19th ANNUAL SCIENTIFIC CONFERENCE OF THE
CANADIAN SPINE SOCIETY

Wednesday, February 27th - Saturday, March 2nd

ABSTRACTS FOR PRESENTATION
2019

Fairmont Royal York  100 Front Street West  Toronto Ontario  Canada

**Accreditation:** This event is an Accredited Group Learning Activity (Section 1) as defined by the Maintenance of Certification Program of the Royal College of Physicians and Surgeons of Canada, approved by The Canadian Orthopaedic Association.

**Course Objectives:** The Annual Scientific Conference of the Canadian Spine Society is a yearly review of the state of spine care in Canada providing a uniquely Canadian perspective on the treatment of spinal problems. Held jointly with the Canadian Paediatric Spine Society the meeting encompasses both adult and paediatric issues. Attendees will discuss and debate current concepts in both the surgical and non-operative management of a wide range of spinal pathologies. This year the conference highlights means to achieve optimal patient care both before and after surgery: “prehabilitation” as well as rehabilitation. It examines the highly relevant subject of civility and professionalism in an increasingly confrontational society. The program takes a broad look at the contemporary pressures driving spine care from the impact of wait times to the influence of the latest technological advances. Topics encompass everything from breakthroughs in basic science to surgical manpower requirements. This meeting offers participants in the Canadian Spine Outcomes and Research Network (CSORN) a chance to come together and review ongoing research while exchanging ideas for future projects. This Annual Scientific Conference with its CME approved mix of didactic lectures, interactive symposia, hands-on product demonstrations and professional interaction is the most important spine meeting in Canada.
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VEPTR Treatment of Early Onset Scoliosis (EOS) in Children without Rib Abnormalities: Long-Term Results of a Prospective, Multicenter Study

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Objectives

In 2007, a prospective study on VEPTR treatment of EOS in children without rib abnormalities was initiated. Two-year follow-up results from this cohort have demonstrated that scoliosis is controlled and spinal growth continues. This study examines whether, at minimum 5-year follow-up, VEPTR continues to control scoliosis and allow spinal growth.

Method

A prospective, multicenter, design was employed. Participants underwent traditional VEPTR implantation ≥5 years prior to analysis. Pre-implantation and last available images were compared, regardless of whether VEPTR remained in vivo. Additional analysis was performed if VEPTR was in vivo ≥5 years.

Results

59 patients (age at insertion 6.1±2.4 years; mean f/u (6.9±1.4 years). Currently 24 patients still have VEPTR, 24 have converted (13 fusions, 6 MCGR, 3 growing rods, 1 hybrid and 1 Shilla). Three have had VEPTR explanted, 6 unknown and 2 deceased. On last available imaging (n=59; mean f/u 4.8±1.9 years), scoliosis improved 71.8±18.0° preoperatively to 60.9±20.3° (p<0.001) and T1- T12 height increased (15.8±3.2 cm to 19.3±3.8 cm, p<0.001). T1-S1 height increased (24.8±4.4 cm to 31.2±5.3 cm, p<0.001), representing 119% age-matched growth. Composite improvement of scoliosis, T1-T12 and T1-S1 height was achieved in 79% of patients.

A subset of 29 VEPTR patients was analyzed at most recent f/u ≥5 years while VEPTR remained in vivo (24 VEPTR patients above, and 5 who later had VEPTR removed). Age at insertion 5.0±2.2 years, with mean VEPTR treatment duration 6.2±1.1 years. Scoliosis improved preoperatively (69.3±14.5° to 61.6±16.1°, p=0.006), with mild recurrence from post-op to 5 years. T1-T12 height increased (15.0±3.3 cm to 18.7±3.3 cm, p<0.001) and T1-S1 height increased (23.7±4.5 cm to 30.1±4.6 cm, p<0.001), representing 83% age-matched growth. Composite improvement was achieved in 83% of patients. Instrumented sagittal length also increased during this period (21.8±4.2 cm to 30.3±5.1 cm, p<0.001).

Conclusions

At minimum 5-year follow-up, VEPTR treatment continues to control scoliosis and allow spinal growth.
A Prospective, Multicenter Analysis of the Efficacy of Anterior Vertebral Body Tethering (AVBT) in the Treatment of Idiopathic Scoliosis

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Objectives

AVBT has sparked interest as a possible alternative in the management of progressive idiopathic scoliosis (IS). To date limited available data exists regarding its efficacy and complication rate. Our aim was to evaluate clinical, radiographic and perioperative outcomes and complication rates to determine the efficacy of AVBT in skeletally immature IS patients.

Method

A retrospective review of all consecutive patients treated with AVBT at two centers with minimum 2-year follow-up was conducted using a prospective multicenter database. Clinical success was set a priori as major coronal curve size ≤30° at most recent follow-up.

Results

Fifty-seven patients were analyzed. Mean surgical age was 12.7 (8.2-16.8) years with majority female (95%) and mean follow-up was 29.2 (22.1-51.4) months. Mean pre-op major curve of 51° (32°-81°) improved to mean 29° (5°-63°) at first erect x-ray (mean 43% correction) with further correction to a mean 23° (5°-47°) at most recent follow-up (55% 2-year curve correction, p<0.01). Significant spontaneous curve correction was also observed in the un-instrumented curves on average by 31% (p<0.01) at 2-year follow-up. Average EBL was 219 (50-650) cc with no patient requiring allogeneic blood. Length of hospital stay was mean 4.7 (3.0-8.0) days. Clinical success was noted in 70% of patients at most recent follow-up. Fourteen complications were reported with six unplanned revision surgeries in five patients: three reoperations for tether breakage, adding on, and overcorrection; three patients had conversion to fusion. Those not requiring reoperation, one tether breakage, two persistent pain in the hip and shoulder, one superficial infection, and four respiratory issues were reported.

Conclusions

AVBT was effective in obtaining clinical success in immature IS patients at minimum 2-year follow-up with an acceptable safety profile. Although initial results are promising, a 9.5% reoperation rate demonstrates the need for further scrutiny of AVBT regarding its true effectiveness and long-term risk in the surgical management of IS.
Variability in Forces Applied During Traction Films for Scoliosis Pre-Operative Planning and Correlation with Two Year Post-operative Correction

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Objectives

To quantify forces applied during traction radiographs, and examine relationships between forces and curve reduction as well as correction during pre-operative exams compared to actual post-operative correction.

Method

All pre-operative scoliosis patients during a one year period were prospectively invited. The force applied during traction exams, pre-operative standing and traction Cobb angles, post-operative Cobb angles, and patient demographics were assessed.

Results

31 enrolled (23 female; 8 male), mean age 13.9 (3.0-18.9; SD: 3.9) and mean weight 48.5kg (13.1-107.7; SD: 22.4). 20 were idiopathic, 7 neuromuscular, 3 congenital, and 1 syndromic. Two orthopaedic technologists pulled “firm but not painful” during traction exams, with an average force of 25.6±8.1 kg. One technologist applied an average 16.5kg (10.9-24.1; SD: 4.7) and a second applied 30.1 kg (21.3-43.1; SD: 5.3) (p<0.05). There was a moderate correlation between applied traction forces and age (r=0.47, p<0.05), but none between force and weight (r=0.28, p=0.17) or Cobb angle change (r=0.10, p=0.60). There was a high correlation between the correction with traction and the pre- to post-operative correction for upper, thoracic and lumbar curves (r from 0.75 to 0.89, p<0.05), whereas supine bending was significant for thoracic only (r=0.86, p<0.05). Both traction and bending results maintained correlation at two year follow-up for thoracic curves only.

Conclusions

This study shows a variability in applied forces in pre-operative traction exams, but the high correlation with post-operative curve reduction suggests the clinical goal has been reached. Knowing these forces could allow this exam to be moved to the EOS imager, and further research may allow for patient-specific, measured traction forces which could provide a quantitative measure of spine rigidity.
The Evolution of Scoliosis Surgery: Which Advancements Have Improved Patient Outcomes?

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Objectives

Scoliosis corrective surgery has many risks and complications. Infection rate is 5-10% and re-operation rate is 20-40%. Literature shows improved outcomes with two surgeons operating simultaneously versus one surgeon, with decreased complications and shorter hospital stay. No study has examined the re-operation rate with two surgeons. At London Spine Centre, halo-femoral traction, intra-operative 3D imaging, SmartLinks sequential rod reducers, bone scalpel, and two surgeons have been instituted over the last ten years. The objective of this study was to determine the effect of these measures on the infection, complication, and re-operation rates.

Method

Retrospective review identified 262 scoliosis cases from 2007-2018. Inclusion criteria was scoliosis surgery. Exclusion criteria were staged surgeries, revision surgeries, incomplete data, growing rods, and placement of cages. Intra-operative records and clinic follow-ups were used to determine operative duration, number of screws, and complications. 218 cases met criteria. Outcomes were infection and complication rate, blood loss, and re-operation. Statistical analysis was performed with SPSS.

Results

218 cases with a mean of two years follow-up were identified. Mean age was 15.5 ± 5.8 years. 181 (83%) were pediatric patients. Two surgeons were present for 101 (46%) cases. 156 (71%) cases used traction, 45 (21%) cases used 3D imaging, 84 (39%) cases used SmartLinks, and 75 (34%) cases used the bone scalpel. Infection rate was 10% (n=23), complication rate was 20% (n=44), and re-operation rate was 18% (n=40). Two surgeons had a lower infection rate (p=0.006), lower re-operation rate (p=0.006), and shorter operations (p=0.04). Traction was associated with a lower re-operation rate (p<0.001). There were no statistically significant differences with 3D imaging, SmartLinks, or the bone scalpel.

Conclusions

At London Spine Centre, two surgeons operating simultaneously decreased infection rate, re-operation rate, and operative duration. Halo-femoral traction was associated with lower re-operation rate. This study did not find any significant differences attributable to 3D imaging, SmartLinks, or the bone scalpel, and did not examine the degree of correction obtained. This presentation does not differentiate between causes of scoliosis.
Spinopelvic alignment affects Health-related Quality of Life (HRQoL) for Patients with Early Onset Scoliosis

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Objectives

The purpose of this study is to determine if spinopelvic parameters affect HRQoL in patients with EOS.

Method

75 children from 2 EOS registries, treated with rib (52) and spine (23)- based distraction implants at a mean age of 5.4 years were evaluated with EOS 24-Item Questionnaire (EOSQ-24) and radiographs at a mean follow-up of 4.5 years. Spinopelvic parameters were measured on AP and lateral radiographs. For HRQoL domains - General Health, Pain/Discomfort, Pulmonary Function, Transfer, Physical Function, Daily Living, Fatigue, Emotion, Parental Impact, Satisfaction - scores≥80 were considered good outcomes, scores<80 poor. Scores were compared using unpaired t-test, risk ratios were calculated and analyzed using chi squared testing.

Results

Etiologies: 32 congenital, 20 idiopathic, 18 syndromic, 4 neuromuscular, 1 unknown. Pre-operatively, major curve was 69°, thoracic kyphosis (TK) 40°, lumbar lordosis (LL) 51°, pelvic incidence (PI) 48°, and pelvic tilt (PT) 11°. At final follow-up, the major curve corrected to 55°, TK was 42°, LL 53°, PI 53° and PT 15°.

Etiology affected General Health (p=0.007) as outcomes were poor in 56% of syndromic and 50% of neuromuscular patients as compared to 25% of idiopathic and 9% of congenital patients. A post-operative PI-LL mismatch of > ±20° increased the risk for poor outcomes (score <80) in the following HRQoL domains: Fatigue (RR: 2.29, CI: 1.23-4.24, p=0.01), Pain (RR: 1.70, CI: 1.07-2.71, p=0.04), Daily Living (RR: 2.37, CI: 1.17-4.82, p=0.02), Parental Impact (RR: 1.94, CI: 1.14-3.31, p=0.002) and Emotion (RR: 1.82, CI: 1.03-3.22, p=0.05).

Post-operative LL>70° increased the risk for high Family Burden (RR: 1.88, CI: 1.17-2.87, p=0.05) and post-operative PI>60° negatively impacted Transfer (RR: 1.76, CI: 1.24-13.25, p=0.008).

In contrast, pre- and post-operative TK >40° decreased the risk for low Pulmonary Function (pre-op: RR: 0.202, CI: 0.05-0.84, p=0.009; post-op RR: 0.313, CI: 0.10-1.03, p=0.018). HRQoL was not affected by PT>30°, implant type or fusion to pelvis.

Conclusions

For children with EOS, post-op PI-LL mismatch or more than ±20° poses the greatest risk for low HRQoL.
Bone Marrow Concentration vs. Iliac Crest Bone Graft: 2-Year Results in a Single-Blinded Randomized Controlled Trial on Thoracolumbar Spinal Fusion Bone Grafts in Multi-Level Adult Spinal Deformity

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Objectives

The goal of this study was to compare the efficacy of BMC+allograft to ICBG used in multi-level posterior fusion for lumbar or thoracolumbar deformity in high-risk patients for nonunion.

Method

Patients >18 being surgically treated for adult spinal deformity were randomized in a 2:1 ratio into two study arms with respect to graft adjunct: BMC+allograft or ICBG. All patients received posterior lumbar fusion performed by an open posterior approach. Clinical data, health-related quality of life scores, and full-length radiographs were compared using t-tests at baseline, 6-weeks, 3-months, 6-months, 1-year, and 2-years post-operative. Fusion assessment was performed using 1-year CT scans by two independent radiologists.

Results

27 patients were randomized in a 2:1 fashion consisting of 17 patients receiving BMC and 10 receiving ICBG. Average fusion construct spanned 6.1 intervertebral levels. Within the 2-year follow-up period, there were 7 complications in the BMC group (41.1%) and 4 in the ICBG group (40%). ICBG patients had greater incidence of rod breakage (BMC: 0% vs. ICBG: 25%, p=0.024). 88.2% of BMC and 60% of ICBG patients were graded ‘fused’ at 1-year follow-up (p=0.088).

Conclusions

In long fusions for adult spinal deformity, where autologous graft is limited, bone marrow concentrated via centrifuge is a viable alternative to iliac crest bone graft. The current study found a decrease in implant failures in patients with BMC compared to ICBG, and a trend towards better fusion scores (>0.05, but <0.1).
The Impact of Surgical Reduction of High-Grade Lumbosacral Spondylolisthesis on Quality of Life

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Objectives

Surgical reduction of high-grade lumbosacral spondylolisthesis is often performed in young patients. However, reduction criteria leading to optimal outcomes have yet to be defined. The purpose of this study is to determine if surgical reduction of pelvic balance, slip grade, lumbosacral angle and L5 incidence are associated with quality of life after surgery.

Method

A prospective cohort of 61 patients (14.4±2.7 years) with high-grade lumbosacral spondylolisthesis was followed for a minimum of 2 years after surgery. SRS-22 quality of life scores, slip grade, lumbosacral angle, pelvic balance and L5 incidence were assessed before surgery and at latest follow-up. Multivariable regression analyses were performed with postoperative SRS scores as dependent variables. Independent variables consisted of preoperative SRS scores, pelvic balance, slip grade, lumbosacral angle and L5 incidence. The influence of slip grade, lumbosacral angle and L5 incidence on pelvic balance was also assessed.

Results

Achieving a balanced pelvis postoperatively was mainly predictive of improved satisfaction and self-image, and also tended to be associated with higher scores for other domains. Improved mental health was associated with reduction to a low grade slip but reduction of lumbosacral angle was not predictive of quality of life. Postoperative pelvic balance was mainly associated with preoperative pelvic balance, although there was a tendency for achieving normal pelvic balance when the postoperative L5 incidence was 60° or smaller.

Conclusions

Achieving normal pelvic balance is important when performing surgery in young patients with high-grade lumbosacral spondylolisthesis because it is associated with improved quality of life. Reduction to a low-grade slip is predictive of improved mental health but reduction of lumbosacral angle is not associated with postoperative quality of life. There was a tendency for obtaining normal postoperative balance in patients with postoperative L5 incidence 60° or smaller. Future studies should attempt to identify reduction techniques that can reliably restore or maintain pelvic balance after surgery.
Demographics, Presentation and Symptoms of Patients with Klippel-Feil Syndrome: Analysis of a Global Patient Reported Registry

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Objectives

Klippel-Feil Syndrome (KFS) occurs due to failure of vertebral segmentation during development. Minimal research has been done to understand the prevalence of associated symptoms and pain. It is therefore the objective of the present study to address this knowledge gap by investigating one of the largest collections of KFS patient data.

Method

Data was obtained from the CoRDS registry. Participants with cervical fusions were categorized into Type I, II, or III based on the Samartzis criteria. Symptoms and comorbidities were assessed against type and location of fusion.

Results

75 patients (60 female/14 male/1 unknown) were identified and classified as: Type I, n=21 (28%); Type II, n=15 (20%); Type III, n=39 (52%). Cervical fusion by level were: OC-C1, n=17 (22.7%), C1-C2, n=24 (32%); C2-C3, n=42 (56%); C3-C4, n=30 (40%); C4-C5, n=42 (56%); C5-C6, n=32 (42.7%); C6-C7, n=25 (33.3%); C7-T1, n=13 (17.3%). 94.6% of patients reported current symptoms, and the average age when symptoms began and worsened was 17.5 (±13.4) and 27.6 (±15.3), respectively. Patients reported an average of 12.5±7.1 comorbidities, and 12.2±6.3 general and chronic symptoms. Sprengel deformity was reported in 26.7%. Multilevel fusions (Samartzis II or III) were associated with dizziness (p=0.040), limited range in spine motion (p=0.022), and Sprengel deformity (p=0.036). Patients with cervical fusions: (1) in the upper region were more likely to report missing ribs (p=0.018), CCJ abnormalities (p=0.022), cervical instability (p=0.001), and mirror movements in hand (p=0.041); (2) in the middle region were more likely to report osteoarthritis (p=0.019), headaches, migraines, and/or head pain (p=0.007); (3) in the lower region were more likely to report mirror movements in hand (p=0.026), Spina Bifida Occulta (p=0.029) and cord tethering (p=0.049).

Conclusions

KFS is associated with multiple musculoskeletal and neurological problems. Fusions are more prevalent toward the center of the cervical region, and less common at the occipital and thoracic junctions. Associated comorbidities including Sprengel Deformity may be more common with multilevel cervical fusions.
Can Distraction-Based Surgeries Achieve Minimum 18 cm Thoracic Height for Patients with Early Onset Scoliosis (EOS)?

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Objectives

It has been proven in previous studies that thoracic height has a strong correlation with pulmonary function. Karol et al. introduced the concept that 18 cm thoracic height is the critical point where a patient could maintain adequate pulmonary function. Our purpose was to determine if distraction-based surgeries will increase thoracic spine height to at least 18 cm in patients with EOS.

Method

Patients with EOS treated with distraction-based systems (minimum 5 years follow up, minimum 5 lengthenings). Radiographic analysis of the thoracic spine height (T1-T12) at the last lengthening procedure.

Results

(n=135: 25 Idiopathic, 59 congenital, 32 syndromic, 19 neuromuscular) with pre-operative mean age 4.7 yrs, scoliosis 74°, kyphosis 44°. Mean age at final lengthening procedure was 11 yrs (6-16.2), average no. of lengthening was 11 (5-21), mean final scoliosis was 55°, kyphosis 55°.

Final thoracic height was > 18cm in 65% (n=87) and was > 22cm in 30% (n=41) of patients. Based on etiology, only 48 % of the congenital patients reached 18cm compared to 80% neuromuscular, 86% syndromic and 68% Idiopathic. This spine height gain was closely related to the percentage of scoliosis correction achieved for each etiology. Comparing congenital etiology to other etiologies, there was a lower percentage of patients in the congenital group that passed the 18cm threshold (48% vs. 77%) (p<0.05).

Conclusions

At minimum 5 year follow up, distraction-based surgeries increased thoracic spine height for patients with EOS to greater than 18cm in 65% of patients; however, only 48% of congenital patients reached this thoracic spine height threshold.
Health-State Utility Values in Cerebral Palsy Patients Following Deformity Surgery: Are we Now Ready for Cost-Utility Analysis in this Patient Population?

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Objectives

Cost-utility analysis (CUA) can quantify the economic value of surgery. Health state utilities (HSU) provide a value to health outcomes and are used in calculating quality-adjusted life-years. Disease-specific health-related quality of life (HRQoL) measures commonly lack preference weights necessary to produce HSU values for use in CUA. A solution is to map a disease-specific HRQoL measure to a generic preference-based measure. Our aim was therefore to develop HSU values for patients following scoliosis surgery for cerebral palsy (CP) by mapping disease-specific CPCHILD outcome scores to the preference-based Health Utility Index (HUI) questionnaire.

Method

A prospective, multicentre CP scoliosis surgical database identified consecutive patients with ≥2-year follow-up who completed both CPCHILD and HUI pre-op and at 2-year follow-up. Spearman’s correlations between paired CPCHILD and HUI utility scores were calculated. Ordinary least squared regression models were constructed to estimate HUI utility values from CPCHILD scores. Influence of age, sex, weight, GMFCS level, and major coronal Cobb was explored for predictive accuracy. The regression model was developed using pre-op data while 2-year follow-up data were used for confirmatory analysis and goodness of fit.

Results

232 patients were included. Several significant correlations between CPCHILD scores and HUI utility were noted. Strongest correlation was observed between HUI total score and CPCHILD communication (p=0.646, p<0.001), HUI pain and CPCHILD comfort (p=0.644, p <0.001), and HUI cognition and CPCHILD communication (p=0.585, p<0.001). The best fitting regression model is shown in Table 1 ($R^2$ 0.442, RMSE 0.185). The mean difference of means between observed HUI values and calculated HUI values at 2 years was 0.005 points (p=0.708).

Conclusions

We demonstrate that HUI scores can be accurately predicted using the CPCHILD questionnaire. This mapping algorithm will be useful in estimating HSU in clinical trials of CP patients undergoing scoliosis surgery to help better inform all stake-holders of the economic impact of surgery.
Understanding and Managing Neuromonitoring Changes During Spinal Deformity Surgery

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Objectives

Intra-operative multi-modality neuromonitoring (IONM) has been established as the standard adjunct to spinal deformity surgery. Despite its universal acceptance and use, there remains significant controversy into what constitutes a neuromonitoring change, what significance does that change represent, what actions should be taken in response to the change and which factors led to the changes.

Method

A retrospective review of prospectively collected neuromonitoring data in pre-established forms on consecutive patients undergoing spinal deformity surgery was performed. The inclusion criteria included paediatric patients with a minimum of 50-degrees primary coronal deformity for idiopathic or syndromic causes. All patients underwent posterior column osteotomy (PCO) or intraoperative traction with motor-evoked and somatosensory-evoked monitoring.

Results

97 patients, 71 females and 26 males, with a mean age of 14.9 (11-18) years were included in this study. There were 39 alerts in 27 patients (27.8% overall incidence). Significant differences were noted among the groups with no MEP changes (n=70) vs those with MEP changes (n=27) based on mean Cobb (76.6° vs 84.4°), and patients who underwent PCOs (25.7% vs 51.9%). IONM alerts were divided into 2 subgroups: cases involving spinal cord perfusion deficits and those occurring as a result of direct trauma to the cord. All perfusion-based changes (n=23) involved bilateral MEP loss without SSEP loss. Direct trauma (n=16) resulted in unilateral MEP alerts with 2 cases having SSEP changes as well. All bilateral changes responded to a combination of transfusion, increasing blood pressure, and rod removal. Unilateral changes as a result of direct trauma, mainly during decompressions, resolved with removal of the causative agent and time.

Conclusions

A high incidence of alerts occurred in our series of cases. Dividing IONM changes into perfusion-based vs direct trauma helped direct treatment to the offending cause, allowing for safe corrections of the deformities. Patients did not need to recover signal to baseline to have a normal neurological examination. Careful monitoring and management helped to maintain spinal cord perfusion in the peri-operative period.
Pain and Functional Outcomes following Scoliosis Surgery in Adolescents: A Latent Growth Mixture Modelling Analysis

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Objectives

To describe postsurgical pain trajectories using repeated assessments during the first postsurgical year and to compare functional outcomes across trajectories.

Method

Two hundred and twenty children, aged 10 to 18 years, who underwent posterior spinal fusion and instrumentation for adolescent idiopathic scoliosis were included. Participants completed assessments prior to surgery and at six postsurgical time points. Measures of average pain intensity, general and health-related quality of life and functional disability were administered. Latent class growth mixture modeling was used to produce a three-trajectory model of the data that included baseline pain as a covariate.

Results

The majority of the sample (48.6%, n = 98) were grouped into a trajectory labelled, ‘moderate pain with good resolution’. A large portion of the sample (38.6%, n = 78) were grouped into a trajectory labelled, ‘mild pain with good resolution’, and the smallest portion of the sample (12.9%, n = 26), were grouped into a trajectory labelled, ‘moderate pain with incomplete resolution’. A series of one-way ANOVAs showed significant differences among the trajectories on functional outcomes with individuals in the ‘moderate pain with incomplete resolution’ trajectory having the poorest outcomes.

