRI are complementary techniques and together eliminate the need for fluoroscopy and unnecessary radiation exposure.

**THE APPLICATION OF BRAIN-DERIVED NEUROTROPHIC FACTOR TO THE SPINAL CORD FOR THE TREATMENT OF CHRONIC SPINAL CORD INJURY.** *Brian K. Kwon, Loren Oschipok, Jie Liu, Wolfram Tetzlaff.* Combined Neurosurgical and Orthopaedic Spine Program (CNOSP), Department of Orthopaedics and International Collaboration on Repair Discoveries (ICORD), University of British Columbia, Vancouver, BC

In this study, we assessed the efficacy of brain-derived neurotrophic factor (BDNF) application to the site of a chronic spinal cord injury. Male Sprague Dawley rats underwent a posterolateral spinal cord section to unilaterally cut the rubrospinal tract. Two months later, the injury site was resected, and gelfoam soaked in 1 of 3 concentrations of BDNF was inserted into the defect. Animals were then either sacrificed 2 weeks later for evaluation of the rubrospinal neurons or axons, or a peripheral nerve transplant was implanted into the injury site for evaluation of axonal regeneration. Cross-sectional area measurements of the axotomized rubrospinal neurons revealed no reversal of atrophy with any of the 3 doses of BDNF as compared to control animals. In situ hybridization revealed no stimulation of GAP-43 and T $\alpha$ 1 tubulin mRNA expression in the injured neurons with any of the 3 doses of BDNF. Axonal regeneration into peripheral nerve transplants was not enhanced by any of the 3 doses of BDNF. Immunohistochemistry of the red nucleus and of anterogradely labelled rubrospinal axons adjacent to the injury site revealed positive trkB staining on the rubrospinal cell bodies but not on the labelled axons. This suggests that the lack of response to BDNF applied at the chronic injury site may be due to the loss of necessary receptors on the axons over time. Finally, these findings serve to characterize the chronic state of the injured rubrospinal system and help in the design of therapies for chronic spinal cord injury.

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**STERNAL SPLIT APPROACH TO CERVICAL THORACIC JUNCTION.** *Stephen Tredwell, Jacques LeBlanc, Kishore Mulpuri, Vic Sahjpal.* British Columbia's Children's Hospital, University of British Columbia, Vancouver, BC

The anterior approach to dealing with complex spinal deformities around the cervical-thoracic junction presents a surgical challenge. In our institution, with the help of a cardiothoracic surgeon, we have utilized a sternal splitting technique to resolve this difficulty.

A longitudinal incision is made parallel to the sternocleidomastoid muscle and extended across the sternum for a median sternotomy. The strap muscles are then divided. The sternocleidomastoid muscles are retracted to the lateral aspect of the incision. The digastric and the omohyoid are isolated and divided. The carotid and jugular vein are dissected out. The phrenic and vagus nerves are isolated. To continue with the dissection and exposure of the upper thoracic spine, an almost full sternotomy is done. We then open the sternum. We are able to extend the dissection of the right carotid over the innominate artery including the bifurcation of the right subclavian artery. The jugular vein is dissected out coming down to the superior vena cava. The innominate vein is isolated. The lower end of the anterior scalenus muscle is divided up to provide good access to the spine. Access to the lower cervical and the upper thoracic spine is granted.

This technique has been used in 5 pediatric patients, aged 3–15 years. Diagnoses included Klippel–Feil syndrome, Proteles syndrome, Larsen syndrome and neurofibromatosis (2 patients). All patients had severe cervical-thoracic kyphosis. This approach gained a range of access gained from C5–T6. In 1

patient, a separate thoracotomy was performed to gain access to the lower thoracic spine.

**HEMATOLOGICAL ABNORMALITIES IN THE ACUTE STAGE AFTER TRAUMATIC SPINAL CORD INJURY.** *Julio C. Furlan and Michael G. Feblings.* Krembil Neuroscience Centre, Spinal Program, Toronto Western Hospital Research Institute, University Health Network; Department of Surgery, Division of Neurosurgery, University of Toronto, Toronto, Ont.

**Objective:** Spinal cord injury (SCI) is a devastating event that may cause motor, sensory and autonomic dysfunction. This study was undertaken (1) to evaluate hematological abnormalities within the first post-SCI week, and (2) to verify the influence of age, gender, level and severity of SCI on post-SCI hematological abnormalities. **Methods:** We reviewed the database of all consecutive individuals with acute, isolated SCI who were admitted to the TWH between 1998 and 2000. Individuals with polytrauma or chronic systemic diseases were excluded. Severity of SCI was classified based on the ASIA scale. Data were analyzed using multiple linear regression. **Results:** There were 24 individuals with acute, isolated SCI and no medical co-morbidity (17M, 7F, ages 17–83 years, mean 55.9). Reduced hemoglobin concentration occurred in 83.3%. There was no correlation between hemoglobin concentration and age or level of SCI, but individuals with more severe SCI (ASIA A-B) showed lower hemoglobin concentration ( $p = 0.003$ ). Lymphopenia (83.3%) and leukocytoses (37.5%) were the only abnormalities in white blood cell counts. Blood leukocyte count was not correlated with age, gender, level or severity of SCI. Lower blood lymphocyte count was significantly correlated with elderly ( $p = 0.031$ ), male ( $p = 0.05$ ), thoracic ( $p = 0.001$ ) and severe SCI ( $p < 0.001$ ). Thrombocytopenia occurred in one third of cases. Blood platelet concentration was unaffected by gender or level of SCI, but lower platelet levels were correlated with elderly ( $p = 0.059$ ) and severe SCI ( $p = 0.007$ ). **Conclusions:** Anemia, leukocytosis, lymphopenia and thrombocytopenia are frequent in the first week after SCI and correlate with the extent of injury. Our data suggest that disruption of neural regulation of the haemopoietic system may play important role in the pathobiology of hematological abnormalities after acute SCI.