Conclusions

Our findings suggest that most individuals with early postoperative pain can experience good recovery. A small subset of children demonstrated less complete recovery and lower functioning; the clinical implications of these findings should be evaluated.
Association Between the Molecular Profiles and Health Outcomes in Patients Followed in a Pediatric Scoliosis Clinic

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Objectives

It is currently difficult to identify children that are at higher risk of scoliosis progression. Treatments are less than optimal and based on the evaluation of an already developed deformity; better diagnostic and prognostic methods are needed. The objective of this study is to determine if molecular profiles are associated with differential spinal health outcomes in pediatric patients with idiopathic scoliosis.

Method

This is a retrospective cohort study evaluating spinal health outcomes in patients aged 5 to 21 followed at Sainte-Justine University Hospital Center. Data from clinical and radiological examinations were collected. Blood test was done to stratify 563 patients into three biological endophenotypes or functional groups (FG1, FG2, FG3) corresponding to the maximal G-inhibitory response to melatonin stimulation in a cell-based assay. The main outcome is the maximum angle of the scoliosis curve (Cobb angle) attained at maturity. The second outcome describes whether the patient has reached or not severe curve size (45 degrees) and/or has had corrective surgery for his scoliosis. Multivariate analyses are performed to evaluate the association between the molecular profiles and each outcome.

Results

The bivariate analysis provided evidence that both outcomes are less favorable for the FG1 group (27.0 degrees of maximum Cobb angle at maturity and 21.2 % reaching 45 degrees during follow-up or going through corrective surgery) when compared to the FG3 group (23.9 degrees; 11.2%). In a multivariate model, when controlling for all the confounding factors, there is a tendency on higher Cobb angles at maturity for FG1 and FG2 patients (respectively p=0.056, p=0.05) as compared to FG3 patients. There is clear evidence of increased likelihood of reaching 45 degrees and/or going through spinal fusion for FG1 and FG2 patients in comparison to FG3 patients (respectively OR= 2.181 [1.002-4.749] and OR= 2.141 [1.038-4.413]).

Conclusions

After controlling for independent predictors of severity outcomes and potential confounders, associations were identified between endophenotype classification groups and clinical outcomes. Patients classified as FG3 seem to have a more favorable outcome.
Impact of Age on Outcomes Following Degenerative Scoliosis Surgery

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Objectives

Seniors make up 16.9\% of the Canadian population. The number of Canadians who are 65 years or older is increasing at an average rate of 20\% every 5 years. In 2017, Sing et al. reported that there is an increasing number of patients undergoing degenerative scoliosis surgery with the largest increase attributed to patients 65-69 years old, followed by those 70-74 years old. The purpose of this study was to assess effectiveness of undergoing spinal surgery to correct degenerative spinal scoliosis in elderly vs non-elderly patients. We hypothesized no significant difference in outcomes between age groups followings degenerative scoliosis surgery.

Method

A retrospective review of prospectively collected data within the CSORN database was conducted. ANOVA was used to analyze continuous variables while Chi Square test was used to analyze categorical variables. Significance level was p < 0.05.

Results

There were 165 patients identified from the registry who had undergone surgery to treat degenerative scoliosis; 94 patients (57 \%) were female, 102 (61.8 \%) patients were 65 years or older. The overall average age was 66.6 years (range 35-84, SD 8.6). There were 27 intra-operative complications, 44 peri-operative complications and 18 post-operative complications. There was no statistically significant difference between the two age groups with regards to risk of developing intra-operative, perioperative and post-operative complications. Elderly patients who underwent degenerative scoliosis surgery reported an average improvement of 2.90 ± 3.23, 4.01 ± 3.58, 15.19 ± 20.85 compared to an average improvement for patients younger than 65 years of 3.04 ± 3.50, 3.00 ± 3.30, 19.55 ± 19.66 points on the back-pain scale, leg pain scale and the Oswestry Disability Index respectively. There were no statistically significant differences in these measures between the two age groups.

Conclusions

As the number of patients undergoing degenerative scoliosis surgery increases, clinicians will need to determine which factors will significantly affect patients’ outcomes. This study shows that outcomes following degenerative scoliosis surgery are not associated with age.
Pre-Operative CT Surface-Merge Navigation Improves Safety of Pedicle Screw Placement in the Treatment of Adolescent Idiopathic Scoliosis

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Objectives

The use of pedicle screws for the treatment of adolescent idiopathic scoliosis (AIS) is the fixation of choice for many surgeons. Various methods of pedicle screw insertion have been described, including free-hand and navigation guided techniques. The safety and complications of these techniques have been investigated, with medial breeches posing the highest risk of neurological deficits. Furthermore, breeches may be described by intra-operative palpation, screw electrical stimulation, or post-operative imaging. This study evaluates screw placement by intra-operative surface-merge navigation compared to free-hand technique, using intra-operative screw stimulation to detect medial breeches.

Method

A single-center retrospective chart review between April 2014 and September 2018 of posterior spinal instrumentation and fusion (PSF) for AIS was conducted. Two patient groups were based on a transition in practice: Free-hand and Navigation, using pre-operative CT with intra-operative surface-merge navigation. All screws were tested with intra-operative electrical stimulation for the detection of breeches. Charts were reviewed for reported breeches, changes in Motor Evoked Potentials (MEP) or Somatosensory Evoked potentials (SSEP) and post-operative clinical neurological deficits.

Results

There were 154 patients that had PSF for AIS; 83 in the free-hand group and 71 in the Navigation group. They were equivalent for age, pre-operative Cobb angle, correction percentage, levels fused and estimated blood loss. A total of 2606 screws were placed; 1418 free-hand and 1188 with navigation. The micro-breech rate was 4.4% in the Freehand group and 3.5% in the Navigation group (p<0.0001). The frank-breech rate was 0.71% in the Freehand group and 0.59% in the Navigation group (p<0.035). The total breech rate was 5.1% in the Freehand group and 4.0% in the Navigation group (p<0.0001). In the freehand group there was 1 SSEP change, 9 MEP changes and no clinical neurological deficits. In the Navigation group there were no SSEP, MEP or clinical neurological changes.

Conclusions

Pre-operative CT surface-merge navigation decreases the incidence of medial breeches measured by intra-operative screw stimulation compared to the freehand technique in AIS patients treated with PSF.
Effect of Tobacco Smoking on Implant Failure Rate and Risk of Intra-Operative Bleeding: Analysis of 270 Patients from the Prospective, Multi-Center SCOLI-RISK-1 Study of Complex Adult Spinal Deformity Surgery

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Objectives

To determine the effect of tobacco smoking on the peri-operative and long-term complications of patients undergoing complex adult spinal deformity surgery in the SCOLI-RISK-1 study.

Method

The Scoli-RISK-1 study enrolled 272 patients who had undergone complex adult spinal deformity surgery from 15 centers, with a minimum 2 year follow up. The outcomes and incidence of AEs in patients with a history of smoking (n=26) were compared to the non-smoking patients (n=244) using univariable analysis. Multivariable regression analysis was used to adjust for the effect of patient demographics, complexity of surgery and other confounders.

Results

No difference was observed in the number of levels or complexity of surgery in both cohorts. In the univariable analysis, the rates of implant failure were almost double (n=7; 26.9%; Odds Ratio 2.28; [95%CI 0.75 – 6.18]) that observed in the non-smoking group (n=34; 13.9%; p=0.088), but this was not statistically significant. Surgery related excessive bleeding was however significantly higher in the smoking group (n=5 vs n=9; 19.2% vs 3.7%; OR 6.22[1.48 – 22.75]; p=0.006). Wound infection rates were similar (n=3 vs n=17; 11.5% vs 7.0%; OR 1.74[0.30-6.70], p=0.422), as were rates of respiratory complications (n=1 vs n=13; 3.8% vs 5.3%; OR 0.71[0.02-5.13], p=1.000). In the multivariable analysis, the smoking group demonstrated a higher incidence of surgery related AEs over 2 years (n=13 vs n=95; 50.0% vs 38.9%; OR 2.12 [0.88-5.09]) (p=0.094), but this was not statistically significant.

Conclusions

Smoking significantly increased the risk of excessive intra-operative bleeding compared to the non-smoking group. The rate of implant failure was higher (but not significantly) in smokers, as was the rate of all post-operative surgery-related AEs. Even though this sub-analysis was likely underpowered, we recommend smokers undergo an active smoking cessation program prior to undergoing complex adult spinal deformity surgery.
Outpatient 1, 2 or 3 Level Anterior Cervical Discectomy and Fusion Procedures have Similar Complication Rates and Outcomes Compared to Overnight Stay; Analysis of 284 Patients in the Public Healthcare Setting

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Objectives

To assess the safety and efficacy of day surgery for 1, 2, or 3 level anterior cervical discectomy and fusion (ACDF) at a single Canadian institution.

Method

A retrospective review of the inpatient spine surgery database of a single Canadian institution over 13 years was performed to compare the complication and readmission rates of patients undergoing day surgery or short-stay ACDF. Regression analysis was used to assess outcomes at 2 months and 2 years post-surgery with the Neck Disability Index (NDI).

Results

143 patients underwent ACDF with the intention to treat (ITT) as a day surgery procedure, with 130 admitted for short stay (24-hours). The day surgery cohort included 73 single, 51 two and 19 three level patients. The short stay cohort included 55 single, 45 two, 29 three level and 1 four level procedures. 6 patients (4%) with the ITT as day surgery were admitted for overnight stay or longer (range 2 – 21 days). Intra-operative dural tear was reported in 8 patients (5.8%) in the day surgery group (4 required admission), compared to 4 patients (3.1%) in the short stay group (odds ratio [OR] = 1.81 [0.53-6.2], p=0.5). 1 patient (0.7%) in the day surgery group suffered a permanent post-operative neurological deficit compared to 0 patients in the short stay group (p=1). 3 patients (2.1%) in the day surgery group and 2 patients (1.5%) in the short stay group required readmission within 30 days (OR = 1.36 [95%CI 0.22 – 8.3], p=1). Regression analysis showed no significant differences in the 2-month and 2-year outcomes post-ACDF between groups (p=0.796, 0.315 respectively) after accounting for total number of levels.

Conclusions

Day surgery ACDF for 1, 2 or 3 levels does not have a significantly higher rate of complications, readmission within 30 days, or differences in short and long term outcomes when compared to overnight stay. This provides evidence that day surgery ACDF is a safe and effective treatment option in the public healthcare setting.
The Safety and Efficacy of Riluzole in Enhancing Clinical Outcomes in Patients Undergoing Surgery for Cervical Spondylotic Myelopathy: Results of the CSM-Protect Double-blinded, Multi-center Randomized Controlled Trial in 300 Patients

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Objectives

Cervical spondylotic myelopathy (CSM) is the most common cause of spinal cord dysfunction in adults. Surgical decompression improves clinical outcomes; however, many patients have residual disability. We hypothesized that adjuvant treatment with the sodium-glutamate blocker riluzole may be effective in enhancing surgical outcomes.

Method

In this Phase 3 multi-center, placebo-controlled, double-blinded, randomized controlled trial (ClinicalTrials.gov NCT01257828), surgically naïve subjects undergoing operative decompression for moderately severe CSM (mJOA 8-14) received riluzole 50 mg bid for 14 days before surgery and 28 days after surgery, or placebo. The primary outcome was change in mJOA score at 6 months post-operatively. Subjects were followed up 6 months for the primary efficacy analysis and 12 months in total.

Results

300 subjects were enrolled and 290 (141 riluzole and 149 placebo) received surgery. Subjects in both trial arms improved with regard to all endpoints. At 6-month and 12-month follow-up, there was no difference between riluzole and placebo regarding improvement in mJOA (2.45 and 2.82 in riluzole and placebo groups at 6 months, respectively, p=0.16), Nurick grade, NDI, SF-36, EQ-5D, ASIA motor and sensory scores, pain, and grip strength. In a repeated measurement analysis, riluzole subjects showed greater 35-day reduction in neck pain (VAS) that was maintained at 6 and 12 months.

Conclusions

Adjuvant treatment with riluzole does not improve functional recovery because the effects of surgical decompression dominate the clinical picture. The potential effect of riluzole in reducing pain in surgically treated CSM patients merits further study.
Shoulder Traction Device for Increasing Visualization of Cervical Vertebra on Fluoroscopy During Cervical Spine Surgery

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**Objectives**

Intraoperative fluoroscopic imaging of the cervical spine is usually used to locate the right level in cervical spine surgery. Radiographic visualization of all cervical vertebra on lateral projection is sometimes not achievable because of the shadow of shoulders. Here, we describe and evaluate Cervision system, a new traction device designed to decrease the shoulder superimposition on the cervical fluoroscopy.

**Method**

A retrospective matching-cohort study was conducted to evaluate the system. Patients undergoing cervical spine surgery at our institution were included in this study and divided into two cohorts. The first cohort included 33 consecutive patients operated by the senior author and Cervision system was used to pull the patient’s shoulders down. The second cohort included 33 patients operated by other spine surgeons and adhesive tape was used for shoulder caudal displacement. These two cohorts were matched. We compared the number of cervical vertebra visible on the lateral fluoroscopy, the installation time and the rate of post-operative brachial plexus palsy complication between the two groups.

**Results**

There was a difference in cervical vertebra visualization on the lateral radiography between two groups. Mean number of vertebra visible in Cervision cohort was 6.3 ± 0.41 while it was 5.6± 0.32 in the control group (p<0.01, unpaired t-test). Patients with T1 vertebra visible is 5/33 (15.15%) in Cervision cohort and 0/33 (0%) in control cohort (p-value = 0.02, Pearson Chi-Square test).

The installation time which was the period from the beginning of intubation procedure until the moment of making the incision was 83.9 ± 5.15 minutes in Cervision cohort and 73.7± 6.32 minutes in the control group (p<0.02). Analysis of the data showed a learning curve with a decreasing tendency in installation time with Cervision system.

There was no post-operative brachial palsy in the two cohorts.

**Conclusions**

Cervision is a safe and useful device for increasing the visualization of lower cervical vertebra levels on the intraoperative fluoroscopy.
Rates and Predictors of Return to Work after Surgery for Cervical Spondylotic Myelopathy: Analysis from the Canadian Spine Outcomes and Research Network (CSORN)

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Objectives

Cervical Spondylotic Myelopathy (CSM) is the most common cause of spinal cord dysfunction internationally; however, few studies have evaluated return to work (RTW) after CSM surgery. Our goals were to determine rates and predictors of post-operative RTW and to compare postoperative rates to a lumbar spondylolisthesis cohort.

Method

Data were derived from the CSORN prospective, multi-center surgical CSM registry. From this cohort, we included all non-retired patients with at least 1-year follow-up. RTW rate was defined as the proportion of patients with active employment at 1-year from the time of surgery. Bivariable and multivariable logistic regression were used to identify patient, disease and treatment variables predicting RTW.

Results

Of 211 surgically treated CSM patients with 1-year follow-up, 102 (48.3%) were considered non-retired preoperatively, with 54.5% working and 45.5% not working in the immediate period before surgery. At 1-year, 60 patients (58.8%) had returned to work, while 42 (41.2%) were not working. In bivariable analyses, while working preoperatively predicted post-operative RTW (p<0.05), there were no significant differences between the postop employment groups with respect to age, gender, preoperative mJOA, duration of symptoms and anterior vs. posterior surgical approach (p>0.05). In multivariable analyses, only preoperative employment status predicted RTW, with those working pre-op having 12 times greater odds of working at 12 months post-op (OR:12.1,95%CI:2.2,66.5). For comparison, the 1-year post-surgical RTW rate in the CSORN lumbar spondylolisthesis study cohort was 70.0%.

Conclusions

The majority (58.8%) of non-retired patients undergoing surgery for CSM had returned to work 12 months post-op; preoperative work status was the only significant predictor of RTW in this analysis. RTW rates appear to be lower in CSM compared to lumbar spondylolisthesis. These results will help to inform preoperative patient counseling, enable economic analyses and serve as a focus for future quality improvement efforts.
Multiparametric Quantitative MRI as an Accurate Diagnostic Tool for Myelopathy

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Objectives

Clinical diagnosis of myelopathy is challenging as symptoms and signs can be subjective and diagnostic uncertainty is common. Anatomical MRI in this setting has poor specificity. MRI techniques that measure demyelination, axonal injury, and atrophy may provide enhanced accuracy in such cases. The diagnosis of degenerative cervical myelopathy (DCM) is important because it is a progressive disease and early treatment can avoid permanent disability. We describe a multiparametric quantitative MRI protocol for microstructure analysis of the spinal cord to determine the precise degree of injury to the spine in the setting of DCM. We used the metrics to develop a diagnostic tool, comparing 5 statistical approaches for classification between healthy subjects and those with DCM.

Method

35 controls and 56 DCM patients were studied. All subjects were examined clinically followed by MRI scans acquiring T2-weighted (T2w) imaging, diffusion tensor imaging (DTI), magnetization transfer (MT), and T2*-weighted (T2*w) imaging covering C1-C7.

Image analysis was performed on Spinal Cord Toolbox to calculate cross-sectional area (CSA), fractional anisotropy (FA), MT ratio (MTR), and T2* white to gray matter ratio (T2*W WM/GM).

Statistical analysis was performed with R V3.3. Models were developed using subject characteristics and MRI data using 1) logistic regression (LR), 2) linear discriminant analysis (LDA), 3) principle component analysis with logistic regression (PCA-LR), 4) k-nearest neighbors (kNN) with various k values (3,5,7), and 5) a support vector machine (SVM) model. Estimates of diagnostic accuracy were reported as corrected area under receiver operating characteristic curves (AUC).

Results

All 5 models showed good diagnostic accuracy, with the SVM model showing the highest performance (AUC=95.6%), outperforming LR (AUC=93.6%), PCA-LR (AUC=89.0%), LDA (AUC=87.9%), and kNN (k=5, AUC=84.6%). The SVM model with cost=100 outperformed other SVM models, which showed AUC ranging from 91.2% to 94.3%.

Conclusions

Multiparametric quantitative MRI techniques can provide immense amounts of data for a single patient. Supervised machine learning algorithms such as SVM allow us as clinicians to harness this information and achieve greater diagnostic accuracy than conventional statistical approaches.
A Comparison of Surgical Outcomes in Mild, Moderate, and Severe Degenerative Cervical Myelopathy: Analysis of a Prospective Multicenter Cohort of 735 Patients

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Objectives

Degenerative cervical myelopathy (DCM) is the most common cause of spinal cord dysfunction in adults worldwide, leading to significant impairment in quality of life (QOL). Current treatment paradigms indicate surgery for moderate or severe DCM, whereas there is controversy over the optimal treatment strategy in mild DCM. With the aging population, this remains a critical knowledge gap to address. The objective of this study was to comparatively evaluate the functional, disability, and QOL outcomes in patients with mild versus moderate versus severe DCM.

Method

Data were derived from two prospective, multicenter cohort studies (AOSpine CSM-North America and AOSpine CSM-International). Outcomes were evaluated pre-operatively and at 6 months, 1 year, and 2 years after surgery using the mJOA, NDI, SF-36, and SF-6D. A normalized recovery index using a novel area under the curve technique measuring total recovery as a proportion of maximal possible recovery was calculated and compared between mild (mJOA: 15-17), moderate (mJOA: 12-14), and severe (mJOA<12) DCM groups by one-way ANOVA.

Results

A total of 735 patients were enrolled, 192 with mild, 294 with moderate, and 249 with severe DCM. Baseline characteristics for each group were assessed. The mJOA scores showed greater relative upper limb sensory improvement in mild DCM compared to moderate and severe DCM (p<0.05). However, the overall improvement in mJOA score was lower in the mild group (p<0.05). NDI scores showed significantly higher relative improvements in personal care, driving, and concentration in mild DCM compared to moderate DCM (p<0.05). The bodily pain component of SF-36 scores showed a significantly greater improvement in mild DCM, but physical component scores demonstrated lesser improvement in mild DCM compared to moderate and severe DCM (p<0.05). SF-6D scores showed the greatest relative improvement in mild DCM compared to moderate and severe DCM (p<0.05).

Conclusions

More sensory improvements were seen in mild DCM patients while more gait improvements were seen in moderate and severe DCM patients. Overall, this study suggests that patients with mild DCM do receive significant benefit from surgical decompression.
The Influence of Cervical Spondylolisthesis on Clinical Presentation and Surgical Outcome in Patients with Degenerative Cervical Myelopathy: Analysis of a Multicenter Global Cohort of 458 Patients

Aria Nouri

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Objectives

Cervical Spondylolisthesis (CS) is common amongst patients with Degenerative Cervical Myelopathy (DCM). However, its impact on clinical presentation and surgical outcome have not been well-described. It is thus the objective of the present study to address this knowledge gap by comparing the difference between patients with and without CS undergoing surgical treatment for DCM.

Method

458 MRIs from the AOSpine North America and International Studies were reviewed. CS was identified using MRIs. Patients with DCM were divided into two cohorts, those with CS and those without, and propensity matching was performed. Patient demographics, neurological and functional status at baseline and 2-year follow-up were compared.

Results

Compared to non-spondylolisthesis patients (n=404), CS patients (n=54) were 8.8 years older (p<0.0001), presented with worse baseline neurological and function status (mJOA, p=0.008; Nurick, p=0.008; SF-36-PCS, p=0.01), more commonly presented with ligamentum flavum enlargement (81.5% vs 53.5%, p<0.0001), were less commonly from Asia (p=0.0002), and tended to have more compressed levels (p=0.052) and lower prevalence of OPLL (p=0.098). There was no difference in sagittal alignment (p=0.94). Surgical approach varied between cohorts (p=0.0002), with posterior approaches favored in CS (61.1% vs 37.4%). CS patients also had more operated levels (4.3+/–1.4 vs 3.6+/–1.2, p=0.0002), and tended to undergo longer operations (196.6+/–89.2min vs 177.2+/–75.6min, p=0.087). The mean improvement of neurological function was lower with CS [mJOA (1.5+/–3.6 vs 2.8+/–2.7, p=0.003); Nurick (-0.8+/–1.4 vs -1.5+/–1.5, p=0.002)], and CS was an independent predictor of worse mJOA recovery ratio at 2-years (B=-0.190, p<0.0001). After propensity matching, the mean improvement of neurological function was still lower in patients with CS [mJOA (1.5+/–3.6 vs 3.2+/–2.8, p<0.01); Nurick (-0.8+/–1.4 vs -1.4+/–1.6, p=0.02)].

Conclusions

CS patients are older and present with worse neurological and functional impairment. Furthermore, they receive surgery on more levels and more commonly from the posterior. CS may indicate a more advanced state of DCM pathology and is more likely to result in a suboptimal surgical outcome.
Minimum Clinically Important Difference in Patient Reported Outcomes for Cervical Spondylotic Myelopathy: An Analysis from the Canadian Spine Outcomes and Research Network (CSORN)

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Objectives

Patient reported outcomes (PROs) are increasingly used to assess patients with spinal disorders; however, the numerical scores of PROs lack interpretability. We sought to determine the minimum clinically important difference (MCID) in several PROs, including the EQ-5D Index, Neck Pain Numeric Rating Scale (NRS), and Arm Pain NRS, in patients with cervical spondylotic myelopathy (CSM).

Method

Data were derived from the CSORN prospective, multi-center registry of patients undergoing surgical decompression for CSM. MCIDs were determined by distribution-based (half standard deviation, standard error of measurement [SEM]) and anchor-based (ROC) methods. A satisfaction question asking patients how they feel at 12 months compared to before surgery served as the anchor for the EQ-5D Index; the MCID was defined as the change score with even sensitivity and specificity to distinguish patients who reported “Much better” or “Better” versus “Same”, “Worse”, or “Much worse”. For the Neck and Arm Pain NRS, anchor questions were those asking patients whether surgery fulfilled their expectations at 12 months with regards to reduced 1) neck and 2) arm pain; the MCID was defined as the change score with even sensitivity and specificity to separate patients who reported “Yes completely” or “Somewhat” versus “I don’t know” or “No, not at all”.

Results

Two-hundred and five patients with complete data were identified. The calculated MCID for EQ-5D Index was 0.11 by all methods. For both the Neck and Arm Pain NRS, the MCID was -1.5 points by half standard deviation and SEM, and -2 points by ROC analysis.

Conclusions

The MCID is estimated at 0.11 for EQ-5D Index and -1.5 points for both Neck and Arm Pain NRS in patients with CSM. This knowledge will help clinicians identify patients with meaningful improvements in quality of life and pain following intervention and provide a standard for assessing change in PROs in CSM research.
The Impact of Older Age on Functional Recovery After Surgical Decompression for Degenerative Cervical Myelopathy: Results from an International, Multicentre, Prospective Dataset in 757 Patients

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Objectives

To determine the effect of age over 70 on functional recovery and quality of life (QOL) measures after surgery for Degenerative Cervical Myelopathy.

Method

107 patients over the age of 70 were identified from the 757 patients enrolled in the prospective, multi-centre AOSpine CSM North America and International studies. Functional status (mJOA) and QOL (SF-36) outcomes at 6, 12 and 24 months after surgery were compared with unadjusted univariate analysis and multiple linear regression (to model the effect of age without co-morbidities, smoking, number of operated levels, surgical approach or baseline mJOA).

Results

Baseline mJOA in the elderly group was significantly lower than the younger group (11.0[95%CI 10.4-11.5] vs 12.9[12.7-13.1]; p=<0.01). The unadjusted change in mJOA scores were similar in both groups at 6 months (2.30[1.71-2.88] vs 2.21[2.02-2.40]; p=0.75), 12 months (2.79[2.18-3.41] vs 2.50[2.29-2.70]; p=0.30) and 24 months (2.63[1.99-3.27] vs 2.71[2.51-2.92]; p=0.77). After covariate adjustment, the coefficient for change at 6 months in the elderly group was -0.84(p=<0.01), -0.74 at 12 months(p=<0.01) and -1.22 at 24 months(p=<0.01).

Baseline SF-36 physical component summary was unchanged between groups, but the mean change was lower in the elderly group at 6 months, 12 months and 24 months (coefficient of change -3.02[p=<0.01], -1.16 at 12 months[p=0.27] and -3.65 at 24 months[p=<0.01]). SF-36 mental component scores were higher in the elderly group at baseline (43.0[40.6-45.5] vs 39.8[38.7-40.8]; p=0.02), were no different at 6 or 12 months, but were lower at 24 months (2.59[-0.028–5.47] vs 5.96[4.97 – 6.96]; p=0.01; coefficient of change -4.53, p=<0.01).

Conclusions

In this large prospective dataset, the elderly group demonstrated significantly worse functional and QOL recovery compared to the younger cohort after adjusting for the effect of co-morbidities, number of operated levels, surgical approach and baseline mJOA. Elderly patients undergoing surgery for DCM should therefore be counseled appropriately regarding expectations of surgery.
Importance of Sagittal Alignment in Cervical Spondylotic Myelopathy: An Observational Study from the Canadian Spine Outcomes and Research Network

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Objectives

Recent evidence suggests that sagittal alignment may play a role in the presentation and management of patients with cervical spondylotic myelopathy (CSM), but its importance has not been fully established. In this study, our objectives were to evaluate the extent to which (1) pre-operative sagittal alignment is associated with baseline function and symptoms, (2) surgery leads to changes in sagittal alignment, and (3) post-operative sagittal alignment is associated with function and symptoms at follow-up.

Method

We performed an observational cohort study using prospectively collected data from the Canadian Spine Outcomes and Research Network (CSORN). We included all patients diagnosed with CSM at seven participating centers between 2015 and 2017. We measured sagittal alignment using two methods: surgeon classification and Ishihara’s Cervical Curvature Index (ICCI). We measured function and symptoms with multiple Patient Reported Outcome Measures (PROMs), and we adjusted for age, gender, severity, and comorbidities using multiple linear regression.

Results

Among 474 patients, baseline alignment was neutral in 196 (41%), lordotic in 190 (40%), and kyphotic in 88 (19%). In comparison to lordosis, baseline kyphosis was associated with significantly worse EQ 5D (p<0.05) and Short Form 12 Mental Component Summary (SF12 MCS) scores (p<0.05). Surgical treatment altered alignment towards lordosis in patients that were neutral or kyphotic pre-operatively, and was associated with significantly improved function and symptoms regardless of baseline alignment (mJOA, NDI, VAS, SF12, and EQ-5D: p<0.01). There were no statistically significant associations between post-operative alignment and PROMs at 3 or 12 months.

Conclusions

Baseline kyphosis appears to be associated with greater impairment in health-related quality of life among patients with CSM. Surgery for CSM improves symptoms and function regardless of baseline alignment, but post-operative sagittal alignment does not seem to be associated with final patient-reported outcomes. These findings suggest that sagittal alignment restoration may not be important in the surgical management of patients with CSM.
Machine Learning Approaches to Predict Surgical Outcomes in Degenerative Cervical Myelopathy

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Objectives

Degenerative cervical myelopathy (DCM) represents a series of degenerative changes that compress the cervical spinal cord. While the treatment for moderate to severe cases is surgical, the treatment for mild cases is controversial due to the heterogeneous response to surgery in patients. Here, machine learning (ML) algorithms were used to determine which groups of mild myelopathy patients benefitted most from surgery.

Method

193 patients from the AOSpine CSM clinical trials with mild DCM at baseline were enrolled. Patient-reported quality of life outcome scores, particularly the Short Form-36 (SF-36) mental component summary (MCS) and physical component summary (PCS), were obtained before and 1 year after surgery. The change between the baseline MCS and PCS scores and the scores at 1 year was dichotomized according to whether it exceeded the minimal clinically important difference (MCID). The 193-patient dataset was then divided into training and testing sets (75% training: 25% testing). The training set was used to optimize four ML algorithms (classification trees, support vector machines, random forests, k-nearest neighbor), while the testing set was used to evaluate algorithm performance.

Results

The ML algorithms performed well on the testing set, with areas under the receiver operating characteristic curves (AUCs) ranging from 0.72-0.80 and 0.69-0.77 for predicting improvements in the MCS, and PCS respectively. Additionally, the classification trees provided insight on which patient phenotypes were likely to achieve meaningful post-operative improvement. For example, female patients with a low MCS pre-operatively were less likely to improve in mental health than males. Moreover, patients starting in an intermediate range of PCS improved based on multiple factors, such that younger non-smokers and lower BMI patients lacking lower limb spasticity improved more significantly in physical health.

Conclusions

ML algorithms showed good performance and demonstrated that patient factors such as age, BMI, gender, and smoking history were important in predicting which mild DCM patients were more likely to benefit from surgery. Overall, ML provides a reliable framework for clinicians to make management decisions in mild DCM patients.
**Predictors for Home Discharge after Degenerative Cervical Myelopathy Decompressive Surgery; An Analysis of the Canadian Spine Outcomes and Research Network (CSORN)**

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**Objectives**

To identify those factors associated with discharge to home after Degenerative Cervical Myelopathy Surgery

**Method**

A retrospective analysis of patients who underwent cervical spinal myelopathy decompressive surgery between 2008 and 2017 using multicenter prospectively collected data from the CSORN database (n=394). Multivariable logistic regression with a backward selection procedure was used to identify predictors of patient discharge destinations: home versus other facilities. A data-splitting technique was utilized to develop and test the multivariable models.

**Results**

Regression analyses identified three significant predictors of home discharge: those patients that were working at the time of the surgery (odds ratio [OR]= 3.6); those that had ACDF (OR=5.1); and higher values of baseline mJOA (OR=1.3 odds of home discharge increase by 30% for each one-point increase in mJOA). The final model was internally validated and confirmed the same predictors. ROC curve analysis revealed area under the curve of 0.791.

**Conclusions**

Predictors identified with “Home Discharge” after degenerative cervical myelopathy decompression surgery were: Those patients working at the time of the surgery, those treated with ACDF, and those with higher baseline mJOA.
Are There Gender Based Differences in Outcomes for Elective Lumbar Spine Surgery in Canada

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Objectives

The purpose of this study was to determine gender differences in the outcome for lumbar decompression, microdiscectomy, and lumbar decompression and fusion, utilizing a national Canadian spine database.

Method

Retrospective analysis was performed on 1316 patients who underwent either a single level microdiscectomy(n=614), lumbar decompression(n=343) or a single lumbar decompression with fusion surgery(n=259). Patients were prospectively enrolled in a national multi-center database, between October 2008 and August 2017. Baseline measurements included Back and Leg Pain scales, ODI, Health state, SF 36 PCS / MCS, and EQ-5D, along with measurements at 3 and 12 months post-operatively.

Results

In the microdiscectomy group at baseline (124F,135M), mean MCS score was higher in males(46.2+/8.3versus44.9+/7.9,p<0.05). Significantly more females were on pain medications(97%vs 91.1%,p<0.012). One year post-operatively, males had higher change in the mean PCS value(14.6+/9.7versus 1.7+/10.3,p<0.012). Otherwise both groups had similar improvements.

In lumbar decompression surgery, there was a higher mean baseline back pain scale score amongst females(7+/2.0 versus 6.3+/2.6, p<0.016), and females had a higher baseline ODI score(48.1+/13.4 versus 42.0+/15.6,p<0.001). There was a larger percentage of female patients on pain medications(95%versus77%, p<0.05). 12-months following surgery, females had a larger change in health state score(16.3+/23.1versus9.4+/22,p<0.05) and a trend towards larger PCS score improvement.

In decompression and fusion surgery, baseline scores showed a higher Patient Health Questionnaire PHQ9 scores in females(10.9+/6.4versus7.9+/5.6,p<0.001). There was a trend towards higher baseline ODI scores and worse baseline MCS scores for females. There were no significant differences in outcomes after surgery.

Conclusions

Female patients present with worse baseline scores than male counterparts for all three elective lumbar spine operations. Despite baseline differences, lumbar decompression and fusion surgery was effective, with no differences in outcomes, and in lumbar decompression surgery females had better health state change. Only in microdiscectomy operations, male patients improved significantly with higher PCS scores following microdiscectomy surgery. Reasons for these differences need further investigation.
Posterolateral Versus Posterior Interbody Fusion for the Management of Lumbar Degenerative Spondylolisthesis: A Feasibility RCT

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Objectives

It remains controversial if the use of the interbody fusion (IF) in the treatment of degenerative spondylolisthesis is necessary. The objectives of this study were to assess the acceptability and feasibility of trial procedures, the distribution of scores on the Oswestry Disability Index (planned primary outcome), and efficient working of trial components.

Method

A non-inferiority single-centre pilot RCT randomized patients to IF or PLF. Inclusion criteria included: age ≥ 18 years, and diagnosed with lumbar degenerative spondylolisthesis at one or two levels. Feasibility was accessed including recruitment rate, adherence to allocation, follow-up, and missing data. ODI score was assessed at 12 months postoperatively for sample size. Time-to-discharge, patient-rated outcomes, and adverse events were also compared.

Results

We recruited 38/48 eligible patients (7 eligible patients declined and 3 were excluded prior to surgery). No patient was lost to follow-up, or deviated from allocation. Data completion was 78% at 1 year. Study participants mostly were: female, had grade II spondylolisthesis, a single level, and symptoms for more than 2 years. At 12 months the ODI had improved from 50.3 (±15.1) to 27.1 (±19.5) compared to 51.3 (±11.2) to 34.3 (±18.6) for the PLF and IF groups, respectively. The mean difference was -7.2 (95%CI: -20.9, 6.5) with an upper limit below the non-inferiority margin of 10 points, indicating PLF was non-inferior to IF. PLF had a mean shorter operation time and intraoperative radiation dose but equal blood loss, adverse events, and length of stay. At 12 months the intensity of leg pain was significantly lower in the PLF cohort 1.2±2.2 versus 4.1±3.3, mean difference -2.8 (95%CI, -5.0, -0.7)].

Conclusions

Finding from this study provides confidence in the feasibility of a large-scale multi-centre RCT. As the hypothesis was that there would be equivalence between procedures, it was surprising that 12 month leg pain was significantly worse for IF, suggesting the multi-centre RCT should investigate that as the primary outcome.
The Association between Improvements in Mental Health with Pain and Disability Improvements after Thoracolumbar Spine Surgery: A CSORN study

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Objectives

Chronic spine disease is associated with substantial morbidity, pain, and decreased quality of life and is associated with depression. Thoracolumbar surgery reduces pain and disability for some chronic spine conditions and several small studies have shown an associated improvement in mental health after surgery. The Canadian Spine Outcomes and Research Network (CSORN) registry provides an opportunity to examine the association between spine surgery and mental health on a large scale.

Method

Patients undergoing surgery for chronic thoracolumbar spine disorders were extracted from the CSORN registry. Infection, inflammation, tumors, and fractures were excluded. The primary endpoint was the change in Short Form-12 Mental Component Score (MCS) between pre- and 12-month postoperative assessments. Previous literature identified MCS<45 as a cutoff sensitive and specific for major depression. Associations were tested with outcome measures including Patient Questionaire-9 (PHQ9), Oswestry Disability Index (ODI), SF-12 physical component score (PCS), and leg and back pain numeric rating scales.

Results

3222 patients met inclusion criteria and had preoperative and 12-month outcomes. Mean MCS improved from 48.1 (95%CI 47.8-48.4) pre-operation to 51.7 (95%CI 51.4-51.9; p<0.00001) post-operation, with the improvement significant in every diagnosis separately. 78.3% of patients meeting the depression cutoff preoperatively reached Minimally Clinically Important Difference (MCID) versus 48.3% of those who did not (p<0.001). Overall, there was a 45.7% drop in the proportion meeting the depression cutoff after surgery (p<0.001). Improvement in MCS correlated with improvement in ODI (r= -0.36; p<0.0001), PCS (r=0.15; p<0.0001), leg pain (r=-0.20; p<0.0001), and back pain (r=-0.25; p<0.001).

Conclusions

Patients receiving surgery for chronic spine conditions demonstrated a significant improvement in overall mental health, consistent with previous reports. This was clinically significant in the majority of cases meeting criteria for preoperative major depression. Postoperatively there was a substantial decrease in the overall proportion of depressed patients. Improvements in mental health correlated with improvements in disability and pain suggesting that the benefits of surgery for these conditions may extend to include mental as well as physical health.
The Influence of Multi-joint Symptoms on Outcome Following Surgery for Lumbar Spine Osteoarthritis (LS-OA)

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Objectives

Up to one-third of patients experience limited benefit following surgical intervention for LS-OA (i.e. spinal stenosis). Thus, identifying contributing factors to this is important. People with OA often have multi-joint involvement, yet this has received limited attention in this population. We documented the occurrence and evaluated the influence of multi-joint symptoms on outcome following surgery for LS-OA.

Method

141 patients undergoing decompression surgery+/fusion for LS-OA completed the Oswestry Disability Index (ODI) pre- and 12-months post-surgery. Also captured pre-surgery: age, sex, education, BMI, smoking, depressive symptoms and comorbidities. Any joints with “pain/stiffness/swelling most days of the month” were indicated on a homunculus. A symptomatic joint site count (e.g. one/both knees=1 site), excluding the back, was derived (range 0-9) and considered as a predictor of magnitude of ODI change, and likelihood of achieving minimally clinically important improvement in ODI (MCID=12.8) using multivariable adjusted linear and log-Poisson regression analyses.

Results

Mean age: 66 years (range:42-90); 46% female. 76% reported 1+ joint site other than the back, 43% reported 3+, and nearly 10% reported 6+. <10% of those with 0-2 joint sites had no improvement in ODI versus 29% of those with 3+ sites. Adjusted analyses: increasing joint count was associated with less improvement in ODI (p<0.01), as was higher BMI. Predicted mean improvement was 18 units for those with 0 joint sites, 12 units (< MCID) for those with 3 sites, and 4 units for those with 6+ sites. Associated with a greater likelihood of not achieving MCID were increasing joint count (11% increase per site (p=0.012)), higher BMI, current/former smoker, and worse baseline ODI.

Conclusions

Results suggest there is more than just the back to consider to understand patient-reported back outcomes. Multi-joint symptoms directly contribute to disability, but there is potential they may contribute to systemic, largely inflammatory, effects in OA as well.
Patients Undergoing Surgery for Lumbar Spinal Stenosis Experience Unique Courses of Pain and Disability: A Group-Based Trajectory Analysis

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Objectives

Identify patient subgroups defined by trajectories of pain and disability following surgery for degenerative lumbar spinal stenosis (LSS) and investigate the construct validity of the trajectory subgroups by evaluating for meaningful differences in clinical outcome.

Method

The study design was a retrospective analysis of prospectively collected data. Patients with LSS and deemed to be surgical candidates were recruited from 13 surgical spine centers that contribute to the Canadian Spine Outcomes and Research Network. Study outcomes (leg and back pain numeric rating scales, modified Oswestry disability index) were measured before surgery and after 3, 12, and 24 months. Patients were fit to pain and disability trajectory subgroups with group-based trajectory modeling. We examined for differences in the proportion of patients achieving minimum clinically important change in pain and disability (30%) and clinical success (50%) reduction in disability or Oswestry score ≤22).

Results

Data from 548 patients (mean [SD] age = 66.7[9.1] years; 46% female) were included. The group-based trajectory models identified 4 unique leg pain trajectories, and 3 trajectories each for back pain and disability. The construct validity of the trajectory subgroups was supported by differences in the proportion of patients meeting thresholds for minimum clinically important change in pain and disability (30%) and clinical success (50%) reduction in disability or Oswestry score ≤22).

Conclusions

Subgroups of patients with LSS can be identified by their trajectories of pain and disability following surgery. These groups may represent useful patient phenotypes. Although most patients experienced important reductions in pain and disability, many patients (29% to 42% depending on outcome) were classified as members of an outcome trajectory subgroup that experienced little to no benefit from surgery. These findings highlight the need for better methods of treatment selection for patients with LSS.
Spine Surgery Outcomes: A Comparison of Patient Versus Surgeon Expectations from a Canadian Perspective

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Objectives

The objective of this study was to elicit whether any differences exist between patient and surgeon expectations after spine surgery and if age plays a role in these differences.

Method

A retrospective study from a prospectively collected database (CSORN) was conducted. To begin, ten common clinical scenarios were generated and sent to Canadian spine surgeons to determine surgeon expectations for standard spine surgeries. Patients in the CSORN database were then identified with matching symptoms and procedures to those in the scenarios. Patient expectation data was then extracted and compared to surgeon responses. A Chi squared analysis was then completed to determine discrepancies between surgeon and patient expectations.

Results

A total of 51 Canadian spine surgeon completed the survey on expectation and 876 patients for multiple centers in Canada were identified in the CSORN database to match the clinical scenarios. Our results did demonstrate that patients tended to be more optimistic about the surgery expected outcomes in comparison to the treating surgeon. The majority of patients in all clinical scenarios analyzed in this study anticipated to have improvement in back or neck pain after surgery which differed with statistical significance from surgeon expectations. Results also highlighted the effect of age on both patients and surgeons’ expectations. In general, all scenarios with younger patients tended to have higher number of positive expectations by the surgeons which matched patient expectations compared to similar scenarios for older patients. Therefore, discrepancies between patient and surgeon expectations were higher for older patients.

Conclusions

In this study we present data on patient and surgeon expectation for spine surgeries and show that differences do exist. We also show that age plays a role in the agreement between the treating physicians and patients in regard to surgical expectations. Furthermore, this paper shows discrepancies exist between patients and their surgeon’s expectations. The reasons for the discrepancies need to be clarified and should encourage spine surgeons to clarify anticipated benefits of surgery with their patients.
Does National Occupation Classification Affect Time to Return-To-Work, Post-Operative Opioid Use, or Pain and Disability Outcomes in Spine Surgery Patients?

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Objectives

To examine if there are group differences between patient outcomes following spine surgery based on National Occupation Classification (NOC).

Method

A prospective observational cohort study. Patients (N =199) recruited were participants in the Canadian Spine Outcomes and Research Network, who in addition to their 24 month follow-up completed an Occupation Recording Form. Participants were coded according to their NOC Major Occupation Group. Chi squared analyses was done for categorical variables of time to return-to-work and opioid use. A 2 way (time: baseline, 24 month follow-up) mixed measures ANOVA was performed for ODI, leg pain and back pain as the dependent variables and NOC category as the independent between-subjects variable. Significance was set at p≤0.05.

Results

All patients showed significant improvement in NRS Leg/Arm pain, NRS Back/Neck pain and ODI from baseline to follow-up (F(1,155)=12.318, p<0.001). A statistically significant relationship was found between NOC and total time off work (χ²(18)=35.496, p=0.008). Agriculture/ Natural Resource occupations were associated with higher ODI (39.80) scores at 24 months (p<0.05), and more of these patients (45.5%) required >24 weeks off work. Manufacturing/ Utilities occupations were associated with higher NRS-Leg/Arm scores at 24 months, and also had a higher proportion of patients (50.0%) requiring >24 weeks off work. Trades/Transport occupations, while associated with worse NRS-Back/Neck and NRS-Leg/Arm, were not associated with larger proportion of patients requiring >24 weeks off work.

There was no significant relationship between NOC and opioid use at 24 months.

Conclusions

Significant differences in post-operative outcomes were found between NOC groups, including time off work, disability, back/neck pain, and extremity pain. Although this was a relatively small study, the results indicate further research into the role of occupation is warranted.
Multi-Level Decompression/Fusions are as Effective as Single Level Lumbar Spinal Stenosis Operations

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Objectives

A common hypothesis is that multi-level decompressions with/without fusion have worse clinical outcomes than similar single level operations. Our objective was to evaluate Patient Reported Outcomes (PROs), length of hospital stay and complication rates between two groups of patients: 1) 3-4 level decompressions with/without fusion and 2) single level decompressions with/without fusion.

Method

We performed an observational cohort study using prospectively collected data from the Canadian Spine Outcomes and Research Network (CSORN). We included all patients diagnosed with stable lumbar spinal stenosis from 18 participating sites, operated on between 2008 and 2018. PROs were evaluated at 1-year post surgery. Length of hospital stay and complication rates were determined at hospital discharge.

Results

There were 1024 patients who met in/exclusion criteria (single level n=826, multi-level n=198); average age of the cohort was 65.9 (range 24-90, SD 11.4) with 63% males.

Unadjusted, adjusted and Propensity Score Matched analyses were performed to determine any significant differences.

The multi-level group had a statistically significant longer length of hospital stay (4.5 days vs 2.0; p<0.001), intra-operative (12.6% vs 7.0%; p<0.009) and peri-operative (20.2% vs 10.3%) adverse events.

Of the full cohort, 769 were eligible for 1-year follow up; 575/769 were successfully contacted (follow up rate =75%). At 12-month follow up, the multi-level group had a statistically significant smaller change in SF12 Mental Component Score between groups (2.9 vs 3.5). There were no statistically significant differences in PROs between groups for VAS back/leg pain, SF12 Physical Component Score, EQ-5D or Oswestry score. Analyses using MCID change and Propensity Score Matching did not alter these findings.

Conclusions

Length of stay and complication rates differ significantly, but long term, there were no statistically significant differences in PROs between multi and single level decompressions with/without fusion for stable lumbar spinal stenosis. Common assumptions that bigger surgery is worse long term, were not shown in this cohort.
Preoperative Disability Predicts Prolonged Hospital Stay Following Elective Lumbar Fusion Surgery

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Objectives

Prolonged length-of-stay (LOS) after surgery are associated with poor patient outcomes and increased health-care costs. Accurate prediction of LOS following elective lumbar fusion may help optimize the utilization of resources and assist with framing physician and patient expectations. The goal of this study is to identify pre- and peri-operative predictors of prolonged LOS following elective posterior lumbar fusion.

Method

Data from 150 patients enrolled in a randomized controlled-trial evaluating safety and efficacy of intrathecal-morphine vs. placebo on postoperative pain following elective lumbar fusion was analyzed. The primary outcome was prolonged LOS defined as >5 days (75th percentile in this series). The influence of preoperative variables (including patient age, sex, ASA status, body mass index, Oswestry Disability Index (ODI), and visual analogue scale for pain) and perioperative variables (including number of level fused, surgery type, blood loss, length-of-surgery time and presence of perioperative adverse events) on the odds of prolonged LOS was assessed by a multivariable logistic regression model.

Results

The mean patient age was 62.0 years, and 64 (42.7%) patients were male. The median LOS was 4.0 days (IQR: 3.0), and 41 (27.3%) patients had LOS>5 days. Preoperatively, the mean ODI was 37.6 (SD: 13.6), and the mean VAS for pain was 54.3mm (SD: 22.0). Multivariable analysis showed preoperative ODI (p=0.004), age (p=0.001), length-of-surgery (p=0.005), and presence of perioperative adverse event (p=0.005) were independently associated with prolonged LOS. When dichotomized, patients with severe disability (ODI >40/50) had 4.4 times the odds of prolonged LOS compared to patients with mild/moderate disability (p=0.002). Preoperative pain was not found to be associated with prolonged LOS.

Conclusions

Four pre- and peri-operative predictors were found to be significantly associated with prolonged LOS following elective open posterior lumbar fusion. Preoperative disability measured by ODI is a novel modifiable risk factor that may benefit from targeted intervention before surgery.
Is a Positive Nerve Root Sedimentation Sign Associated with Better Outcomes after Lumbar Laminectomy?

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Objectives

The nerve root sedimentation sign (SedSign) has been correlated with clinically significant lumbar spinal stenosis (LSS) and promoted as a possible prognostic indicator, both for operative and non-operative outcomes. However, the methods used to distinguish LSS from non-specific low back pain were not clearly defined in prior reports, and in most studies, the diagnosis was made by only one evaluator. In the Saskatchewan Spine Pathway (SSP), patients are categorized through a multidisciplinary process using clearly defined clinical criteria. The objective of this study was to compare the outcome of lumbar laminectomy for neurogenic claudication with respect to SedSign.

Method

This was a retrospective analysis of prospectively-collected data in patients with SSP Pattern 4 (intermittent leg dominant) pain who underwent elective lumbar laminectomy between January 1, 2012 and March 30, 2018. Outcomes included Oswestry disability index (ODI), visual analogue pain scores (VAS) for back and leg, and EuroQol Group 5-Dimension self-report (EQ-5D). Inter- and intra-rater reliability for SedSign was 73% and 91%, respectively.

Results

Laminectomy was performed in 106 patients (discectomy in 57.6%; instrumentation in 36.8%; tubular-assisted in 36.8%). SedSign was positive in 60/106 (58.8%) patients. Outcomes did not differ with respect to positive or negative SedSign (mean ODI improvement 9.2 vs. 8.3 points, mean VAS back improvement 3.69 vs. 3.58 points, mean VAS leg improvement 4.82 vs. 4.05 points, mean EQ-5D improvement 15.15 vs. 11.83 points, respectively). Non-instrumented and instrumented cohorts had similar findings. On multivariate analysis, Sub-section 4 ODI (walking distance) was associated with cross-sectional area of stenosis (p=0.02), but not SedSign. VAS back and leg improvements were associated with back (p = 0.038) or leg (p = 0.0036) dominance, but not SedSign.