**THE INFLUENCE OF AGE AND GENDER ON THE AXONAL CHANGES WITHIN SPINAL CORD WHITE MATTER AFTER ACUTE TRAUMATIC SPINAL CORD INJURY.** *Julio C. Furlan and Michael G. Feblings.* Krembil Neuroscience Centre, Spinal Program, Toronto Western Hospital Research Institute, University Health Network; Department of Surgery, Division of Neurosurgery, University of Toronto, Toronto, Ont.

**Objective:** This study was undertaken to evaluate the effects of age and gender on the extent of axonal survival within white matter after spinal cord injury (SCI). **Methods:** We carried out immunocytochemical examination of postmortem spinal cord tissue from spinal cord injured and uninjured individuals using neurofilament 200 staining for axons. The number of axons within corticospinal tracts (CST), dorsal column

(DC) and dorsal portion of lateral funiculus (LF) were quantitated from individuals with moderate/severe (ASIA A-C) cervical SCI and control cases with intact CNS by image analysis. Data were analyzed using *t*-Student test, Fisher's exact test and multiple linear regression. **Results:** There were 7 SCI individuals (2F, 5M; ages 31–82 years, mean 60) and 5 control cases (2F, 3M; ages 30–73 years, mean 51.4). Both groups were comparable regarding age ( $p = 0.42$ ) and gender ( $p = 1$ ). There were significant differences between both groups regarding number of axons within CST ( $p < 0.001$ ) and LF ( $p = 0.004$ ), but not DC ( $p = 0.201$ ). In SCI individuals, there was no correlation between number of axons and age/gender within CST, LF and DC. However, males showed a trend for higher number of preserved axons within DC ( $p = 0.059$ ). In control cases, the number of preserved axons within CST, LF and DC were not significantly correlated with age/gender. **Conclusions:** The number of axons within motor, sensory and autonomic tracts was unaffected by age/gender in individuals with SCI nor in uninjured individuals. However, males showed a trend toward a greater preservation of sensory axons after acute SCI in comparison with females.

**HEALTH RELATED QUALITY OF LIFE OUTCOMES FOLLOWING ATLAS FRACTURES.** *Michael G. Johnson, Marcel Dvorak, Charles Fisher, Garth Johnson, Michael Goytan.* University of Manitoba, Winnipeg, Man.; University of British Columbia, Vancouver, BC; University of Ottawa, Ottawa, Ont.

**Objective:** Describe the long-term outcomes of patients with atlas fractures using generic (SF-36) and disease specific (North American Spine Society [NASS] Cervical Spine) Health Related Quality of Life (HRQoL) outcome measures. **Methods:** A database-generated retrospective review with cross-sectional outcome analysis was performed. Adults with burst, anterior arch, posterior arch or lateral mass fractures of the atlas were included. **Results:** Study group of 31. SF-36 health survey revealed atlas fracture patients as having lower ( $p < 0.004$ ) physical component scores (PCS) when compared with published normative data. Similarly, the NASS cervical spine follow-up outcome scores revealed the mean pain and disability scores (PS) were lower ( $p < 0.002$ ) than published normative values. Subjects with Spence criteria  $>7$  mm displacement demonstrated lower ( $p < 0.047$ ) PCS scores than those with  $<7$  mm displacement. Patients with other injuries demonstrated lower scores on PCS ( $p < 0.008$ ), NS ( $p < 0.008$ ) and PS ( $p < 0.0001$ ). **Discussion:** Impairment in generic (SF-36 PCS) and disease-specific (NASS PS) outcomes when compared with normative data was demonstrated. Patients with residual lateral displacement beyond 7 mm were more likely to report worse functional status (PCS). Patients with other injuries had lower PCS, NS and PS scores.

**DECOMPRESSION, FUSION AND INSTRUMENTATION IN LUMBAR DEGENERATIVE SPONDYLOLISTHESIS.** *E.P. Abraham, C. Coles.*

The role of instrumentation in the surgical treatment of symptomatic degenerative spondylolisthesis is controversial. Seventy (70) patients (average age 63) were followed at least 4 years post-surgery. All patients were assessed pre- and postopera-



tively with standard pain and function scores, as well as radiographic analysis of the deformity and pathology. Patients underwent surgery for treatment of symptoms related to spinal stenosis, as well as potential subsequent instability. All patients underwent surgical decompression and fusion using transpedicular segmental fixation. Twenty percent (20%) of

patients had minor complications that were treated successfully. As well, 86% of patients had satisfactory postoperative results. Adjacent segment degeneration was noted in 10% of patients. Based on these results and an analysis of the literature, decompression, fusion and instrumentation in degenerative lumbar spondylolisthesis may be the best treatment available.