Conclusions

This is the largest analysis of SedSign with respect to operative outcomes to date and the only study to use validated clinical criteria to define neurogenic claudication. Although several clinical and radiological factors are associated with laminectomy outcome on univariate and multivariate analysis, SedSign did not correlate with outcome.
Minimally Invasive Versus Open Transforaminal Lumbar Interbody Fusion Surgery: An Analysis of Opioids, Non-Opioid Analgesics, and Perioperative Characteristics

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Objectives

Examine the effect of minimally invasive versus open TLIF on long-term postoperative narcotic consumption

Method

Differences between MIS and open TLIF including inpatient opioid and non-opioid analgesic use, discharge opioid use, and post-discharge duration of narcotic usage were compared using appropriate statistical methods.

Results

172 patients (109 Open; 63 MIS) underwent primary TLIF. There was no difference in baseline characteristics. The MIS TLIF cohort had a significantly shorter operative time (223 min vs. 251 min, p=.006) and length of stay (2.7 days vs. 3.7 days, p<.001) as well as less estimated blood loss (184 mL vs. 648 mL, p<.001). MIS TLIF had significantly less total inpatient opioid usage (167 MME vs. 255 MME, p=.006) and inpatient oxycodone usage (71 mg vs. 105 mg, p=.049). Open TLIF cases required more ongoing opiate usage at 3 month follow-up (36% Open vs. 21% MIS, p=.041). A sub-analysis found that patients who underwent an Open TLIF with a history of preoperative opioid use are significantly more likely to remain on opioids at 6 week follow-up (87% vs. 65%, p=.027), 3 month follow-up (63% vs. 31%, p=.008), and 6 month follow-up (50% vs. 21%, p=.018) compared to MIS TLIF.

Conclusions

Patients undergoing MIS TLIF required less inpatient opioids and had a decreased incidence of opioid dependence at 3 month follow-up. Patients with preoperative opioid use undergoing MIS TLIF are less likely to require long-term opioids.
**Impact of Resident Involvement on Cervical and Lumbar Spine Surgery Outcomes**

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**Objectives**

Resident involvement in the operating room is a vital component of their medical education. Conflicting research exists regarding the effects of resident participation on spine surgery patient outcomes. Our objective was to determine the effect of resident involvement on surgery duration, length of hospital stay and 30-day post-operative complication rates.

**Method**

This study was a multicenter retrospective analysis of the prospectively collected American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) database. All anterior cervical or posterior lumbar fusion surgery patients were identified. Propensity score for risk of any complication was calculated to account for baseline characteristic differences between the attending alone and trainee present group. Multivariate logistic regression was used to investigate the impact of resident involvement on surgery duration, length of hospital stay and complication rates.

**Results**

1441 patients met the inclusion criteria: 1142 patients had surgeries with an attending physician alone and 299 patients had surgeries with trainee involvement. After adjusting for confounding, the multivariate analysis demonstrated that there was no significant difference in complication rates between the two groups. Surgery times were found to be significantly longer for surgeries involving trainees. To further explore this relationship, separate analyses were performed for extent of predicted surgery duration, cervical or lumbar surgery, instrumentation and inpatient or outpatient surgery. The effect of trainee involvement on increasing surgery time remained significant for medium and longer predicted surgery duration, cervical surgery, lumbar surgery, lumbar fusion surgery and inpatient surgery. There were no significant differences reported for any other factors.

**Conclusions**

We demonstrated in a national database that resident involvement in surgeries did not increase complication rates, length of hospital stay or surgical duration of more routine surgical cases. We found that resident involvement in surgical cases that were more complexed resulted in increased surgery time. Further study is required to determine the relationship between surgery complexity and the effect of resident involvement on surgery duration.
The Efficacy of Advanced Practice Physiotherapy Assessment for Cervical and Lumbar Spine Pathologies

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Objectives

We developed an Advanced Practice Physiotherapist (APP) spine assessment to improve access and quality of care for patients with cervical (CER) and lumbar (LUM) spine pathologies. To date, other Canadian assessment models have been limited to lumbar pathologies only. We present the results of our one-year pilot examining its efficacy and exploring any differences between cervical and lumbar presentations.

Method

2 APP's underwent 3 months training from spine surgeons, based on the ISAEC program. Adaptations of CORE Cervical and Lumbar Tools were utilized for assessment. All consecutive referrals to our quaternary spine program were assessed. Wait times for all referrals (WT1), for Emergency Dept. referrals (WTEmerg) and for final surgical consult (WTSurgCon) were compared to the prior 12-month historical. We prospectively recorded referral patterns and agreement between APP and surgeon, for both diagnosis and urgency. Patient satisfaction was also examined. Data is presented as mean, for the first (6M1) and second (6M2) 6 months of the pilot.

Results

1576 patients were seen in the 12-month pilot. 34% were CER cases. WT1 decreased from 687 to 14 days. WTEmerg decreased from 55 to 7 days. WTSurgCon decreased from 687 to 62 days. % of patients referred monthly to a surgeon remained unchanged for LUM (mean 36%), but decreased for CER 30% to 11% (6M1 to 6M2). % agreement for diagnosis improved for LUM from 82% to 94% (6M1 to 6M2), and for CER from 77% to 98% (6M1 to 6M2). % agreement for urgency improved for LUM from 81% to 93% (6M1 to 6M2), and for CER from 74% to 96% (6M1 to 6M2). Patient satisfaction was 95% for 6M1 and 97% for 6M2.

Conclusions

APP assessment provides timely and appropriate triage of patients with both cervical and lumbar spine pathologies. Significant reductions are achieved for all wait-times. Lumbar complaints predominate while there appears to be a learning curve to improved screening of cervical pathology. APP/surgeon agreement increases with APP experience. Patient satisfaction with the process is very high.
Can MRI Findings in Lumbar Stenosis Predict Which Patients have Neurogenic Claudication? What are the Clinical and Radiologic Characteristics of Patients With and Without a Positive Nerve Root Sedimentation Sign?

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Objectives

Previous studies have shown varied results with respect the diagnostic utility of a positive nerve root sedimentation sign (SedSign) on MRI for symptomatic lumbar stenosis. The objective of this study was, for the first time, to analyze the clinical characteristics of SedSign utilizing a reliable, validated classification for low back and leg pain (Saskatchewan Spine Pathway classification; SSPc), as well as patient self-reported pain/function scores and several radiologic criteria.

Method

This was a retrospective review of prospectively-collected data in 367 consecutive adult patients presenting to a spine surgeon with back and/or leg pain between January 1, 2012 and May 31, 2018. We excluded patients with trauma, tumor, infection, cauda equina syndrome and prior lumbar surgery. Baseline clinical characteristics included SSPc, Oswestry disability index (ODI), visual analogue pain scores for back and leg, and EuroQol Group 5-Dimension Self-Report (EQ-5D). Inter- and intra-rater reliability for SedSign was 73% and 91%, respectively (3 examiners).

Results

SedSign was positive in 111 (30.2%) and negative in 256 (69.8%) of patients. On the univariate analysis, a positive SedSign was correlated with age, male sex, several components of ODI, EQ-5D mobility, cross-sectional area (CSA) of stenosis, antero-posterior (AP) diameter of stenosis, and SSPc pattern 4 (intermittent leg dominant pain). SedSign was more likely to be negative in patients with back-dominant pain (SSPc Pattern 1 and 2) and sciatica (SSPC Pattern 3). Patients with a positive SedSign were more likely to be offered surgery, in particular non-instrumented decompression. On multivariate analysis, SedSign was associated with age, male sex, CSA stenosis and ODI sub-score for walking distance. The sensitivity and specificity of SedSign for detecting neurogenic claudication was 50.3 and 82.9, respectively (positive predictive value 65.8%, negative predictive value 71.9%).

Conclusions

For every 1mm reduction in CSA stenosis, the odds of SedSign positivity increased by 4%. For every one-unit decrease in ODI walking distance, the odds of SedSign positivity decreased by 26%. The SedSign has high specificity for neurogenic claudication, but the sensitivity is poor.
Utilization and Outcomes for Spine Surgery in the United States and Canada

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Objectives

Spine surgery is common and costly. Within-country variation in spine surgery utilization is well studied, but there has been little exploration of variation in spine surgery between countries.

Method

We used population level administrative data from Ontario (years 2011-2015) and New York (2011-2014) to identify all adults who underwent inpatient spinal decompression or fusion surgery. We compared Ontario and New York with respect to patient demographics and the percentage of hospitals performing spine surgery. We compared rates of decompression and fusion surgery (procedures per-10,000 population per-year) in Ontario and New York for all procedures, emergent procedures alone, and elective procedures and after stratifying by patient age.

Results

Patients in Ontario were older than patients in New York for decompression (mean age 58.8 vs. 51.3 years; P<.001) and fusion (58.1 vs. 54.9; P<.001). A smaller percentage of hospitals in Ontario performed decompression or fusion compared to New York (decompression, 26.1% in Ontario vs 54.9% in New York; fusion 15.2% vs 56.7%; both P<.001). Overall, utilization of spine surgery in Ontario was 6.6 procedures per-10,000 population per-year and in New York was 18.0 per-10,000 per-year (P<.001). Ontario-New York differences in utilization were small for emergent cases (2.0 per-10,000 in Ontario vs. 2.8 in New York; P<.001), but large for elective cases (4.6 vs 15.2; P<.001); differences were particularly large in younger age-groups (age <60) and for elective fusion.

Conclusions

We found significantly lower utilization of spine surgery in Ontario than New York. These differences should inform policy reforms in both jurisdictions.
Surgery Versus Standardized Non-Operative Care for Lumbar Disc Herniations with 4-12 Months of Symptoms: 2 Year Follow-Up

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Objectives

We recently reported on a randomized controlled trial demonstrating microdiscectomy to be superior to non-operative care at 6 months post treatment for chronic radiculopathy secondary to a lumbar disc herniation. This study was performed because Canadian patients with chronic sciatica who are surgical candidates frequently have not exhausted non-operative care. This study reports the clinical outcomes at 2 years post-treatment.

Method

Subjects were enrolled if they were 18-60 years old with a unilateral, single radiculopathy for 4-12 months from a posterolateral L4-5 or L5-S1 disc herniation. Patients were excluded if they had previous conservative care or they were not a surgical candidate. Non-operative patients could not cross-over to surgery for six months. The primary outcomes were the numerical rating scale (NRS) for leg pain (0-10) and Oswestry Disability Index (ODI). Secondary outcome measures included NRS back and leg pain, ODI, SF-36, work status, and satisfaction. A mixed-model of repeated-measures analysis was used according to the intention-to-treat principle.

Results

At the 2 year time point data was available for 42/64 (66%) patients in the non-operative cohort and 48/64 (75%) patients in the surgical cohort. The non-operative cohort had a higher leg pain score than the surgical cohort (4.2±0.4 vs. 2.8±0.4, P<0.001) while the ODI score was not different (25.0±2.5 vs. 20.9±2.4, P=0.238). All secondary outcomes were similar by 2 years except for PCS (38.2±1.4 vs. 43.5±1.3, P=0.006) and intensity of back pain (4.1±0.4 vs. 2.9±0.3, P=0.022) both favoring surgery. The time-weighted treatment effect taking all time-points into consideration favored surgery for all primary and secondary outcomes. 24 patients randomized to non-operative treatment eventually required surgery.

Conclusions

Physical function, back pain and leg pain maintained a significant beneficial effect from surgery at 2 years follow-up.
Advanced Practice Physiotherapy Spine Assessment Improves MRI and Emergency Department Resource Utilization

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Objectives

We developed an Advanced Practice Physiotherapist (APP) spine assessment program to improve access to and quality of care for patients with cervical and lumbar spine pathologies. Inappropriate imaging and Emergency Department visits are key metrics of triage program efficacy. We hypothesized that the APP clinic would reduce both inappropriate imaging and Emergency department visits for patients with both cervical and lumbar spine pathologies.

Method

After 3 months of training, two APP’s assessed a random 50% of all consecutive referrals to our quaternary spine program. Appropriateness of pre-referral imaging was determined based on the Choosing Wisely Canada, the CSS and CIHR guidelines. Additional appropriate imaging ordered by the APP was recorded. Spine related Emergency Department visits were recorded for all pilot and non-APP patients. Annual wasted imaging for incomplete referrals and back-log referrals was recorded for the non-APP arm.

Results

1576 patients were seen in the 12-month pilot with 34% being cervical cases. Of the patients seen at the pilot, 72% of referrals had inappropriate imaging prior to referral. There were 953 inappropriate MRI’s (CAD$857,700), 1093 CT’s (CAD$874,400) and 819 X-Ray’s (CAD$114,660), at a total cost of CAD$1,846,760. 8% of non-APP referrals were incomplete with 207 MRI (CAD$186,300), 111 CT’s (CAD$88,800) and 52 X-Rays (CAD$7,280), total cost CAD$282,380. Expired Imaging for back-log non-APP patients was 960 MRI (CAD$864,000), 1290 CT’s (CAD$1,032,000) and 540 X-Rays (CAD$75,600). Total annual imaging savings from APP clinic was CAD$4.1 million. The APP’s ordered 40 MRI’s, 4 CT’s and 17 X-Rays at a cost of CAD$42,780. For the APP group, 53 (3.9%) patients had 69 spine related Emergency Department visits after assessment. For non-APP group 226 patients (11.9%) had 317 visits while awaiting appointment.

Conclusions

APP assessment provides timely and appropriate triage of patients with both cervical and lumbar spine pathologies leading to significant resource savings from elimination of inappropriate and wasted imaging and by reducing spine related emergency department visits.
Translation of the Interprofessional Spine Assessment and Education Clinic (ISAEC) to the New Brunswick Population

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Objectives

To demonstrate the effective establishment, through knowledge translation, of the ISAEC program in New Brunswick, assessed by examining patient outcome scores, patient activation, and primary care provider satisfaction.

Method

Prospectively collected data from the NB-ISAEC database was included for all patients with both intake and 6 week follow-up data as of October 2018 (N=75). Continuous variables were analyzed using a paired samples t-test, and one-way ANOVA and categorical variables were analyzed using chi-squared analysis. Significance was α<0.05.

Results

6 weeks following a NB-ISAEC appointment, participants reported statistically significant improvements in ODI scores (t(74)=7.010, p<0.001), PCS scores (t(66)=6.705, p<0.001), NRS-B scores during activity (t(71)=4.227, p<0.001), NRS-L scores at rest (t(69)=3.417, p=0.001) and during activity (t(68)=4.853, p<0.001). There was a statistically significant decrease in number of patients with a clinically relevant PCS (score >30; χ² (1) =6.115, p=0.013), and a significant change in patient’s self-reported pain status between intake and follow-up (χ²(2)=36.053, p<0.001), with an increase in patients indicating improving pain.

At 6 weeks patients reported high compliance with their given exercise plan; 53.3% of patients reported daily exercise, and only 4.0% of patients reported not performing their exercise weekly.

A repeated measures ANOVA was performed for a preliminary look at patients with 3 month outcomes, with changes in ODI (F(2,30)=6.461, p=0.005) and PCS (F(2,30)=3.891, p=0.044) being statistically significant.

Preliminary PCP satisfaction results (N=11) show a favorable attitude towards the program with 90.9% of PCPs indicating they believe this program improved patient support and management and 81.8% PCPs reporting improved access to care for their patients.

Conclusions

After participation in NB-ISAEC, the improvements in outcome scores, high patient activation and high PCP satisfaction suggest the successful translation of the ISAEC program to the New Brunswick population. Future work should quantify longer term patient health and economic benefits and Medicare cost avoidance and efficiency.
Does a Multidisciplinary Triage Pathway Facilitate Better Outcomes after Spine Surgery?

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Objectives

Retrospective studies have shown the Saskatchewan Spine Pathway (SSP) facilitates timelier MRI and more appropriate surgical referrals. The objective of this study was to compare surgical outcomes after triage through conventional processes or the SSP, with respect to baseline clinical features, indication for surgery, therapies received prior to surgery, type of surgery, wait times, overall patient satisfaction and outcome. This is the first prospective SSP study and the only study of SSP clinical outcomes.

Method

A prospective non-randomized matched cohort comparison of 150 patients (SSP group n=75; conventional group n=75) undergoing elective lumbar surgery for mechanical back and leg pain between 2011 and 2016 was performed. Follow-up was 1 year. Patient self-reported outcomes included the Oswestry disability index (ODI), visual analogue pain scores (VAS) for back and leg, and EuroQol Group 5 –Dimension self-report (EQ-5D).

Results

There were no between group differences for baseline demographics, body mass index (BMI), SSP classification of pain pattern, pain scores, functional scores, quality of life scores, indication for surgery, or type of surgery (instrumented or non-instrumented). There was no difference with respect to wait times to see the surgeon or wait time for surgery; however wait time for MRI was significantly shorter for the SSP group (16.8 vs. 63.0 days, p<0.001). Patients triaged through the SSP were significantly more likely to utilize non-operative treatment strategies prior to seeing the surgeon (physiotherapy, chiropractic, massage, acupuncture) p<0.04. Although there was a statistically significant difference in VAS leg pain at one year favoring the SSP group (VAS leg 2.8 vs. 2.1 conventional group, p=0.05), ODI and EQ-5D scores did not differ significantly between groups. Patient satisfaction was significantly higher for SSP patients prior to surgical assessment (p=0.03), but did not differ between groups throughout the postoperative period.

Conclusions

There are minimal differences in post-surgical outcomes for SSP patients versus conventionally referred patients; however, the SSP facilitates significantly shorter wait times for MRI and non-operative treatment strategies. Pre-surgical patient satisfaction is significantly higher among SSP patients.
Health Status, Quality of Life and Healthcare Utilization in Patients with Degenerative Spine Conditions: A Pain in the Neck or a Pain in the Back?

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Objectives

While the societal burden of back pain is well established, much less is known of patients with neck complaints. Unlike previous Canadian models, our Advanced Practice Physiotherapist (APP) clinic triages patients with both cervical and lumbar spine pathologies. We examined patient demographics, health status, health care quality of life and healthcare utilization measures between those with cervical and lumbar presentations.

Method

1576 patients were assessed using CORE Cervical and Lumbar Tools. 25% had cervical pathology. Data included demographics, health status, health care quality of life and healthcare utilization measures. Differences between cervical and lumbar presentations were examined using paired and unpaired t-tests and the non-parametric analogue of the Wilcoxon rank-sum test, as appropriate.

Results

APP and surgeon agreement was superior for lumbar than cervical conditions for both diagnosis (OR3.5(1.96-6.26);p<.0001) and urgency (OR3.1(1.83-5.14);p<.0001). Lumbar patients were more likely to have had symptoms for <12 weeks(p=.001) or > 1 year(p<0.0001); be on modified work duties(p=.01); have seen another spine surgeon(p=.003); report primarily axial symptoms(p=0.001); have a diagnosis of osteoarthritis(p=.05); be currently employed but not working(p=.0009); be retired(p=.008); have seen their GP more than 10 times(p=.028); have received a fluoro-guided injection(p.014); have ranked remaining independent as a treatment priority(p =.005). Cervical patients were more likely to exercise(p=.007); have an MRI(p=.023); take medications for their symptoms(p=.0013); consider spine surgery(p<.0001); be involved in litigation(p=0225); be depressed(PHQ-9, p=.001); have poor EQ-5D(p=.0227); be physically disabled PCS12(p=.005); list GP recommendations as a reason to want surgery (p=.0225).

Conclusions

We identify fundamental differences in Health Status, Quality of Life and Healthcare Utilization between patients with cervical and lumbar complaints in an APP triage clinic. Understanding of these differences will allow improved patient triage and thus positively impact referral practices, resource utilization and patient outcome.
Small Area Variation in Compliance with Clinical Practice Guidelines in the Management of Acute Low Back Pain

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Objectives

Compliance with Clinical Practice Guideline (CPG) recommendations could reduce Low Back Pain (LBP)-related healthcare costs and improved care. Our study aimed to use Provincial administrative data to investigate the compliance of CPG in primary care. Specifically we wished to assess the conformity, and small area variations related to specific CPG recommendations.

Method

We performed a retrospective administrative database analyses of all Ontario residents from 2012 to 2016. The denominator population was constituted by the number of individuals who presented to a primary care provider with acute non-specific LBP. The numerator population was defined by the number of opioid prescriptions dispensed within 7 days, or CT or MRI lumbar spine performed within 3 and 6 months of the index LBP. Age and gender adjusted Prevalence Ratios (PR) were then calculated to determine small area variations between geographic health regions (LHINS). The 2016 Canadian Census was used to determine population level sociodemographic information for each LHIN to inform an ecological analysis.

Results

There was minimal small area variation in the adjusted rates of acute low back pain by LHIN (PR = 1.2). However, there was substantially greater small area variations in the rates of early CT (PR = 2.9), MRI (PR = 3.5) and new opioid starts (PR = 1.8). These small area variations became much higher when sub-LHINS were analyzed. LHINs with higher rates of these events were significantly associated with a higher rural index, lower socioeconomic factors and fewer family doctors per capita.

Conclusions

There is substantial small area variations in the rates of non-CPG conforming practices. Proper CPG primary care of acute LBP requires engagement to educate and reassure the patient, instead of reliance on advanced imaging and pain killers. We noted an association between higher rates of non-CPG conforming practices and various factors related to barriers to engaged primary care.
Understanding Surgeon Decision Making and Current Surgical Practice Regarding the DSIC Scheme and DLS Treatment: A CSORN Study

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Objectives

This study aims to determine whether surgeons are following DSIC scheme treatment recommendations as well as which radiographic/clinical parameters and surgeon characteristics are most influencing classification and treatment decisions. In order for the treatment of DLS to become standardized, and therefore uniform and cost-effective, we must first understand how current treatment decisions are being made.

Method

The data, which included 224 CSORN DLS cases, was cleaned and analyzed using recursive feature elimination analysis, stability selection analysis, and principal component analysis to determine the correlations between classification and treatment. Machine learning models (support vector machine and logistic regression) built using Python-based libraries were used to test the strength of the correlations found.

Results

Most cases of DLS were classified as being DSIC Type II (52%). However, 61% of cases were treated with a 360° fusion regardless of their stability even though only 18% of cases were classified as Type III. For Type I cases, the recommended surgical treatment was employed 41% of the time. The use of recommended surgical treatment was much lower for Type II (17%). For Type III, 91% of cases were treated with the recommended procedure. Dynamic Translation was found to be the parameter most correlated with the DSIC grade. Meyerding Grade and Disc Angle Standing were the two parameters the most correlated with treatment decision making.

Conclusions

This study presented the demographics of DLS classification and treatment. It demonstrated that most surgeons are choosing the most extensive surgical procedure even when not indicated by the DSIC scheme. The study also found important correlations between patient parameters, classification, and treatment (e.g. Dynamic Translation most correlated to classification and Meyerding Grade to treatment). Further efforts are needed to develop a new scoring algorithm to classify the stability of DLS based on the correlations found in this study. This new scoring algorithm would be extremely clinically significant as it would be more comprehensible and reproducible than the DSIC scheme and able to guide the treatment of DLS.
Predictors of Surgical Referral from an Advanced Practice Physiotherapy Rapid Access Clinic

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Objectives

Our Advanced Practice Physiotherapist (APP) clinics assess patients with both cervical and lumbar spine pathologies, using validated algorithms, to triage potential surgical candidates. We examined the predictors of referral to a surgeon, determining patient characteristic differences between those with cervical and lumbar presentations.

Method

1576 patients were assessed (75% lumbar), and referral to a surgeon was decided, using the validated CORE Cervical and Lumbar Tools. Data collected included demographics, health status, health care quality of life and healthcare utilization measures. Predictors of referral, correlations and differences between cervical and lumbar presentations were examined using paired and unpaired t-tests and the non-parametric analogue of the Wilcoxon rank-sum test, as appropriate.

Results

Factors predictive of surgical referral in both cohorts included Neck Disability Index (NDI: OR1.61[1.2-2.16], p=.0016)/Oswestry Disability Index (ODI: OR1.85[1.33-2.57], p=.0003); degree of arm(p=.0001) and neck(p=.0009)/leg(p<.0001) and back(p=.0037) pain; use of neuroleptic medication (p=.0178); EuroQol (EQ-5D) (Cer:p=.0073; Lum:p<.0001); SF-12 PCS (Cer:p=.0004; Lum:p=.002). Patients who did not perceive surgery as helpful were less likely to be referred in both cohorts (Cer:p=.012; Lum:p=.0001). Medical comorbidities and measures of recent healthcare utilization were not predictive of surgical referral in either group. Predictors of surgical referral in cervical cohort only included PHQ-9, (OR1.67[1.01-2.75], p=.044); use of antidepressant medication (p=.02); change in work status (p=.0004); patients taking pain medication (p=.03). Predictors of surgical referral in lumbar cohort only included a diagnosis of osteoarthritis (p=.0002); no litigation involvement (p=.0001); more than 5 previous GP visits (p=.028); previous fluoro-guided injection (p=.014). Exercise frequency (p=.015), and duration (p=.0375) were negative predictors of referral in lumbar, but not cervical patients. Patients who highly ranked a desire to remain independent (p=.005), and to decrease their level of pain (p=.0018) were more likely to be referred.

Conclusions

Numerous patient and disease characteristics predict APP to surgeon referral. Significant baseline differences exist between patients with cervical and lumbar presentations. Understanding these factors may improve patient triage and thus positively impact referral practices, resource utilization and patient outcome.
Health Care Utilization and Costs for Spinal Conditions in Ontario

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Objectives

To examine the magnitude and costs of physician care and hospital service use for spinal conditions (non-trauma and trauma-related) in Ontario, considering physician types and hospital settings.

Method

2013/2014 administrative data were analyzed for adults 18+ years (N=10,841,302). Data sources: Ontario Health Insurance Plan Claims History Database, with in- and out-patient physician services data; Canadian Institute for Health Information (CIHI) Discharge Abstract Database, with diagnoses and procedures for hospitalizations; CIHI National Ambulatory Care Reporting System, with data on emergency department (ED) and day surgery encounters. Services for spinal conditions were identified using the single 3 digit ICD-9 diagnosis code on each physician claim for outpatient physician visits and the “most responsible” ICD-10 diagnosis code recorded for hospitalizations, ED visits and day surgeries. Patient visit rates and numbers of patients and visits were tabulated. Direct medical costs were estimated.

Results

Overall, 822,000 adult Ontarians (7.6%) made 1.6 million outpatient physician visits for spinal conditions in 2013/14; 1.1 million of these visits (69%) were for non-trauma related conditions. Approximately 86% of outpatient visits for spinal conditions were in primary care. There were 130,000 ED visits for non-trauma spinal conditions, accounting for 2.8% of all ED visits in Ontario. Total costs for spine-related care were $264 million, with 64% of costs ($168 million) due to non-trauma conditions. For these non-trauma conditions, 53% of costs were due to hospitalizations, 19% were for primary care, 17% were for ED care. For trauma-related conditions, 71% of costs were for hospitalizations, 16% for primary care and 9% for ED care. Spine imaging costs for patients who made musculoskeletal-related physician visits were $66.5 million. Including these costs yields a total of $330 million.

Conclusions

Spinal conditions place a large and costly burden on the health care system. The significant costs associated with ED care for non-trauma conditions highlights the need for implementation of more clinically and cost effective models of spinal care.
**National Adverse Event Profile After Lumbar Spine Surgery for Lumbar Degenerative Disease and Comparison of Complication Rate Between Hospitals: A CSORN Registry Study**

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**Objectives**

Most of the previous work investigating the rates of adverse events (AE) in spine surgery have been retrospective, with data collection from administrative databases, and often from single centers. To date, there have been no reports utilizing a rigorous and prospective analysis to capture adverse events in spine surgery on a national level or compare the rates of AEs between each center.

**Method**

The incidence and severity of AEs after spinal surgery was captured using the Spine AdVerse Events Severity system, version 2 (SAVES), in 14 spine centers from the Canadian Spine Outcomes and Research Network (CSORN) prospective registry. Minor and major AEs were defined by SAVES grades 1-2 and 3-6, respectively.

**Results**

A total of 3556 patients were enrolled in this cohort. As defined by SAVES, there were 85 (2.4%) patients with major AEs and 682 (19.2%) with minor AEs. There were 25 patients with major intraoperative AEs and 262 with minor intraoperative AEs. Post-operatively there were 61 patients with major AEs with a total of 80 major AEs and 84 minor AEs. Of the 487 patients with minor AEs post-operatively there were 698 total AEs. The rate of AEs varied by each hospital site. Of the 11 sites with more than 10 patients enrolled in the registry (3 sites had 10 or fewer patients enrolled) the average enrollment was 321 patients per site. The rate of major AEs was consistent between sites (mean 2.9±2.4%, range 0-9.1%). However, the rate of minor AEs varied widely between sites from 7.9-42.5% with a mean of 18.8±9.7%.

**Conclusions**

Between centres, the rate of major adverse events is consistent after lumbar spinal surgery but there is large variation between the rates of minor adverse events and is likely influenced by the method of reporting adverse events. This study has implications for the reporting of adverse events as well as implementation of strategies to mitigate adverse events.
Efficacy and Cost-Effectiveness of Photodynamic Therapy in Prevention of Surgical Site Infection

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Objectives

Incidence rates of Surgical Site Infection (SSI) following instrumented spine surgery vary from 1-9%. We have previously reported significant variability in SSI prevention practice amongst CSS members. Patient skin and nasal cavity colonization with MSSA remains a major risk factor. The purpose of this study was to investigate the efficacy and cost effectiveness of chlorhexidine skin decolonization (CSD) and nasal photo-disinfection therapy (nPDT) on surgical site infection.

Method

Since 2009, as a local QI initiative at a quaternary referral center, all patients undergoing high risk surgery (including instrumented spine surgery, vascular, cardiothoracic and ortho trauma) received CSD and nPDT preoperatively. SSI rates, microbiological data, treatment data and costs were prospectively recorded. Amongst the spine surgery cases, age, BMI, comorbidities, spine surgery invasiveness index (SSII), blood loss and adverse events (AE) were recorded using the SAVES2 system.

Results

From 2009 to 2017 the SSI rate for spine cases decreased from 7.2% to 1.6%, the greatest magnitude of reduction of all surgery types (p<0.01). The Absolute Risk Reduction for spine was 5.6%, and the number needed to treat (NNT) to prevent one infection, 18 patients. This resulted in an average of 53 fewer cases of SSI per year. CSD / nPDT costs CAD$45-55 per person. The estimated annual cost saving was CAD$4.24 Million. CSD / nPDT was most effective in diabetics (relative risk, RR 2.1), BMI > 35 (RR 2.25), midline lumbar surgery versus cervical or thoracic (RR 2.2), cervical versus thoracic (RR 1.9), revision surgery (RR 2.9) and in those undergoing more complex instrumentation [SSII> 21] (RR 3.35). The use of CSD / nPDT was not associated with any additional AE’s.

Conclusions

CSD / nPDT is both efficacious and cost-effective in preventing surgical site infection, particularly in complex instrumented cases in the highest risk patients. Given the minimal resource cost, we recommend the routine use of this technology for SSI prevention.
Higher Adverse Events and Longer Lengths of Stay for Posterior Compared to Anterior Cervical Spinal Surgery. Findings from a Multivariate Adjusted Analysis of a Multicentre North American Prospective Database

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Objectives

Background: The evidence supporting anterior or posterior cervical spinal surgery is conflicting.

Objectives: Use a North American database to determine if length of stay and adverse events are different for anterior compared to posterior cervical spinal surgery procedures.

Method

Methods: This is a retrospective multivariate adjusted analysis of prospectively collected data using the ACS NSQIP database. Two independent reviewers with fellowship training in spinal surgery assessed all procedural and diagnostic codes to standardize their definitions. All elective cervical inpatient spinal surgery between 2005-2016 considered. Infection, tumour, fracture, paraplegia or combined anterior / posterior procedures were excluded.

Results

Results. 1073 patients underwent posterior procedures and 7925 underwent anterior procedures. There were 189 (17.6%) adverse events in the posterior group compared to 322 (4.1%) adverse events in the anterior group. The mean length of stay was 3.4 days in the posterior group and 1.8 days in the anterior group. Both outcomes were significantly higher in the posterior group (p < 0.0001).

Using multivariate analyses with adjustments for age, gender, BMI, ASA score, Charlson Comorbidity, multilevel surgery, myelopathy / radiculopathy, primary / revision, instrumentation and operative time demonstrated significantly (p < 0.0001) higher adjusted odds of 3.76 of adverse events and adjusted mean of 1.2 days longer length of stay for posterior procedures. These difference remained significant (p < 0.0001) in subgroup analyses of single or multilevel procedures alone.

Conclusions

Conclusions: In a North American prospective outcomes analysis of the ACS NSQIP database of elective inpatient cervical surgery, posterior spinal procedures had significantly higher adverse events rates and length of stay. We were able to adjust for the effects of multiple factors but recognize that unmeasured confounding factors may affect our conclusions.
Delayed Treatment of Spine Fractures without Spinal Cord Injury Leads to an Increase in Major Complications: A Review of Nearly 17,000 Cases

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**Objectives**

There is a general consensus in the literature that early decompression (defined as <24 hrs) of patients with spinal cord injury (SCI) leads to improved clinical outcomes. There is however a lack of high quality evidence to guide surgeons on the management of patients with a mechanically unstable spine fracture in the absence of an SCI. The aim of this study was therefore to determine if rates of major complications (defined as systemic sepsis, pneumonia, pulmonary embolism, acute respiratory distress syndrome, acute renal failure, cardiac arrest, myocardial infarction, and cerebrovascular accident) had a temporal association with a delay in surgical fixation of mechanically unstable spine fractures.

**Method**

The American College of Surgeons Trauma Quality Improvement Program database was queried using ICD 9 and ICD 10 procedure codes indicating operative fixation of the cervical, thoracic and lumbar spine. From this group, patients who possessed an ICD9/10 diagnostic code indicating either a complete/incomplete SCI, a penetrating mechanism of injury, and operative fixation more than 14 days after admission were excluded. The study group was then divided into two cohorts: those undergoing operative fixation within 24 hours of their admission, and those with delayed fixation beyond 24 hours. We next dichotomized major complications as a binary event, and compared the relative risk of sustaining any major complications based on early vs late fixation.

**Results**

16,964 patients were included; 4,447 were assigned to the early surgery group and 12,517 to the delayed group. The relative risk of a sustaining a major complication given spinal fixation beyond 24h was 1.6151 (95% CI 1.4359 - 1.8167). When comparing mortality during the initial admission, 1.35% of patients perished in the early fixation group as compared to 1.81% in the delayed group (p<0.05).

**Conclusions**

Early spine fixation group demonstrated fewer complications and an overall lower mortality rate. Our data supports early intervention within 24 hours for mechanically unstable spine fractures even in the absence of a SCI.
Hypoalbuminemia in Elective Lumbar Spine Surgery as a Risk Factor for Increased Complications and Length of Stay: An Analysis of the National Surgical Quality Improvement Program (NSQIP) Database

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Objectives

Serum albumin is a biomarker that reflects nutritional status. It is easily measured and responds to appropriate interventions in a predictable fashion. In multiple studies across several surgical specialties hypoalbuminemia has been associated with increased morbidity and mortality. The purpose of our study is to assess the effect of hypoalbuminemia on surgical outcome and hospital length of stay (LoS) for patients undergoing elective lumbar spine surgery.

Method

We performed a retrospective multivariate adjusted analysis of prospectively collected data from the NSQIP database. We included elective lumbar surgeries performed between 2005-2016 while excluding those presenting with infection, tumour, trauma and spinal cord injury. The conditions excluded are that these represent states of high physiologic stress and lead to a rapid drop in serum albumin.

Results

8698 patients met our criteria and had preoperative serum albumin reported within two weeks of their surgery. Of these 548 patients (6.3\%) had hypoalbuminemia (serum albumin <3.5g/dL). Patients with preoperative hypoalbuminemia had a significantly longer LoS (7.3 vs. 3.6 days) compared to those with normal values. The odds of pre- or postoperative medical or surgical complications was significantly higher in patients with hypoalbuminemia compared to those with normal values (OR = 2.4). These findings remained significant (p < 0.0001) after adjustments for age, gender, duration of surgery, ASA grade and Charlson Comorbidity Index.

Conclusions

Hypoalbuminemia is independently associated with negative outcome in the setting of elective lumbar spine surgery. Measuring serum albumin preoperatively could help identify malnutrition and a patient at increased risk of complications. Detecting hypoalbuminemia and addressing it with nutritional counselling and optimization prior to elective surgery could offer an accessible and low-cost intervention to decrease LoS and complication rates.
Presentation 58

The Cost-Effectiveness of a Quality Improvement Initiative to Minimize Minor Adverse Events after Spine Surgery

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Objectives

Minor post-surgical adverse events are very common, yet their effects are largely unknown or ignored. Meanwhile they represent the greatest opportunity for quality improvement initiatives. Medical Outreach Programs (MOP) are efficacious in reducing medical adverse events in non-spinal post-operative populations. The purpose of this study was to examine efficacy and cost-effectiveness of a MOP on minor adverse events in postoperative high dependency spine patients.

Method

A prospective cohort study of all consecutive surgical patients admitted to a quaternary center from 2008 to 2017. Demographic, surgical and outcomes data was collected on two cohorts: pre- (2008-2012) and post- (2013-2017) MOP, in 2012. The frequency of AE’s was recorded using SAVES2. Previous work by Rampersaud and The Canadian Patient Cost Database (CPCD) were used to estimate the cost of each event.

Results

A mean of 984 patients admitted each year (range 912-1090). Following introduction of MOP, the annual event incidence of all recorded postoperative AE’s decreased. Electrolyte imbalance decreased by 35% (451 to 294 annual events). Medication related events decreased by 70% (402 to 117), ileus/constipation by 46% (255 to 137), nausea by 64% (215 to 78), cardiac complications by 55% (176 to 78), pulmonary by 65% (167 to 59), and delirium/psychiatric by 62.5% (118 to 44). (P-values all <0.001). The cost estimate of a Grade 1 AE is CAD$6370 and a Grade 2 AE is CAD$21500. MOP prevented 285 cases of medication related AE and 157 cases of electrolyte imbalance annually with cost savings of $2,895,884 and $1,595,276 respectively. Total annual cost saving was $9,927,294.

Conclusions

The introduction of MOP, as a QI initiative to manage postoperative high dependency spine patients, not only reduces the incidence of Grade 1 and 2 adverse events but can do so with substantial cost savings. This study highlights the leverage that an AE system such as SAVES provides in the development and implementation of quality improvement initiatives.
Personalized Risk Prediction in Spinal Surgery

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Objectives

Personalized risk assessment in spinal surgery may help with shared decision making (SDM) but is currently lacking. The objective of this study is to develop a personalized risk prediction tool using machine learning and an institutional National Surgical Quality Improvement Program (NSQIP) database for patients undergoing spinal surgery.

Method

A single center NSQIP database of consecutive patients undergoing spinal surgery was used to develop a two stage prediction model for 30 day medical and surgical complications. The two stage model utilized known preoperative and perioperative features. Various machine learning algorithms were compared for both stages of prediction. The two models were then combined in a stacking scheme where the output of the first model was used as a covariate by the second model. Seventy percent of patients were used for parameter optimization and 30% of patients were used as an independent test set to evaluate model performance.

Results

The study included 1542 patients. After comparing the performance of various machine learning algorithms, a gradient boosted decision tree (GBDT) and a support vector machine (SVM) were selected as the best models for first and second stage respectively. Given the intrinsic challenge of class imbalance in the dataset (only 10% of the patients had complications) a preprocessing stage consisting of under sampling was also employed prior to model training. The model at the first stage was able to predict post-surgical complications with a performance of 0.64 AUC. Adding peri-operative features (second stage), resulted in an improvement in the predictive performance of the final two-stage stacked model, allowing to achieve an AUC higher than 0.70. Explainable artificial intelligence using novel facilities for complementing model predictions will allow the model to produce decision-tree-generated, human-interpretable rules that justify the model prediction and may promote its uptake in clinical practice.

Conclusions

A personalized risk prediction tool for patients undergoing spinal surgery was developed using an institutional NSQIP database and machine learning. This tool may help with SDM in spinal surgery.
Risk Factors for Surgical Site Infection Following Posterior Thoracolumbar Spinal Surgery with Drain Placement

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Objectives

The purpose of this study was to identify risk factors for post-operative surgical site infection (SSI) in patients undergoing posterior thoracolumbar surgery with instrumentation followed by placement of a closed-suction drain.

Method

A retrospective analysis was performed on data that was prospectively collected in a prior randomized controlled trial of 552 patients who were randomized to 24 hours or 72 hours of post-operative antibiotic (to ensure 24 hours of antibiotics post-drain removal, as drains were discontinued by post-operative day 2). The SSI was not different between groups. For the current study, a stepwise multiple logistic regression model was used to determine the best combination of predictors of post-operative SSI. The regression coefficients obtained from the multivariate model were used to estimate the probability of a SSI.

Results

There were a total of 80 infections out of 552 procedures (14.5%). Of the total infections 31 (5.6%) were deep and 49 (8.9%) were superficial infections. In the stepwise regression model, the odds of a SSI were greater when a patient had a BMI ≥30 kg/m² (OR = 2.34 P =0.006), prophylactic pre-operative vancomycin (OR=3.00, P=0.020), prolonged surgery (OR=1.96, P=0.033), worse pre-operative mental functioning (1.87, P=0.055), blood loss >600 mL (2.32, P=0.048) and a revision procedure (1.86, P=0.077). The AUC for the final model was 0.723±0.037, indicating acceptable predictive discrimination. The odds of developing a SSI decreased by 22% for patients that had pre-operative prophylactic cefazolin, decreased by 16% for patients that had a BMI<30 Kg/m², decreased by 12% for patients that surgery <280 min, decreased by 16% for patients that had blood loss<600 mL, decreased by 11% for patients who had MCS>35 at the preoperative assessment, and decreased by 11% for patients undergoing primary surgery.

Conclusions

In this study cohort, obesity, antibiotic type, prolonged surgery, blood loss, revision procedure, and preoperative mental functioning were modifiable risk factors for surgical site infection.
Application of the Mayo Clinic Mortality Review System (MRS) to Identify Opportunities for Quality Improvement in a Spine Patient Population

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Objectives

The Mayo Clinic MRS is a validated retrospective model, previously used to identify potential quality improvement opportunities in cases of in-hospital mortality. Opportunity categories include communication, documentation, delayed or missed diagnosis, patient deterioration, diagnosis, end of life discussion, hospital acquired infection, medication/blood, prophylaxis, technology, transition of care, triage, treatment, and hospital acquired conditions. The Mayo MRS model has not previously been used in a spine patient population, nor for non-mortality cases. The purpose of this study was determine the inter- and intra-rater reliability of the Mayo MRS model in a population of traumatic cervical spinal cord injury patients.

Method

Two teams, each of five health-care professionals (one physician, one advanced clinical nurse specialist, an occupational therapist, and two additional allied health professionals, e.g. nurse, physiotherapist, occupational therapist, spine speech-language pathologist) performed data abstraction using the Mayo MRS methodology from ten charts of patients with traumatic cervical spinal cord injury having suffered a pre-defined adverse event (unanticipated re-intubation). The categories and number of Opportunities for Improvement (OFIs) were recorded for both teams. Inter- and intra-rater reliability was evaluated using intra-class correlation coefficient (ICC) and agreement was evaluated using Bland-Altman plots.

Results

An average of 14 OFI’s were identified for each case. The OFI’s most frequently identified by MRS were those related to inadequate communication/documentation (34.6%), delayed or inadequate escalation of care or resuscitation (26.8%) and incorrect or delayed diagnosis (17.2%). Inter- and intra-rater reliability of MRS was poor/moderate (ICC range of 0.4694-0.49520) and excellent (ICC range of 0.9720-0.9966), respectively. MRS detected significantly fewer adverse events than SAVES2, p<0.001 (mean 1.4 vs 3.1 per patient).

Conclusions

The Mayo MRS framework is reliable for investigation of a pre-defined adverse event in a traumatic spinal cord injury population. This retrospective tool offers a promising approach for the identification and development of QI initiatives and is not meant as an adverse event identification system. The as expected poor inter-rater reliability confirms the critical importance of a multidisciplinary team approach.
The Effect of Peri-Operative Adverse Events on Long-Term Patient Reported Outcomes after Lumbar Spine Surgery

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Objectives

Peri-operative adverse events (AE) lead to patient disappointment, resource utilization, and increased healthcare costs. There is a paucity of data on how adverse events affect long-term patient reported outcomes (PRO). The purpose of this study is to examine peri-operative adverse events and their long-term impact on PROs after lumbar spine surgery.

Method

3556 consecutive patients undergoing elective spine surgery for degenerative lumbar spine disorders enrolled in the CSORN prospective database were analyzed. Major and minor adverse events were defined using the validated Spine AdVerse Events Severity system (SAVES). Perioperative adverse events were analyzed for lumbar disc disease, degenerative spondylolisthesis, spinal stenosis, and lumbar degenerative deformity. Outcomes at 3 and 12 months post-operatively for physical function (Oswestry Disability Index (ODI) and SF-12 PCS), pain (visual analog scale (VAS) for leg and back pain) and mental quality of life (SF-12 MCS, and EQ-5D), and satisfaction were assessed using univariate and multivariable analyses.

Results

Adverse events occurred in 767 (21.6%) patients, 85 (2.4%) suffered major AEs, and 682 (19.2%) experienced minor AEs. Patients with major AEs had significantly worse post-operative ODI scores and did not reach minimum clinically important differences at 1 year (Baseline: no AE: 47.5±15.5, major: 48.2±14.8, vs. 1 year: no AE 25.5±19.5, major: 37.3±19.3, p<0.001). On VAS leg and back, EQ-5D, and SF12 PCS the 1 year PROs were significantly different between the major AE group and the no AE group (<0.01) but these differences were small and unlikely clinically relevant. MCS scores were not significantly different between the major and no AE cohorts at 1 year. At 1 year post-operatively patients that faced a major AE had significantly lower rates of satisfaction (no AE: 83.5%, major: 71.6%, minor: 82.8%, p<0.01).

Conclusions

Major adverse events during hospital admission after elective lumbar spine surgery lead to significantly worse long-term functional outcomes and lower rates of patient satisfaction. This information highlights the need to implement strategies aimed at reducing in-hospital adverse events.
Factors Associated with an Increased Risk of Developing a Post-operative Infection Following Spine Surgery

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Objectives

Post-operative infection is a serious complication of spine surgery and can contribute to the strain on the healthcare system’s resources. The purpose of this study is to determine what factors affect the risk of developing postoperative infection. We hypothesize that female gender, smoking, diabetes, having thoracolumbar procedures, having a neurological deficit, increased age, body mass index (BMI), American Society of Anesthesiologists (ASA) score, blood loss, number of operative levels, operative time and undergoing non-elective surgery will increase the patients’ risk of developing a post-operative infection.

Method

A retrospective review of prospectively collected data within the Canadian Spine Outcome and Research Network (CSORN) was conducted. Data was analyzed using IBM-SPSS. Multivariable logistical regression analysis was conducted (odds ratios) to determine any association between the outcome and independent factors. Significance level was p < 0.05.

Results

There were 7747 patients identified from the registry that had completed at least 12 weeks of follow up. There were 199 infections recorded representing a 2.6% risk of infection. There were no association found between the risk of developing a post-operative infection and gender, smoking, diabetes, having thoracolumbar procedures, having a neurological deficit, ASA score, blood loss, number of operative levels and undergoing non-elective surgery. The following were associated with an increased risk of developing a post-operative infection: Older age (adjusted OR=1.021, 95% CI=1.005-1.038, p<0.05), having an elevated BMI (adjusted OR=1.042, 95% CI=1.013-1.072, p<0.005), longer operative time (adjusted OR=1.002, 95% CI=1.001-1.004, p<0.001).

Conclusions

There is a 2.6% overall rate of post-operative spine infection across 20 Canadian centres. The factors that were associated with an increased risk of developing a post-operative-infection were older age, increased BMI and longer operative time. This study establishes a benchmark against which the effectiveness of future interventions to reduce infection can be compared.
The Impact of Surgical-Site Infection on Functional Recovery and Surgical Outcomes After Adult Posterior Thoracolumbar Spinal Surgery

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Objectives

The purpose of the present study was to determine if surgical-site infection (SSI) affects functional recovery and surgical outcomes up to 2 years following posterior thoracolumbar spinal surgery.

Method

Retrospective analysis was performed on patients enrolled in a previously completed prospective RCT which was examining antibiotic use in association with closed-suction drain removal. The trial included 552 patients who were randomized to either 24 or 72 hours of post-operative antibiotics. In the present study, a comparison was made between patients who had a SSI (n=80), and those who did not have a SSI (n=472). Outcome measures included the Oswestry disability index (ODI), the numeric rating scale (NRS) for pain, SF12 summary scores (MCS and PCS), and satisfaction with treatment, adverse events, readmissions and additional surgery. Outcomes were assessed prior to surgery and at 1.5, 3, 6, 12 and 24 months.

Results

The infection rate was 14.5% (80/552), and the median time to infection was 15 days. 31(5.6%) were deep and 49 (8.9%) were superficial infections. Patients that had an infection had a higher body mass index (P<0.001), were more likely to have had pre-operative prophylactic vancomycin (P=0.048), be undergoing a revision procedure (P<0.001), and have worse pre-operative mental functioning (MCS 43.9±11.0 vs. 40.5±12.5). Following surgery they had more emergency room visits (2.5% vs. 11.3%), re-admissions (0.0% vs. 46.3%), and additional surgery (5.5% vs. 38.8%) than patients that did not have a SSI (P<0.05 all comparisons). Patients that had an infection had worse overall ODI (P=0.024) and PCS (P=0.038) scores (averaged over all timepoints). Comparison between the groups at 2 years showed no difference in functional outcomes, or satisfaction with treatment.

Conclusions

SSI nearly doubled the re-admission and additional surgery rates. Patients with SSI initially (6-months) had poorer overall physical function representing the delay to recovery associated with the infection; however, the negative impact resolved during the second postoperative year.
Development of Clinical Prognostic Models for Postoperative Survival and Quality of Life in Patients with Surgically Treated Metastatic Epidural Spinal Cord Compression

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Objectives

Surgery is generally considered for patients with metastatic epidural spinal cord compression (MESCC) with life expectancy >3 months. No existing clinical prognostic models (CPMs) of survival are consistently used, and no CPMs exist which predict quality of life (QoL) following surgical treatment. These knowledge gaps are important given the challenges involved in managing MESCC.

Method

Using TRIPOD guidelines and data from 258 patients (AOSpine North America (NA) MESCC study and Nottingham MESCC registry), we created 1-year survival and QoL CPMs using Cox model and logistic regression with manual backward elimination. The outcome measure for QoL was the minimal clinical important difference (MCID) in EQ-5D scores. Internal validation involved 200 bootstrap iterations; calibration and discrimination were evaluated.

Results

Longer survival was associated with higher SF-36 physical component score (PCS) (HR: 0.96) whereas primary tumor other than breast, thyroid, and prostate (unfavorable, HR: 2.57; others, HR: 1.20), organ metastasis (HR: 1.51), male sex (HR: 1.58), and preoperative radiotherapy (HR: 1.53) were not (c-statistic: 0.69, 95% CI: 0.64-0.73). KPS <70% (OR: 2.50), living in NA (OR: 4.06), SF-36 PCS (OR: 0.95) and mental component (OR: 0.96) were associated with the likelihood of achieving a MCID improvement in EQ-5D at 3 months (c-statistic: 0.74, 95% CI: 0.68-0.79). Calibration for both CPMs was very good.

Conclusions

We developed and internally validated the first CPMs of survival and QoL at 3 months postoperatively in patients with MESCC using TRIPOD guidelines. A web-based calculator is available (http://spine-met.com) to assist clinical decision-making in this complex patient population.
Developing Therapeutic Guidance for Potentially Unstable Spinal Metastases by Evaluating Health Related Quality of Life Outcomes for Surgery and/or Radiotherapy

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Objectives

The objective of this study was to evaluate HRQOL outcomes at 12-weeks post-treatment in patients treated with surgery and/or radiotherapy for potentially unstable spinal metastases.

Method

An international multicenter prospective observational cohort study was performed. Demographic, primary tumor, treatment, adverse event, and HRQOL data were collected. The NRS pain score, EQ-5D, SF-36v2 and Spine Oncology Study Group Outcome Questionnaire (SOSGOQ2.0) were used to evaluate HRQOL. A Spinal Instability Neoplastic Score (SINS) score between 7 and 12 defined potentially unstable spinal metastases. HRQOL scores were modeled and compared within and between treatment groups using mixed effect models with adjustment for baseline characteristics.

Results

Between August 2013 and May 2017, 120 patients with potentially unstable metastases were treated with surgery +/- radiotherapy and 82 patients with radiotherapy alone. At baseline, patients who underwent surgery more often presented with mechanical pain (p<0.001), a lytic tumor (p=0.031), a higher median SINS score (10 vs 8 for radiotherapy alone), and worse baseline performance status, HRQOL and pain scores. Patients treated with surgery-radiotherapy also exhibited more often a combination of mechanical pain and a vertebral compression fracture compared to patients treated with radiotherapy alone. At 12 weeks post-treatment, surgically treated patients experienced a 2.7-point decrease in adjusted mean NRS pain (95%CI=-3.9 – -1.5, p<0.001) and a 12-point increase in adjusted mean SOSGOQ2.0 (95%CI=5.1 – 19.0, p<0.001) as compared to a 1.4-point decrease in NRS pain (95%CI=-2.9 – 0.0, p=0.053), and a 6.2-point increase in SOSGOQ2.0 (95%CI=2.2 – 14.6, p=0.352) in those treated with radiotherapy alone.

Conclusions

Profound improvements in pain and HRQOL scores are observed following surgery+ radiotherapy for potentially unstable spinal metastases as compared to modest improvements following radiotherapy alone. Consultation of a spine surgeon is recommended for patients with a SINS score between 7 and 12 including mechanical pain and a vertebral compression fracture.
A Phase I Trial on the Use of Photodynamic Therapy in Vertebral Metastases

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Objectives

The spine is a common site of metastasis. Complications include pathologic fracture and spinal cord compression. Vertebroplasty (VP) and Balloon Kyphoplasty (KP) are minimally invasive stabilization procedures used in palliative treatment for spinal metastases. Photodynamic therapy (PDT) is a tumour-ablative modality that may complement mechanical stability afforded by VP/KP. This first-in-human study evaluates PDT safety when applied in conjunction with VP/KP.

Method

This dose escalation trial involved one light only control group and four light-drug doses (50,100,150,200J;n=6) delivered at 150mW from a 690nm diode laser by 800-micron optical fibres. Patients eligible for VP/KP in treating pathologic fracture or at-risk lesions were recruited. Exclusion criteria included spinal canal compromise or neurologic impairment. PDT is a 2-step binary therapy of systemic drug followed by intravertebral light activation. Light was applied via bone trocar prior to cementation. Drug/light safety, neurologic safety, generic (SF-36) and disease-specific outcomes (VAS,EORTC-QLQ-BM22,EORTC-QLQ-C15-PAL) were recorded through 6 weeks.

Results

30 (10 male,20 female) patients were treated (13 KP,17 VP). The average age was 61. Primary cancer sites were breast (36.7\%) and lung (23.3\%). All patients had prior interventions involving a combination of surgery, chemotherapy, and radiation therapy before enrolment. All patients completed the study through the six-week follow-up. No group showed significant increases in pain as defined by the EORTC-QLQ. The 50 and 100J groups showed significant reductions in pain compared to the control. The 50J group had the best response, comprised mostly of lytic tumours, an average power density of 12.1mW/cm\textsuperscript{2} measured at various distances ranging from 1.2 to 2.4 cm, and 5/6 lesions located from L2-L5. 40\% of patients experienced complications during the study, none of which were drug or PDT therapy related.

Conclusions

Vertebral PDT appears safe from pharmaceutical and neurologic perspectives. KP/VP failure rate is broadly in line with reported values and PDT did not compromise efficacy. The 50J group demonstrated an improved response. Ongoing study determining safe dose range and subsequent efficacy studies are necessary.
Can Radiomic Features Differentiate between Osteoblastic and Healthy Bone Tissue in Metastatically Involved Vertebrae?

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Objectives

Quantification of osteolytic and osteoblastic metastatic involvement of the bony spine is important for assessing disease progression and treatment response. Metastasis affects bone deposition and quality, resulting in a change in texture within μCT image data. This investigation aims to develop an automated method to segment osteoblastic lesions in μCT images from a preclinical model of metastatically involved vertebrae using a radiomics approach. We hypothesize that radiomic-based feature extraction will be sensitive to changes in osteoblastic lesion bone texture and that these changes will be useful for automating osteoblastic segmentation.

Method

Osteoblastic metastases were generated via intracardiac injection of human ZR-75-1 breast cancer cells into a preclinical athymic rat model (n=3). Four months post inoculation, ex-vivo μCT images (μCT100, Scanco) were acquired of metastatically involved third lumbar vertebra (L3) at 7µm/voxel and resampled to 34µm/voxel.

The trabecular bone within each vertebra was isolated using an atlas and level-set based approach. Pyradiomics was used to calculate 3D image features at each voxel location within the vertebral bone. Thresholding of radiomic feature maps was used to isolate the osteoblastic lesions.

Radiomic feature-based segmentation of osteoblastic tissue was evaluated on randomly selected 2D sagittal and axial slices of the μCT volumes. Feature segmentations were compared to ground truth osteoblastic lesion segmentations by calculating the Dice Similarity Coefficient (DSC). Manually defined ground truth segmentations on the μCT slices were informed by histological confirmation of lesions.

Results

The radiomic based features that best segmented osteoblastic tissue while optimizing computational time were derived from the Neighboring Gray Tone Difference Matrix (NGTDM). Measures of coarseness yielded the best agreement with the manual segmentations (DSC=707%) followed by contrast, strength and complexity (DSC=6513%, 5428%, and 4826%, respectively).

Conclusions

This pilot study using a radiomic-based approach demonstrates the utility of the NGTDM features for segmentation of vertebral osteoblastic lesions. In future work, we will explore combining these features using machine learning based classifiers to improve segmentation performance.
3D-Printed Scaffolds Impregnated with Doxorubicin and Zoledronate for the Treatment of Spinal Bone Metastases

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Objectives

Current non-surgical therapies of spinal bone metastases focus on chemotherapy and bone preservation with Doxorubicin (Dox) and Zoledronate (Zol) respectively being some of the most commonly used drugs. These drugs are usually systemically delivered to patients at high doses, and they can cause multiple adverse effects limiting their prolonged use and effectiveness. Interestingly, we have investigated the potential of local delivery of Zol to the site of bone metastasis and have shown reduced tumor-induced osteolysis compared to systemically-treated xenograft animals. Also, we have recently demonstrated the feasibility of 3D-printed scaffolds to deliver low Dox doses locally over a sustained period while inhibiting bone metastasis in vitro. We aim to develop 3D-printed scaffolds to deliver a combination of Zol and Dox that can potentially allow for a synergistic antitumor activity while preventing concurrent bone loss locally at the tumor site and decreasing side effects in patients.

Method

3D-printed PORO nano-porous scaffolds were loaded with Dox or Zol in aqueous buffer over 7 days. Dox or Zol-containing supernatants were collected daily and analyzed. The scaffold-drug (Dox or Zol) release system was tested in vitro on cancer cell lines and bone metastases cells. Treated cells were subject to proliferation, migration and invasion assays. Scaffolds loaded with both Dox and Zol are being tested for drug release and on cancer cells.

Results

We have titrated the drug loading of scaffolds to allow for a release amount of Dox or Zol at the effective dose (EC50) over 7 days. We have shown that Dox or Zol-loaded scaffolds inhibit cancer cell growth in vitro over 7 days using the above cellular assays.

Conclusions

3D-printed nano-porous scaffolds offer a novel and versatile opportunity for delivery of drugs in future clinical settings. These scaffolds can be placed at the tumour site and can be loaded with chemotherapeutics or other bioactive substances to block cancer growth, promote bone repair and decrease systemic side effects in patients.
Outcomes Following Surgery for Spinal Metastases in Ontario, Canada: Population-Based Cohort Study

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Objectives

Our aim was to evaluate survival and complications for patients undergoing surgery for spinal metastases in Ontario.

Method

We performed a population-based, retrospective cohort study using Ontario administrative health data. We identified all patients who underwent surgical treatment of spinal metastases from 2006 to 2016. All patients were followed from surgery until death, out-migration or end of study (Dec 2017). We assessed all-cause mortality, overall and stratified by primary cancer, using Kaplan-Meier survival analysis. Secondary outcomes included hospital readmission, serious perioperative complications and vertebral fractures. Multivariable Cox regression models were fit to evaluate the associations between stereotactic body radiotherapy (SBRT) and conventional radiation (within the 6 months after surgery), controlling for other risk factors (comorbidity, primary cancer, age, sex, socioeconomic status), and time to death.

Results

Among 2358 patients undergoing surgery for spinal metastases, the mean (SD) age was 62.4 (12.3) and 55% were male. Overall, 411 (17.4%) had breast and 288 (12.2%) had prostate cancer (as the primary lesion). Mortality rates were highest for gastrointestinal, lung and melanoma cancers, with 52.6% of patients with upper gastrointestinal cancers dying within 90 days of surgery (vs 50.6% and 48.5% for melanoma and lung cancers, respectively). The overall mean (SD) survival time following surgery was 1.5 (1.9) years. Twelve percent experienced a serious complication and 21.2% were readmitted to hospital within 30 days. Overall, 434 (18.4%) patients experienced a vertebral fracture. We identified 1012 (43%) patients who received conventional radiation; 244 (10%) were exposed to SBRT. SBRT exposure was more frequent among breast and thyroid cancers, whereas patients with prostate, lung, and myeloma cancers were more likely to have conventional radiation. In multivariable analyses, SBRT within 6 months post-surgery was associated with lower mortality risk than conventional radiation: HR 0.73 (95%CI 0.62, 0.85).

Conclusions

Mortality following surgery for spinal metastases was highest for gastrointestinal, lung and melanoma cancers. While we observed an association between SBRT and survival, channeling bias cannot be ruled out.
Development and Validation of Clinical Prognostic Models of Survival and Clinical Outcomes for Patients with Metastatic Epidural Spinal Disease: A Systematic Literature Review

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Objectives

In multivariable prognostic research, the development and external validation are the first phases typically involved towards the establishment of clinical prognostic models (CPMs) in practice. This systematic review aims to identify and assess CPMs created to predict clinical outcomes in patients with metastatic epidural spinal disease (MESD) and their subsequent validation studies.

Method

Three electronic databases were searched (January 1, 1990 to December 31, 2017), without language restriction, to identify studies that addressed review question: What are the existing CPMs that have been developed and/or externally validated to predict survival or other clinical outcomes in patients with MESD? Data extraction, reporting and appraisal of the selected studies were conducted following recommended guidance: CHARMS, TRIPOD, and PROBAST (CRD42017072908).

Results

Among 8,077 unique full-text articles, 117 were included. Among the 52 articles describing a CPM (CPM creation, n=44; update of an existing CPM, n=8), 44 did not include any assessment of model performance (calibration and/or discrimination) while 20 reported the number of outcome events and 7 discussed missing data. Among the 5 articles with the term “external validation” or “external validity” in the title or abstract, missing data, number of outcome events, and calibration along with discrimination were discussed in 4, 3 and 2 studies, respectively.

Conclusions

Since 1990, while over 50 CPMs predicting clinical outcomes in patients with MESD were developed, only 5 studies claimed performing an external validation of any of these tools. The majority of the studies included in this review did not report on key methodological and data analysis elements. Greater rigor in the development and validation of CPMs could promote the establishment of CPMs in clinical practice in this patient population.
Patient Satisfaction after Treatment for Spinal Metastases

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Objectives

The objective of this study was to evaluate patient satisfaction following either surgery+- radiotherapy or radiotherapy alone for the treatment of metastatic spine disease.

Method

A prospective international multicenter observational study including patients with spinal metastases treated with surgery+- radiotherapy or radiotherapy alone was performed. Demographic, histologic, treatment, adverse event, and HRQOL data were collected. Evaluation of HRQOL included the NRS pain score, EQ-5D-3L and the Spine Oncology Study Group Outcome Questionnaire (SOSGOQ2.0). Patient satisfaction was evaluated based on the post-treatment SOSGOQ2.0 questions at 6, 12, and 26 weeks post-treatment. Patients were classified as satisfied, neutral or dissatisfied with the results of their spine treatment. A last observation carried forward methods was used in case of missing data.

Results

At 12 weeks post-treatment, 84% (N=158) of the patients treated with surgery+- radiotherapy were satisfied and 5% (N=9) were dissatisfied compared to 77% (N=95) being satisfied and 6% (N=7) being dissatisfied after treatment with radiotherapy alone. Decreased leg strength (p=0.031) and worse lower social functioning at baseline demonstrated to be associated with post-surgery dissatisfaction. Patients who were satisfied after surgery experienced significant improvements in pain, physical function, mental health, social function and EQ-5D compared to non-significant improvements in dissatisfied patients. Being single (p=0.030) and worse lower social function (p=0.069) at baseline were associated with post-radiotherapy dissatisfaction. Post-radiotherapy satisfaction was associated with significant improvements in pain, mental health and overall SOSGOQ2.0 scores.

Conclusions

Both, surgery+- radiotherapy and radiotherapy alone for the treatment of spinal metastases demonstrated high rates of treatment satisfaction. Significant improvements in pain, physical function, social function, mental health and overall HRQOL are associated with post-treatment satisfaction.
Predicting Mortality Following Traumatic Cervical Spinal Cord Injury in the Elderly

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Objectives

As the incidence of traumatic spinal cord injury (tSCI) in the elderly rises, clinicians are frequently faced with difficult decisions regarding the goals of management and the need to discuss prognosis with the patient and their families. The objectives of this study were to determine the specific factors associated with mortality in the elderly following tSCI and develop a simple clinical tool to predict mortality in the acute setting.

Method

Prospectively collected data of all elderly patients (≥65 years) within the national Rick Hansen SCI registry from 2004 to 2017 were analyzed using bivariate and multivariate analyses to determine what factors were associated with in-hospital patient mortality. The main outcome measure was in-hospital mortality with data also collected on patient demographics, injury factors and treatment course.

Results

1382 patients were divided into three groups: 65-69 years, 70-74 years and ≥75 years of age. Overall in-hospital mortality was 15.8% with 218 deaths. The factors associated with mortality included age, injury severity (AIS grade), level of injury, and ISS. Mortality rates were highest in the most elderly (65-69 yrs 7.8%, 70-74yrs 10.6%, ≥75yrs 24%). Those with AIS A injuries had a mortality of 30.6% (OR 6.0, p <0.001). High cervical SCI had a much higher rate of mortality than low cervical (18.4% vs 12.7%, p 0.001) and ISS >25 was strongly associated with mortality (p<0.0001). In the 614 patients ≥75 years, in-hospital mortality was 49% for ASIA A, 29% for high cervical injury, and 20% for low cervical injury. Those with an ISS > 25 were twice as likely to die in hospital. Of the survivors, only 37% were discharged home.

Conclusions

Increasing age, level of injury and AIS grade are strongly associated with mortality in elderly tSCI patients. Using these factors, we can establish a tool for predicting in-patient mortality that may help with decision-making around goals of management and with communication of prognosis to patients and their families.
Using National Administrative Data to Determine Incidence of Traumatic SCI in Canada and Associated in-Hospital Costs and Trends Over Time

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Objectives

Existing incidence and healthcare costs of traumatic spinal cord injury (tSCI) are based on estimates and assumptions which may impair generalizability of research, investigation of aspects within the healthcare system, and identification of trends over time for prevention and best practice implementation. Our aim was to use administrative data to ensure representativeness of Canadians experiencing tSCI, investigate in-hospital costs, and examine discharge destination in the elderly population (75+).

Method

We obtained administrative data from the Canadian Institute for Healthcare Information (CIHI) trauma datasets from 2010-2016 for newly injured tSCI patients using standard ICD-10 diagnosis codes. Data includes all initial inpatient admissions for all provinces except for Quebec. Incidence by year, age, and sex, total length of stay (LOS) in acute care, and cost, based on resource intensity weights (RIW), were calculated.

Results

Incidence of tSCI in Canada 2010-2016 averaged 29 per million; 75% male and average age 52 years. Incidence in the 75+ population increased from 60 per million in 2010 to 87 per million in 2016. Mean acute LOS 2010-2016 was 37d, median 19d (IQR 10-40); no trends over time were identified. Estimated mean and median costs per admission are $62,095 and $30,559 (IQR $16,724-$70,550), respectively. 80% of elderly patients are transferred to another hospital or long-term care; only 20% return home; no trends over time were identified.

Conclusions

There is a trend towards increased incidence in the elderly population. The annual incidence of tSCI in Canada based on administrative data is 28 per million, lower than existing estimates using statistical modeling. Work is ongoing to examine RIW by injury severity and level between 2010 and 2016 to determine the impact of an aging population on healthcare costs. Changes in policy and population characteristics over time using administrative and SCI registry data should inform future research and optimization of healthcare.
Traumatic Spinal Cord Injuries among Aboriginal and Non-Aboriginal Populations of Saskatchewan: A Prospective Outcomes Study

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Objectives

People of Aboriginal ancestry are more likely to suffer traumatic spinal cord injury (tSCI) compared to other Canadians; however, outcome studies are limited to qualitative (interview) methods. The objectives of this study were to, for the first time, compare Aboriginal and non-Aboriginal populations with acute tSCI with respect to: (1) baseline demographics, comorbidities, mechanism and severity of injury; (2) time to surgery, neurological outcomes, morbidity/mortality, and length of stay in acute care and rehabilitation; and (3) time to discharge to community and outcomes at one-year after discharge (functional independence measures, quality of life scores, secondary health conditions, compensation type, employment status)

Method

This was a retrospective analysis of 159 patients with tSCI prospectively enrolled in the prospective Rick Hansen Spinal Cord Injury Registry (RHSCIR), Saskatoon site between February 13, 2010 and December 17, 2016.

Results

Sixty-two patients consented to the full dataset, which includes ethnic background: 21 "Aboriginal" (33.9%); 41 "non-Aboriginal" (66.1%). There was only one "non-Aboriginal" participant who did not self-identify as "white". Transport injuries were the most common mechanism of injury among Aboriginal peoples, followed by assault. For whites, falls and transport injuries were equally common. Aboriginal patients were younger, had fewer medical comorbidities and had similar severity of neurological injury and similar outcomes compared to non-Aboriginal patients. However, the time to discharge to the community from acute care or inpatient rehabilitation was significantly longer (median 104.0 days versus 38.5 days, \(p=0.021\)). While 35% of whites were discharged home from acute care, all patients of Aboriginal ancestry were transferred from the acute care site to another hospital (inpatient rehabilitation or local hospital).

Conclusions

This study suggests a need for better allocation of resources for transition to the community for Indigenous Peoples with tSCI in Saskatchewan, such as more timely home assessments and modifications. Future study is needed to assess outcomes from tSCI for Indigenous Peoples across Canada.
The Effect of Frailty on Outcome after Traumatic Spinal Cord Injury

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Objectives

Frailty, defined as a state of decreased reserve and susceptibility to external stressors, has previously been shown to negatively affect post-operative outcome in an elective spine surgery population. This study sought to determine the effect of frailty on patient outcome after traumatic spinal cord injury (tSCI).

Method

All patients with tSCI were identified in our prospectively collected database from 2007-2016. Analysis was conducted to examine correlations between patient age, Total Motor Score (TMS) on admission, and mFI on patient outcome variables including acute Length of Stay (LOS), number of Adverse Events (AEs), and in-hospital mortality.

Results

Bivariate analysis revealed multiple statistically significant associations. mFI was a strong predictor of increased acute LOS (corr =0.163; p<.0001), number of AEs (corr=0.1664; p<.0001), and in-hospital mortality (corr=0.155; p<.0001). Age at injury was also significantly correlated with acute LOS (corr=0.0809; p=0.0418), number of AEs (corr=0.0937; p=0.0231), and in-hospital mortality (corr=0.2639; p<.0001). Lastly, motor score on admission was also predictive of acute LOS (corr=-0.4749; p<.0001), number of AEs (corr=-0.3069; p<.0001), and in-hospital mortality (corr=-0.2249; p<.0001).

In patients >65, MFI was not predictive of acute LOS (p=0.1533), number of AEs (p=0.2337), or in-hospital mortality (p=0.6593). Age at injury was not predictive of acute LOS (p=0.0571), however remained significant for number of AEs (p=0.0058), and in-hospital mortality (p<.0001). This was also true for Motor score on admission, which was predictive of acute LOS (p<.0001), number of AEs (p=.0038), and in-hospital mortality (p<.0001).

Conclusions

Age, mFI, and TMS on admission are important determinants of outcome in patients with tSCI. Furthermore, frailty score is predictive of outcome in the general tSCI population, but not in the elderly. This suggests that younger, “frail” individuals have significantly poorer outcomes than young, healthy individuals, however the inter-relationship between advanced age and decreased physiologic reserve is not as clear. Identification of frailty in a younger population as a pre-injury risk factor may be useful for peri-operative optimization, risk stratification, and patient counselling.
Can Health Related Quality of Life of Canadian Patients with Traumatic Spinal Cord Injury Become Normal at One Year? A Prospective Cohort Study

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Objectives

The primary objective of this study was to compare the Health-Related Quality of Life (HRQOL) of Canadian patients with traumatic spinal cord injury (tSCI) after their physical rehabilitation with Canadian normative data matched for sex and age.

Method

A single institution prospective database collected from 2010 to 2016 was screened for the following inclusion criteria: age>25yo; traumatic-SCI (tSCI); vertebral trauma from C1 to L2; available 12month follow-up. HRQOL was measured using the SF-36 questionnaire. Each patient was compared with Canadian normative values of SF-36 questionnaire, matched for age group and sex, considering a normal value of SF-36 being within 1SD.

Results

A total of 168 Canadian tSCI patients met our inclusion criteria. Mean SF-36 physical component score (PCS) of our tSCI population was 37.6/7.5 compared to 49.6/3.1 for a normal Canadian age-sex matched cohort (p<0.05) and the mean mental component score (MCS) of our tSCI population was 41.7/7.5 compared to 53.2/1.7 for a normal matched cohort (p<0.05).

Fifty-one patients (30.4%) reached a normal PCS value and 52 patients (31.0%) reached a normal MCS. Patients who reached normal PCS values were older (61.8yo VS 48.9yo), had less commonly complete SCI (9.8% vs 41.9%) and tended to sustain cervical SCI (80.0% vs 58.9%) (all p<0.05). Patients who reached normal MCS values tended to be younger (46.0yo vs 55.9yo; p<0.05), to have more commonly complete SCI (44.2% vs 26.7%; p<0.05) but had similar rate of cervical SCI when compared to patient who didn’t reached normal MCS.

Conclusions

Roughly 30% of Canadian patients with tSCI could expect to regain normal HRQOL within 12 month after their trauma. Interestingly tSCI with normal physical component of HRQOL were more commonly older with incomplete cervical SCI whereas patients with patients with normal mental component of HRQOL were younger patients with complete spinal cord injury. This study provides high quality epidemiological data for counseling Canadian patients with tSCI about possibility of achievement of normal HRQOL.
Unbiased Recursive Partitioning to Stratify Patients with Acute Traumatic Spinal Cord Injuries: External Validity in an Observational Cohort Study

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Objectives

Clinical trials of novel therapies for acute traumatic spinal cord injuries (SCI) are extremely challenging because variability in spontaneous neurologic recovery can make discerning actual treatment effects difficult. Unbiased Recursive Partitioning regression with Conditional Inference Trees (URP-CTREE) is a novel approach to stratification that was developed through analyses of a large European SCI database. We performed an external validation study to determine how well a previously reported URP-CTREE model performed when applied to an independent cohort.

Method

We included all eligible patients from an ongoing prospective cohort study with complete American Spinal Injury Association (ASIA) Impairment Scale (AIS) A acute traumatic cervical spinal cord injuries and baseline motor levels at C4 to C6. We applied the previously reported URP-CTREE model and evaluated Upper Extremity Motor Score (UEMS) recovery at final follow-up. We tested univariate associations with the Pearson Correlation Coefficient, and differences between medians with the Mann-Whitney U test.

Results

We included 101 cervical AIS A patients, whose mean times from injury to baseline and follow-up neurological examinations were 6.1 days (SD 17) and 235 days (SD 71), respectively. The previously reported model partitioned our cohort into five stratified groups according to four predictors. One of the predictors was not statistically significant, one of the groups did not fit a consistent sequence of progressively improving UEMS scores, and three of the groups had medians that were not significantly different from their adjacent groups. Overall prediction accuracy was 75%, but varied from 82% among participants whose examinations occurred at less than 12h, to 64% at 12 to 24h, and 58% at greater than 24h.

Conclusions

A previously reported URP-CTREE model had limited ability to stratify an independent cohort into distinct homogeneous subgroups. Overall prediction accuracy was reasonably promising, but sensitive to timing of baseline neurological examinations. Further research is warranted to evaluate URP-CTREE in incomplete injuries, consider the influence of timing of baseline examinations, and investigate additional strategies for accurately stratifying patients with acute SCI.
Systemic Protein Kinase Inhibition Reduces Local Inflammation after Cervical Spinal Cord Injury

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Objectives

Traumatic spinal cord injury (SCI) is a debilitating and multifaceted condition that limits the quality of life for millions of patients worldwide. Despite recent advances in the post-traumatic care, the available treatment options for SCI patients are still limited. The disruption of blood-spinal cord barrier (BSCB) by the mechanical trauma is a major challenge that limits the potency of most SCI treatments. Infiltration of pro-inflammatory immune cells following the BSCB disruption leads to further permanent damage to the injury epicentre. Therapeutic stabilization of BSCB can potentially attenuate the immune cells migration and improve SCI recovery. The aim of this study is to examine the effects of systemic protein kinase inhibition on BSCB integrity, and to determine its efficacy as a treatment for SCI.

Method

SCI was induced in 12 wistar rats using the clip-compression injury model at C6-7. The injured rats were randomly assigned two cohorts (n=6), receiving either midostaurin or vehicle control. In addition, 6 laminectomized shams were used to constitute a non-injured cohort. All rats were sacrificed at 24-hours post-operation, and the total RNA and protein were extracted from the spinal cord to evaluate the molecular changes. Western blotting was used to assess the phosphorylation of downstream target molecules. Differentially expressed genes were identified using reverse transcription qualitative polymerase chain reaction. Multiplex Luminex assay was used to examine the inflammatory response after SCI.

Results

Administration of 25 mg/kg midostaurin reduced the phosphorylated GSK3 and STAT3 at the injury epicenter (1-day post-injury). This demonstrates the penetrance of the midostaurin into the spinal cord. The transcriptional analysis reveals downregulation of adhesive and migratory genes including JAM2, THY1, and ITGB1. This ultimately leads to the mitigation of pro-inflammatory markers, such as fractalkine, IL-1a, and IL-5 at 1-day post-injury.

Conclusions

This study demonstrates that systemic protein kinase inhibition is an effective strategy for preventing secondary SCI damage, which can have a significant impact on the enhancement of neuroprotective regime applied upon traumatic SCI.
Does Surgical Intervention Alter Outcome in Elderly with Traumatic Spinal Cord Injury?

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Objectives

With the rising incidence of traumatic spinal cord injury (tSCI) in the elderly, clinicians are increasingly faced with difficult management decisions regarding operative intervention, acknowledging that significant morbidity and mortality is associated with the cord injury, regardless of treatment. Here, we sought to determine whether acute surgical intervention altered neurologic recovery and whether it increased the likelihood of discharge home.

Method

Prospectively collected data of all elderly patients (≥65 years) within the national Rick Hansen SCI registry from 2004 to 2017 were analyzed. Using bivariate and multivariate analyses, the impact of surgical intervention on mortality, motor score recovery, days in ICU, acute and total length of stay (LOS) and final discharge destination was compared between the operative vs non-operative groups.

Results

Of 1034 patients identified, 856 (83%) underwent surgery for their tSCI. Patients managed non-operatively were slightly older (75.7yrs vs. 73.6yrs, p<0.0006) and had more comorbidities, with a Charlson Index Score >3 in 26% compared to 17% of those who had surgery (p=0.0012). The in-hospital mortality was significantly higher in the nonoperative group (21% vs 9.4%, p <0.0001) but after adjusting for age, level, severity and comorbidity, the surgery status did not predict in-hospital mortality.

For the operative group, ICU stays were twice as long (4 days v. 2 days, p=0.0012) with both acute hospital LOS (27 v. 16 days, p<0.0001) and total LOS being significantly longer (94 v. 45 days, p<0.0001) than the nonoperative group. There was no significant improvement in motor score recovery between the two groups (8.0 v. 9.5, p=0.20) or in the number of those whose final discharge destination was home (p=0.65).

Conclusions

Acute surgical intervention in tSCI in the elderly leads to longer ICU stay and substantially increases hospital LOS with no statistically significant improvement in motor recovery, likelihood of discharge home or effect on in-hospital mortality.
A Longitudinal Analysis of Neurological Recovery Based on Timing of Early Post-Injury Neurologic Assessment in Acute Spinal Cord Injury

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Objectives

The trajectory of early neurological recovery following traumatic spinal cord injury (tSCI) is not well characterized. A wide range in recommended post-injury exam times (i.e. 72 hours-one month) used as “baseline” assessments exists in the literature and are based on cross-sectional studies analyzing small sample sizes. Acknowledging the potential for early spontaneous neurological recovery, differences between baseline exam times can introduce bias in clinical research. Our study objectives were to:

1. Characterize early neurological recovery after cervical tSCI using a longitudinal design.
2. Report and compare neurological recovery by AIS grade and level (high/low cervical).

Make recommendations for study design and interpretation.

Method

Two different longitudinal analyses of motor scores during the first 6 months post-injury were used to generate the trajectory of neurological recovery in the Vancouver RHSCIR participants from 2004-12. Data was stratified by AIS and anatomic level (high/low cervical). Age, motor score and time of exam were analyzed.

Results

Cohort size was 194 persons with tSCI; 79% male, mean age 45.1±17.6 and 41.7% complete injuries. Results indicate different trajectories of neurological recovery based on severity and level of injury. Differences in baseline exam time were significantly important in AIS C/D injuries whereas AIS A/B injuries had no significant effect in the first two weeks. Anatomical region was an important factor depending on AIS. Age and gender were non-significant.

Conclusions

No previous longitudinal study has reported on the importance of the timing of neurological exam based on the spontaneous neurological improvement trajectory, particularly during the first two weeks. Large variations in baseline exam times indicate this phenomenon was underestimated by previous studies. In AIS C/D there are significant motor score improvements over the first few days which should be accounted for in research studies. However, in AIS A there is little variation in the first two weeks. Our results support earlier work emphasizing appropriate controls to minimize heterogeneity and reduce error when analyzing and reporting tSCI research studies.
Sarcopenia, Independent of Age, Predicts Mortality and Acute Care Adverse Events in Patients with Traumatic Spinal Cord Injury

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Objectives

Management of traumatic spinal cord injury (tSCI) is characterized by acute care adverse events (AE’s) and an increasingly ageing vulnerable population. Sarcopenia, or a loss of muscle mass with age, cachexia or disuse, variably predicts AE’s in a number of surgical populations. The aim of this study was to investigate the nature of sarcopenia in a tSCI population and the relationship, if any, of sarcopenia to early mortality and AE’s following tSCI.

Method

An ambispective study of all tSCI patients at a quaternary acute care facility from 2009-2017. Data included: demographics, AIS, motor score, Charlson comorbidity index, modified frailty index. AE’s, including mortality were identified using SAVES V2. Sarcopenia was measured using the Total Psoas Area CSA (cm²) technique on lumbar CT. Logistic regression with backward stepwise elimination was used to determine the impact of sarcopenia on the occurrence of AE’s. Spearman Correlation were used to assess the relationship between the number of AE’s and the different predictors studied.

Results

158 of 734 patients had adequate lumbar spine CT at admission. The mean TPA was 16.5cm², SD 6.2. The lower quartile was 12.3cm², the upper 20cm² and the quartile range 7.6cm². Mean psoas area decreased with age. Psoas area, age at injury and motor score on admission, predicted in-hospital mortality (Correlation Coefficient 0.32-0.38, p value <0.0001). Eighty-five percent of patients had at least one acute AE. Patients with lower quartile psoas area had significantly more AE’s than those with upper quartile area (p=0.037). Psoas area also predicted the occurrence of post-op AE (TPA, 1.25±0.52 vs 1.07±0.40; p=0.031). Age and degree of neurological impairment were also predictive of post-op AE (p<0.001).

Conclusions

Sarcopenia, as measured on conventional lumbar CT, predicts both early post-injury mortality and acute care adverse events in patients with tSCI, independent of advanced age. This new knowledge provides a potential tool for timely therapeutic decision making in this complex patient population.
Design and Biomechanical Testing of a Novel Fusion Device for Atlantoaxial Instability

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Objectives

The objective was to design a less invasive C1 implant to be used as a part of a construct for C1-C2 fusion with the potential to treat more patients surgically. C1-C2 fusion for the treatment of atlantoaxial instability is controversial due to high intraoperative risks and poor clinical outcomes. Currently, the Harms procedure (C1 lateral mass screws and C2 pedicle screws) is the most popular treatment. A lower risk alternative with C2 translaminar screws has been used clinically with success but this construct continues to rely on high-risk C1 lateral mass screws. Design and biomechanical testing are presented for a novel C1 posterior arch clamp, intended to replace C1 lateral mass screws.

Method

Design criteria and constraints for the C1 clamp were developed through discussions with clinical experts, reviewing literature and meetings with the engineering team. A combination of computational modeling and benchtop testing was used to develop prototypes that were then biomechanically tested. A spinal loading simulator was used to apply moments and measure the resulting motion for eight fresh frozen human cadaveric specimens, with each one being subjected to six conditions: intact state, destabilized state (after a simulated odontoid fracture), and four fusion constructs. Range of motion was compared using paired t-tests.

Results

Computational modeling and benchtop testing established tightening specifications that were then used during cadaveric testing. Constructs with the novel C1 posterior arch clamp had significantly less motion (p<0.05) than constructs with C1 lateral mass screws in flexion/extension and axial rotation. No significant difference was detected between the constructs in lateral bending.

Conclusions

The combination of computational modeling, benchtop testing and biomechanical cadaveric testing has resulted in a novel C1 clamp that is expected to yield a safer C1-C2 fusion procedure by eliminating C1 lateral mass screws. Superior stability of the C1 clamp compared with C1 lateral mass screws has been demonstrated regardless of the fixation method used at C2, potentially reducing intraoperative risks and improving clinical outcomes for patients with atlantoaxial instability.

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Objectives

The absence of the bulbocavernosus reflex (BCR) in the acute phase following a traumatic spinal cord injury (tSCI) is generally associated to spinal shock. Unfortunately, its impact on the functional recovery following a motor-complete injury remains unknown. The main objective of this study was to determine the impact of the absence of the BCR in the postoperative phase on the functional status 6 to 12 months following a motor-complete tSCI. The neurological recovery was also evaluated as a second outcome.

Method

A review of a prospective database was completed among 66 patients sustaining a motor-complete tSCI (AIS grade A and B). First, the functional and neurological statuses between individuals with and without a BCR in the postoperative period following TSCI were compared. Then, general linear models were used to investigate the association between the postoperative BCR status and the functional outcome, as evaluated by the Spinal Cord Independence Measure (SCIM-III) considering important confounding factors.

Results

A total of 45.5% (N=30) patients had no BCR in the post-operative anorectal examination. Individuals sustaining a motor-complete tSCI with and without a BCR in the post-operative period showed a similar total SCIM score and similar SCIM sub-scores (self-care, respiration/sphincters and mobility) 6 to 12 months post-injury. The degree of completeness and the neurological level of the injury also showed similar recovery. The BCR status in the post-operative period was not a significant factor associated to functional outcome 6 to 12 months post-injury.

Conclusions

The absence of BCR, as a clinical manifestation of the spinal shock, is generally associated with worse neuro-functional prognosis following a tSCI, as it is associated with motor-complete injuries. However, the absence of BCR in the post-operative period may not be a predictor of functional outcome in patients sustaining a motor-complete tSCI.
The Rate of Fusion for Lumbar Degenerative Disc Disease in Ontario Between 2006-2015

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Objectives

To compare the rate and outcome of decompression and fusion versus decompression alone among lumbar degenerative disc disease patients treated in Ontario between 2006-2015, and to determine which factors are associated with receiving a spinal fusion over decompression alone.

Method

We performed a population-based retrospective cohort study using several databases: physician billings, hospital discharge records, and emergency room records from 2006-2015. Patients were identified by physician billing codes and hospital records and categorized into those that received fusion and decompression versus those who received decompression alone. Patients who had previous spine surgery, lumbar disc replacement, a diagnosis other than degenerative disc disease, or were pediatric were excluded. An adjusted logistic regression was used to assess our outcomes.

Results

We identified 33,912 patients, of which 9,748 (28.74%) underwent fusion. Overall, fusion rates increased from 27.66% to 31.33% over the study period. Factors associated with fusion included: older age, female gender, obesity, ASA >3, prior total joint replacement, and surgery by an orthopaedic surgeon. Experienced surgeons were less likely to perform a fusion. Fusion surgery was associated with increased odds of 30 day mortality (OR 1.77, 95% CI 1.01-3.09, p=0.046), 30-day (OR 1.94, 95% CI 1.53-2.46 p<0.0001) and 90-day reoperation rate (OR 1.66, 95% CI 1.35 – 2.05, p<0.0001), and 30-day readmission (OR 1.23, 95% CI 1.02-1.49, p=0.027) when adjusting for confounding variables. The odds of suffering a complication after fusion surgery vs. decompression surgery were 4.3-fold higher (95% CI 3.78-5.09, p<0.0001).

Conclusions

The rates of spinal fusion for degenerative disc disease in Ontario have increased between 2006-2015. Visiting an orthopaedic spine surgeon or having a previous total joint replacement increased the odds of having a fusion. After adjusting for several factors, a patient receiving a decompression and fusion is more likely to have a complication or die in the first 30 days compared to those undergoing a decompression alone.
Differences in Surgical Practices Between Salaried and Fee-for-Service Surgeons for Degenerative Lumbar Conditions in a Universal Health Payer System

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Objectives

Optimal surgical treatment for some spinal disorders remains controversial. By offering different procedures, surgeons are a central driver of health care costs. Even within a universal health payer system, surgeons may offer different treatments for similar conditions on the basis of their compensation mechanism. The purpose of this study was to examine differences in surgical practice, for two common degenerative spine conditions, between fee-for-service and salaried physicians. The second goal was to investigate if there were any differences in baseline characteristics between patients based on surgeon remuneration.

Method

Differences in operative practices based on remuneration scheme (fee for service or salaried) were assessed among registered surgeons in the Canadian Spinal Outcomes Research Network (CSORN) for 2 lumbar conditions: stable spinal stenosis and degenerative spondylolisthesis. The primary outcome was the difference in type of procedures performed between the two groups. Other studied variables included use of minimally-invasive surgery, operative time, and baseline patient characteristics (age, BMI).

Results

Sixty-four surgeons across 8 Canadian provinces were examined in this study; 39 surgeons were fee for service and 25 were salaried.

For stable spinal stenosis (n=2141), salaried surgeons performed significantly more decompressions only (p<0.05), and statistically less interbody fusion procedures (p<0.05) than fee-for-service surgeons. Salaried surgeons tended to operate on fewer spinal levels (p<0.01) and performed less minimally invasive procedures (p<0.001) than their fee-for-service counterparts.

For degenerative spondylolisthesis (n=1228), salaried surgeons performed significantly more instrumentation plus interbody fusions (p<0.05), endured significantly longer operative times (p<0.001) and performed less MIS procedures (p<0.001).

Baseline patient characteristics were similar for both groups.

Conclusions

Surgeon compensation was associated with different approaches to stable lumbar spinal stenosis and degenerative lumbar spondylolisthesis. Salaried surgeons tended to treat spinal stenosis more conservatively, and degenerative spondylolisthesis more aggressively. More than just patient related factors seem to influence surgical decision-making and should be thoroughly explored.
Cost-Utility of Revisions for Cervical Deformity Correction Warrants Minimization of Reoperations

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Objectives

Cervical deformity (CD) surgery has become increasingly more common and complex, which has led to reoperations for complications such as distal junctional kyphosis. Cost-utility analysis has yet to be used to analyze CD revision surgery in relation to the cost-utility of primary CD surgeries. The aim of this study was to determine the cost-utility of revision surgery for CD correction.

Method

Retrospective review of a multicenter prospective CD database. CD was defined as at least one of the following: C2-C7 Cobb>10°, CL>10°, CSVA>4cm, CBVA>25°. QALY were calculated by EQ-5D and NDI mapped to SF6D index and utilized a 3% discount rate to account for residual decline to life expectancy. Medicare reimbursement at 30-days assigned costs for index procedures and revision fusions. Cost per quality adjusted life years (QALY) gained was calculated.

Results

89 CD patients were included (61.6 years, 65.2% female). CD correction for these patients involved a mean 7.7±3.7 levels fused, with 34% combined approach surgeries, 49% posterior-only and 17% anterior-only, 19.1% three column osteotomy. Costs for index surgeries ranged from $20,001-$55,205, with the average cost for this cohort of $44,318 and cost per QALY of $27,267. 11 revision surgeries (mean levels fused 10.3) occurred up to 1-year, with an average cost of $41,510. Indications for revisions were DJK (5/11), neurologic impairment (4), infection (1), prominent/painful instrumentation (1). Average QALYs gained was 1.62 per revision patient. Cost was $28,138 per QALY for reoperations.

Conclusions

Cervical deformity revisions had a cost of $28,138 per QALY, in addition to the $27,267 per QALY for primary CD surgeries. For primary CD patients, CD surgery has the potential to be cost effective, with the caveats that a patient livelihood extends long enough to have the benefits and durability of the surgery is maintained. Efforts in research and surgical technique development should emphasize minimization of reoperation causes such as DJK that significantly affect cost utility of these surgeries to bring cost-utility to an acceptable range.
CSORN Data Quality Analysis 2016-2018: A Review of a Canadian Spine Registry

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Objectives

To determine current follow-up rates and data completeness within the Canadian Spine Outcomes and Research Network (CSORN). To compare current 2018 data with 2016 data for sites that were active at both time points.

Method

A retrospective study of previously collected cervical and thoracolumbar patient data from 20 CSORN sites across Canada. Completeness of data and follow-up rates were assessed via CSORN Study Extract Reports and CSS CSORN Data Quality Reports. Data quality was operationally defined as poor < 60% complete, moderate 60 – 80% complete, good > 80% complete and excellent > 90% complete. Descriptive statistics and paired samples t-tests for completeness of data was conducted. Repeated measures ANOVA assessed follow-up rates for 12-weeks, 12-months and 24-months’ time points. Significance was set at α < 0.05.

Results

From 2016-2018 4,795 new patients were enrolled for a total database population of 11,028. CSORN captures approximately 78% of all patients seen at participating centers for elective spine surgery. Overall, thoracolumbar data quality is excellent (94.81% completed). Cervical data quality is also excellent (94.80% completed). Data quality significantly improved for cervical 24-month data (2016: 65.05% to 2018: 93.32%; p < 0.05). Follow-up rates for 2018; 12-weeks (90%) to 12-months (74.12%) and 24-months (57.41%). Follow-up rate was significantly improved from 2016-2018 for the 12 month (14.86% increase [F (1, 13) = 5.2, p = 0.04] and 24 month showed a 12.07% increase.

Conclusions

CSORN is a rapidly growing national spine registry that demonstrates excellent data quality and is showing excellent 12-week and 12-month follow-up rates. Improvement demonstrated with 24-month follow-up rates is promising.
The Opinion of Canadian Spine Surgeons on Medical Assistance in Dying (MAID): A Cross-Sectional Survey of Canadian Spine Society (CSS) Members

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Objectives

On February 6th, 2015, the Supreme Court of Canada (SCC) rendered a decision striking down the Criminal Code absolute prohibition on providing assisted dying. By June 6th 2016 the new law, Bill C-14, came into effect that allowed for medical assistance in dying (MAID). The objective of this study was to determine the attitudes and opinions of Canadian neurosurgeons and orthopedic spine surgeons regarding MAID.

Method

A cross-sectional survey was sent out to members of the Canadian Spine Society (CSS). The survey included 21 questions pertaining to opinions and attitudes regarding MAID and different facets of the legislation. Responses were collected between May-June 2016.

Results

A total of 51 surgeons responded to the survey, comprised of orthopedic surgeons (68.6%), pediatric orthopedic surgeons (5.9%), and neurosurgeons (21.6%), practicing across the country. The majority of surgeons supported MAID (62.8%), and also supported the right of physicians to participate in MAID (82.4%). Most surgeons supported the right to conscientious objection (90.1%), but also believed in the mandatory duty to refer (49.0%). Only 37.2% said they would refer to a MAID service, and merely 3.9% felt they could ever see themselves actively involved in MAID. The conditions which respondents most frequently felt to be appropriate to consider MAID included metastatic spine tumour (76.5%), malignant intramedullary tumour (64.7%), primary malignant spine tumour (54.9%), cervical spinal cord injury with tetraplegia (49.0%) and multiple myeloma (33.3%).

Conclusions

This study highlights the complex landscape that exists when discussing MAID, but also shows the overall support that most physicians within the CSS have for it. This study also shows the need for ongoing conversations, in particular with respect to the some of the issues that haven’t been addressed with the current legislation, and the importance of physicians to stay informed and up to date so they can be best educated when speaking with their patients.
Radiostereometric Analysis as a Diagnostic for Assessing Vertebral Fusion: A Phantom Study

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Objectives

The purpose of this research was to determine the feasibility of radiostereometric analysis (RSA) as a diagnostic tool for assessing non-union following spinal arthrodesis procedures. Further, to estimate clinical thresholds for precision and accuracy of the proposed method in the cervical and lumbar spine.

Method

Three-level lumbo-sacral and four-level cervical posterior arthrodesis procedures were performed on an artificial spine model and a cadaveric spine. Using a spring loaded inserter, RSA markers were placed within each of the L4-S1 and C3-C6 vertebra. Titanium screws and rods were applied to the spinal segments.

RSA imaging consisted of 12 double exams (24 exams) of the cervical and lumbar regions for both the Sawbones and cadaveric spine to assess precision of measurement under zero-displacement conditions, defined as the 95% confidence interval of error. Accuracy assessment was performed on the Sawbones model in which the middle vertebrae (L5 and C4-C5) were moved relative to the superior (L4 and C3) and inferior (S1 and C6) vertebrae by known, incremental displacements. RSA images were obtained at each displacement. Accuracy was defined as the mean difference between known and measured displacements.

Results

The rate of RSA bead detection was high with 5-8 implanted beads being visible in both the lumbar and cervical regions of the artificial and cadaveric spines.

Translational RSA precision for both spines was better than 0.25 mm and 0.82 mm for the lumbar and cervical regions, respectively. Rotational precision was better than 0.40° and 1.9° for the lumbar and cervical regions, respectively. RSA accuracy for the artificial spine overall demonstrated less than 0.11 mm translational bias (margin < ±0.02 mm) and less than 0.22° rotational bias (margin < ±0.15°).

Conclusions

This study demonstrates that RSA achieves sufficient precision and accuracy to detect intervertebral micromotion for the purpose of assessing arthrodesis. Well dispersed bead placement is critical to achieving sufficient accuracy and avoiding occlusion by metal hardware. The results of this work will aid in the development of a clinical study to assess arthrodesis in patients.
Dynamic Instability in Lumbar Spondylolisthesis: Comparison of Flexion-Extension Radiographs versus Recumbent-Standing Imaging

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Objectives

The purpose of this study is to compare the proportion of patients with lumbar spondylolisthesis detected to have dynamic instability on flexion-extension radiographs versus standing-supine imaging.

Method

This is a single-centre retrospective study of all consecutive adult patients diagnosed with spondylolisthesis from January to July 2018 with the required imaging for analysis. Two independent observers measured the amount of translation, in millimeters (mm), on supine magnetic resonance imaging (MRI) and standing flexion, extension, and neutral radiographs using the Meyerding technique. Inter-observer and intra-observer correlation coefficients were calculated. The difference in amount of translation was compared between: 1. flexion and extension radiographs and 2. neutral-standing radiograph and supine imaging. The proportion of patients with dynamic instability, defined as ≥3mm difference, detected in each group was reported. Correlation between amount of dynamic translation and change in back pain 1 year after decompression and instrumented fusion was analyzed using univariate regression.

Results

56 patients were included in this study. The mean age was 57.1 years and 55.4% were female. The most commonly affected levels were L4/5 (60.7%) and L5/S1 (30.4%). 76.8% had Grade 1 spondylolisthesis. The average translation measured on flexion-standing radiograph, extension-standing radiograph, neutral-standing radiograph, and supine imaging was 12.5mm, 11.9mm, 10.1mm, and 7.2mm, respectively. The average difference between flexion and extension radiograph was 0.58mm with dynamic instability detected in 21.4%. The average difference between neutral-standing radiograph and supine imaging was 3.77mm with dynamic instability detected in 60.7%. The intra-observer variability ranged from 0.77-0.90. The inter-observer variability ranged from 0.79-0.86. In 25 patients who received decompression and instrumented fusion, amount of dynamic translation between standing and supine imaging was significantly correlated with greater improvement in back pain (p<0.001). This correlation was not seen in amount of dynamic translation between flexion and extension radiograph (p=0.60).

Conclusions

More patients were found to have dynamic instability on standing-supine imaging. There was a significant correlation between dynamic translation on standing-supine imaging and postoperative improvement in back pain.
Development and Validation of a Surgical Clinical Decision Support Tool for Lumbar Spinal Stenosis

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Objectives

Up to 40% of patients undergoing surgery for lumbar spinal stenosis (LSS) may not achieve a clinically meaningful outcome. Our objectives were to use machine learning methodology to predict surgery outcomes for LSS patients, and to apply the prediction models in a user-friendly clinical decision support tool (CDST).

Method

Model training utilized data from 430 surgical LSS patients from a tertiary hospital in Toronto, and considered over 100 potential predictors including sociodemographic, physical and mental health, clinical, pain, and function data. Several classification algorithms were tested; the final model used was elastic net logistic regression, which provided the best performance across outcomes. Since surgical treatment goals may vary across patients/clinicians, models were developed for a range of possible 1-year postsurgical goals relating to pain (numeric pain rating), function (Oswestry Disability Index [ODI]), and patient satisfaction. The models were validated using external LSS data (n=1545) from CSORN. Model performance was primarily assessed using area under the receiver-operator curve (AUC). To produce a practical CDST, a web service incorporating the final models was configured using Microsoft Azure Machine Learning Studio, and an interactive Microsoft Power BI dashboard was developed to visualize both patient characteristics and the predictions. The web service and dashboard were integrated into the existing UHN-DADOS (DAta-Driven Outcome System) clinical data collection platform.

Results

Performance varied across outcomes; for example, the model predicting ODI<20 (i.e. minimal disability) 1 year post surgery had AUC 0.77/0.68 in the training/test samples, 72%/67% accuracy, and 78%/62% positive predictive value, respectively. Our model predicted that 27% of the validation sample had a high likelihood (i.e., 75-100% probability) of 1-year ODI<20, 47% had moderate likelihood (50-75% probability), and 26% had low likelihood (0-50%). In comparison, the true proportion of patients with 1-year ODI<20 was 40%.

Conclusions

The final product was an end-to-end clinical decision support tool for data collection, outcome prediction, and visualization, which can improve the patient-surgeon shared decision-making process by providing personalized predictions for meaningful patient goals.
Predictors of Clinical Outcome Following Surgery for Lumbar Spinal Stenosis: A Study of Postoperative Pain and Disability Trajectories

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Objectives

To identify predictors of poor outcomes for disability, leg pain and back pain following surgery for lumbar spinal stenosis (LSS).

Method

A retrospective analysis of prospectively collected data. Patients with LSS (N=548) from 13 centers participating in CSORN were classified by postoperative pain and disability trajectories. Generalized linear mixed models, adjusted for age and sex, were used to identify associations between postoperative clinical outcome and preoperative demographic, clinical history, health status, and surgical factors. The subgroup with excellent outcomes was used as the reference group; associations were reported with relative risk ratios (RR).

Results

Factors predicting membership in postoperative trajectories indicating poor outcomes for disability, leg and back pain were comorbid depression (RR[95%CI]=3.70[1.53-8.90]; RR[95%CI]=3.79[1.11-12.94]; RR[95%CI]=3.78[1.11-12.88]), respectively, scoring moderate to severe on the Patient Health Questionnaire (RR[95%CI]=4.02[1.99-8.15]; RR[95%CI]=2.40[1.09-5.63]; RR[95%CI]=2.60[1.04-6.98], respectively) and previous drug use. Preoperative opioid use was associated with 2.51 (95%CI 1.22-5.20) times the risk of belonging to the poor outcome subgroup for disability and 3.77 (95%CI 1.40-10.18) times the risk for poor back pain outcome. Preoperative neuroleptic use was associated with 3.78 (95%CI 1.02-6.93) times the risk of poor leg pain outcome.

Patients with higher Mental Health Component Summary Scores (MCS-12) had 48% less risk of belonging to the subgroup with poor disability (RR[95%CI]=.52[.40-.68]) and leg pain (RR[95%CI]=.52[.37-.72]) outcomes, and 32% less risk of poor back pain outcomes (RR[95%CI]=.68[.50-.93]).

Additional risk factors were identified for poor disability outcomes: previous surgery (RR[95%CI]=2.08[1.23-3.54]), having fusion surgery (RR[95%CI]=2.45[1.51-3.99]) and being female (RR[95%CI]=1.92[1.20-3.06]).

Conclusions

It is time to look beyond pathology/surgical factors only and include mental health variables as an integral part of the surgical decision making process in an effort to avoid patients at increased risk for surgical failure.
A CSORN Study of the Change in Lumbar Lordosis and Sagittal Alignment with Operative Treatment for Lumbar Degenerative Spondylolisthesis

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Objectives

The object of this study was to evaluate the change in lumbar lordosis and sagittal vertical axis from the operative treatment of patients with lumbar degenerative spondylolisthesis.

Method

Consecutive patients at nine spinal centres were prospectively enrolled in a study evaluating the assessment and management of lumbar degenerative spondylolisthesis patients using the Canadian Spine Outcomes and Research Network (CSORN) database. Pelvic parameters included sacral slope, pelvic tilt, pelvic incidence (PI), sagittal vertical axis (SVA), lumbar lordosis (LL), and thoracic kyphosis. Primary outcome was change in LL and SVA at 6-18 weeks after surgery. Secondary objectives evaluated the effects of preoperative imbalance (SVA ≥50mm and LL < PI-9 degrees) and surgery type (decompression, fusion or interbody fusion) on postoperative spinopelvic alignment.

Results

A total of 341 patients were enrolled between January 2015 and September 2018. Cases not yet receiving surgery or with no radiographic measures were excluded leaving 195 patients. The average age was 65.7 years; most were female (60.0%); had grade I spondylolisthesis (73%) and had a single operated level (83%). Missing data ranged from 22% to 36%. Mean preoperative LL was 46.1±13.5⁰, PI was 56.7±13.1⁰, PT was 23.9±9.5⁰, and SVA was 31.8±40.5 mm (mean ± standard deviation). At 6-18 weeks, the mean LL increased by 2.3±10.9⁰ (n=176; P<0.001) and SVA decreased by -8.5±33.5 mm (n=117; P=0.003). All other measures did not differ after surgery. Preoperatively, 52% had PI to LL mismatch (LL< PI-9⁰) and 26% had significant sagittal imbalance (SVA ≥50mm). Postoperatively, 41% had LL < PI-9⁰ and 19% had SVA ≥50mm. Of the total cohort, 7.3% developed de novo PI to LL mismatch (LL < PI-9⁰), 33.9% had persistence of a LL < PI-9. Mal-alignment developed in 3.4% (SVA≥50mm) and 15.4% with SVA≥50mm pre-operatively remained imbalanced. Surgery type had a similar effect on spinopelvic alignment (P<0.05 for all parameters).

Conclusions

Mean SVA and LL improved after surgery. Most patients that had spinopelvic sagittal balance prior to surgery maintained balance.
Development CT-Ultrasound Fusion for Spinal Surgery

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Objectives

CT based navigation is the standard of care in spinal surgery. However, CT has limited ability to discern soft tissues, which can be altered and displaced during procedures. This investigation seeks to develop a spine-focused navigation workflow including ultrasound (US) images providing soft tissue discrimination in the context of CT images thereby overcoming challenges of US interpretation and localization paired with a rapid US beam universal pose calibration procedure.

Method

A Philips iU22 US system with a L9-3 transducer was instrumented with a custom infrared tracker for navigation with a StealthStation S7. The live US images were obtained using a video capture device (Epiphan DVI2USB 3.0). We developed an US plane calibration procedure whereby a optically tracked instrumented pointer intercepted the US beam at multiple locations, determining the ultrasound beam position in space. Our visual interface includes a real-time 3D view showing the US plane moving/slicing CT-generated bony anatomy (O-Arm, Medtronic). Live US images are shown fused with corresponding CT image planes. System performance was evaluated in a cadaveric porcine model. A posterior surgical approach was simulated with a midline dorsal incision exposing the spinal column and a laminectomy exposing soft tissues. The accuracy of the system was assessed by identifying five features on the dorsal side of the vertebral body in both modalities.

Results

The spine surgery workflow exhibited US-CT fusion intra-operatively, simultaneously displaying hard and soft tissue information. The accuracy of the system yielded a mean distance error of 1.6±0.6mm.

Conclusions

Visually the fused CT-US images showed good spatial correspondence of anatomical features of the bony spine. Given the sub-mm voxel spacing of CT, pixel spacing of US and accuracy of the navigation system, we expect inter-modality spatial correspondence can be further improved via a calibration procedure that better accounts for the US plane’s finite thickness. The accuracy and visualization demonstrated within this investigation are consistent with utility for disc resection, spinal cord decompression and visualization of pathology, ossification and burst fractures.
Comparing Baseline Characteristics of a Prospective Cohort of Patients Stratified by the Degenerative Spondylolisthesis Instability Classification (DSIC): Are all Slips the Same?

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Objectives

Recent randomized control trials have questioned whether spinal fusion surgery confers a significant therapeutic advantage to laminectomy alone in patients with degenerative spondylolisthesis. Many have challenged that patients are unique and that more of an individualized approach to surgical decision making is indicated. An instability classification (DSIC) was proposed to help guide this decision making. The purpose of this project was to determine whether the baseline characteristics of patients varied dependent on the DSIC classification.

Method

A prospective cohort of patients were enrolled from 16 different sites across Canada. Baseline demographic, patient reported outcome measures (PROMs), radiographic data were collected and global stability ratings were assessed based on the DSIC. The DSIC stratifies patients into three groups, type 1 (stable), type 2 (potentially unstable) and type 3 (unstable) with degenerative spondylolisthesis. Baseline data were then compared using SPSS software.

Results

There were 307 patients available for review. Type 1 patients were significantly older than type 2 or 3 patients (68 years versus 65 and 63 years, p=0.018). There were also a higher proportion of females in the type 3 cohort (74% vs 28%). Type 3 patients had significantly different/inferior SF-12 MCS, EQ-5D, PHQ-9 and ODI scores. There were no differences in SF-12 PCS, NDI leg or back pain scores. There were no significant differences in radiographic parameters between groups.

Conclusions

There are potentially significant baseline clinical differences in patients with degenerative spondylolisthesis. Although the post-operative surgical outcomes were beyond the scope of this study, there is some early evidence that future trials should account for these unique patient characteristics by appropriate stratification based on stability.
Morphological Variations within the Posterior Arch of the C1 Vertebrae of the Elderly

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Objectives

Implant fixation to the C1 vertebra remains a significant challenge for safe surgical intervention of atlantoaxial instability in the elderly population. There is a renewed interest in using the posterior arch for fixation to avoid critical neurovascular structures. The primary objective of this study is to examine the sagittal plane morphology of the posterior arch of C1 along the midline and lateral endpoints with the addition of slope in the coronal plane to identify anatomical variations and symmetries.

Method

100 CT scans of the cervical spine from patients aged $\geq$65 visiting the ER of Victoria Hospital from Nov 1 2017 to May 9 2018 were evaluated. In total, 77 CT scans of the cervical spine met the criteria for inclusion and were evaluated. Medical imaging and visualization software (3D Slicer-version 4.8.1) was used for measurement analysis. Measurements of height and width were taken at 8mm and 15mm from the midline of the posterior arch. Additionally, the superior slope angles of the left and right sides of the posterior arch in the coronal plane were also calculated. Statistical analysis was performed using Minitab. The mean and standard deviation were calculated for each measurement and paired t-tests with a 95% confidence level were used to determine the symmetrical relationships, if any.

Results

The measurement analysis did reveal lateral symmetry in height, width and slope angle of the posterior arch ($p>0.05$). However, significant variability in the height and width of the posterior arch in the sagittal plane was observed among patients. Three common shapes of the posterior arch were observed including tall and narrow, short and wide, as well as a more uniformly shaped posterior arch of C1.

Conclusions

This investigation identified morphological measurements and patterns in the anatomical variation of the C1 posterior arch not currently described in the anatomical literature including the new morphometric feature of slope. Atlantoaxial stabilization techniques may benefit from these findings.
Is Depression a Barrier to Achieving Full Benefit from Surgical Intervention in Chronic Thoracolumbar Spine Disease? A CSORN Study

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Objectives

Chronic spine disease is an increasing source of morbidity and pain. There are successful surgical interventions for some of these conditions. However, some reports describe worse outcomes after spine surgery in depressed patients. It is possible that depression prevents achievement of full pain or disability reduction benefit from surgical intervention. Therefore, the Canadian Spine Outcomes and Research Network (CSORN) registry was examined for differences in outcome after thoracolumbar surgery in degenerative spine patients with and without baseline depression.

Method

Chronic spine disease is an increasing source of morbidity and pain. There are successful surgical interventions for some of these conditions. However, some reports describe worse outcomes after spine surgery in depressed patients. It is possible that depression prevents achievement of full pain or disability reduction benefit from surgical intervention. Therefore, the Canadian Spine Outcomes and Research Network (CSORN) registry was examined for differences in outcome after thoracolumbar surgery in degenerative spine patients with and without baseline depression.

Results

3222 patients met inclusion criteria and had preoperative and 12-month outcomes. Although ODI was worse in depressed patients at baseline (54.6 [95%CI 53.7-55.5]) compared to nondepressed patients (43.7 [95%CI 43.1-44.3]; p=0.0002), net ODI improvement was slightly better postoperatively for depressed (-21.9 [95%CI -23.3 to -20.6]) rather than nondepressed patients (-18.9 [95%CI -19.8 to -18.1]) and was not inferior in any diagnosis subanalysis. While, back pain was worse at all timepoints and diagnoses in depressed patients (p<0.1), net back pain improvement did not differ between depressed and nondepressed patients (p>0.1). Leg pain did not differ between depressed and nondepressed patients at any timepoint or diagnosis (p>0.1).

Conclusions

Patients with a baseline mental health state consistent with major depression had worse disability and pain preoperatively, and at all time-points postoperatively, consistent with the theory that these patients represent a different population than non-depressed patients. However, they also had a similar net improvements in disability and back and leg pain compared to nondepressed patients indicating that they benefit similarly from surgical intervention.
The Effect of Peri-Operative Dexmedetomidine on Analgesic Outcomes in Adult Patients Undergoing Elective Spine Surgery: A Systematic Review and Meta-Analysis of Randomized Controlled Trials

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Objectives

Opioid use remains a significant problem in spine surgery patients in Canada and the United States. Specifically, 52% of patients undergoing elective thoracic and lumbar spine surgery have been shown to take opioids pre-operatively. Perioperative administration of dexmedetomidine (Dex) is emerging as a promising alternative to standard anesthetic protocols with opioid-sparing and sedative effects. The aim of this systematic review and meta-analysis was to investigate the effect of peri-operative Dex on opioid requirements and pain scores in patients undergoing spine surgery.

Method

Electronic databases, including MEDLINE, EMBASE and the Cochrane Library, were searched for randomized controlled trials (RCTs) that evaluated the effects of perioperative Dex on analgesic requirements intra- and post-operatively, and post-operative pain scores in adult patients undergoing elective spine surgery. Risk of bias was assessed using the Cochrane Tool.

Results

Eighteen studies enrolling a total of 1067 patients were included. Dex administration protocols included a pre-operative bolus followed by intra-operative infusion with or without post-operative infusion in patient controlled analgesia pump up to 48h post-operatively. Reported outcomes captured included: 0-10 pain rating scales up to 48h post-operatively (eight studies), intra-operative analgesic requirement (six studies) and post-operative analgesic requirement up to 48h post-operatively (five studies).

Conclusions

Dex is efficacious in spine surgery patients as a sedative and analgesic with opioid-sparing effects. Further study to investigate the spine surgery sub-population in which Dex has the greatest benefit and ideal administration protocol is required to optimize the effect of this medication and minimize opioid use in spine surgery patients.
Discrimination of Functional Limitations in Patients with Lumbar Spinal Stenosis (LSS) Using the ODI

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Objectives

The Oswestry Disability Index (ODI) is the most commonly used assessment of functional outcome in spine surgery. The purpose of this study was to determine the ability of the ODI to discriminate the functional impact of LSS and the impact of surgery on different functional limitations.

Method

Retrospective analysis of prospectively collected data on 237 LSS patients. The difference at baseline and the pre-to-post (1-year) surgical change of the ODI individual questions was assessed. Analysis of variance (ANOVA), the Pearson Chi-squared test or the Fisher exact test was used for group comparisons. Two-tailed paired sample Student’s t-test was used for within group comparisons. Cohen d was used as an index of effect size, defined as "large" when $d \geq 0.8$

Results

51% of the patients were male with a mean age of 67 (range 33-88). At baseline, highest functional limitations were noted for standing, walking, lifting and social life (median 4, 3, 3 and 3/5 respectively). At 1-year follow-up, there was a significant decrease in all individual questions and the overall ODI (mean pre/post = 42.5/32.2) (all $p<0.001$). The greatest effect of surgery was noted in the standing, walking and social life domains (all $d \geq 0.84$), while lifting, personal care, sitting and sleeping showed the least improvement (all $d \leq 0.52$). Preoperatively, females had a significantly higher score for lifting, sitting, sleeping, employment/homemaking and total ODI compared to males (all $p \leq 0.043$). However, these differences were largely attenuated by surgery and the only significant difference remaining was a higher score for sleeping ($p=0.014$).

Conclusions

The results of this study support the ability of the ODI to discriminate the different self-reported functional effects of LSS and the changes associated with surgical intervention. Disaggregated use of the ODI could be a simple tool to aid in preoperative education regarding specific areas of dysfunction and potential for improvement by surgery.
A Comparison of Functional and Quality of Life Improvement in Six Different Types of Surgery in a Pan Canadian Database

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Objectives

Patient centred outcomes can be used to rank surgical indications by rate of success for improving patient quality of life (QOL) and function. The objective of this study is to compare the outcomes of common lumbar spinal surgical procedures to each other.

Method

To determine the efficacy of different types of surgical indications across Canada, we examined patient EQ-5D and ODI improvements of 6 common lumbar surgical indications in the CSORN database. The surgeries included 1) discectomy for radiculopathy, 2) artificial disc for degenerative disc disease, 3) spinal fusion for degenerative disc disease, 4) decompression and fusion for degenerative spondylolisthesis, 5) simple decompression for spinal stenosis, and 6) spinal fusion for degenerative scoliosis. Improvements from baseline were assessed at 3, 12 and 24 months. T-tests were used to determine patient improvement. EQ-5D outcomes were compared to published data for total hip and knee replacement.

Results

Table 1: Improvement in QOL (EQ-5D) and Function (ODI) with 6 Surgical Indications

<table>
<thead>
<tr>
<th>Surgical Indication</th>
<th>Improvement in EQ-5D</th>
<th>N (12m)</th>
<th>Improvement in ODI</th>
<th>N (12m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Discectomy for radiculopathy *</td>
<td>0.289</td>
<td>199</td>
<td>25.5</td>
<td>31.8</td>
</tr>
<tr>
<td>2) Artificial disc for degenerative disc disease</td>
<td>0.203</td>
<td>70</td>
<td>16.7</td>
<td>21.5</td>
</tr>
<tr>
<td>3) Spinal fusion for degenerative disc disease</td>
<td>0.181</td>
<td>66</td>
<td>14.5</td>
<td>20.7</td>
</tr>
<tr>
<td>4) Decompression and fusion for degenerative spondylolisthesis</td>
<td>0.255</td>
<td>124</td>
<td>21.3</td>
<td>20.2</td>
</tr>
<tr>
<td>5) Simple decompression for spinal stenosis</td>
<td>0.197</td>
<td>156</td>
<td>18.4</td>
<td>16.8</td>
</tr>
<tr>
<td>6) Spinal fusion for degenerative scoliosis</td>
<td>0.1487</td>
<td>23</td>
<td>-2.2</td>
<td>9.7</td>
</tr>
</tbody>
</table>

*p<=0.05

Sample size varied depending on time point and were as low as 12 for group 6 at 24m.

Conclusions

While surgical outcomes vary widely, within this study, discectomy was found to be the statistically superior surgery for restoring quality of life and function. Simple decompression for spinal stenosis, and spinal fusion for degenerative scoliosis consistently demonstrated the poorest outcomes. Total hip and total knee typically demonstrate QOL improvements of 0.31 and 0.22 on the EQ-5D. The majority of spine surgeries in our list produce results similar to hip and knee arthroplasty. Careful patient selection is required for decompression and adult scoliosis surgery.
Variability in Minimal Important Difference in Spinal Surgery Outcome Measurement

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Objectives

Investigate changes in patients’ minimally important differences (MID) over recovery from spinal surgery and how cognitive appraisal processes are implicated in the change trajectories.

Method

Longitudinal cohort study with up to 12 months follow-up after spinal surgery. Patient reported outcome measures included the Rand-36 Physical and Mental Component Scores (PCS and MCS), Oswestry Disability Index (ODI), Pain Numeric Rating Scale Items (at rest, with activity, back and leg), PROMIS Pain Impact, Global Assessment of Change (GAC), The QOL Appraisal Profile Standards of Comparison Items measured cognitive appraisal processes.

MID was determined with both a distribution based (Cohen effect size) and anchor based technique (GAC). Mean MID change was determined at each follow-up time point for “somewhat better’ patients determined by GAC and was measured compared to last time point and to baseline.

Patients were grouped by pattern of GAC at each time point into three trajectories of outcome: better (i.e., better, better, better), worse (i.e., worse, worse, worse, worse), bouncers (e.g., better, worse, better, worse, better). Linear slope (trajectory) scores over time for each PRO and appraisal score were computed using regression models. Z-score comparison of correlation coefficients tested the hypothesis that GAC groups differed in the relationships between QOL change and appraisal change over time.

Results

Among spine surgery patients experiencing improvement over time, moderate to large changes are recognized as clinically important in the early stages of recovery (i.e., 6 weeks post-surgery). Over time smaller and smaller changes become important. The better group had larger slopes across all PROs, compared to the worse and bouncer groups. Trajectory groups emphasized and de-emphasized different standards of comparison over time. Group differences translated to differential relationships between PRO change and appraisal changes over time.

Conclusions

Soon after surgery, MID is moderate to large. With time from surgery, smaller and smaller changes become clinically significant. Underlying differences in appraisal may influence how patients experience the same change over time creating instability in MID.
Impact of Pre-Surgical Self-Reported Exercise on Post-Surgical Outcomes in Patients with Cervical Pathology

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Objectives

It is unknown if pre-operative self-reported exercise frequency is a predictor of cervical spine surgery outcomes. We hypothesize that patients who report exercise prior to cervical spine surgery will demonstrate less pain, improved health state and/or less disability following surgery compared to patients who do not exercise.

Method

Retrospective review of prospectively collected data from the CSORN registry. Inclusion criteria: elective adult cervical surgery patients with degenerative pathology. Outcome measures: visual analog scales (VAS) for neck and arm pain, Neck Disability Index (NDI), and EuroQOL health state at baseline and 3, 12 and 24 months post-op (n=460). Exercise frequency was self-reported as “none” (n=212) versus “some” (n=248), and further subcategorized into “none” secondary to physical limitations or not, and exercising “≤1/week” or “≥2/week.” Statistics: student’s t-tests to compare mean scores of the outcome measures, and ANOVA for subgroup comparisons (p<0.05).

Results

Those who reported “some” exercise had more favorable VAS neck and arm pain scores pre-operatively (neck: 5.55 vs 6.11, p<0.001) (arm: 5.69 vs 6.04, p=0.011), but no difference at 3 and 24 months post-operatively. Significantly lower NDI scores and higher EuroQOL Index scores were seen in the exercise group compared to the no exercise group pre-operatively (NDI: 39 vs 48, p<0.001) (EuroQOL: 0.60 vs 0.50, p<0.001) as well as at 3, 12, and 24 months post-op (NDI: 24 vs 31, p=0.007) (EuroQOL: 0.75 vs 0.68, p=0.001). Further subgroup analysis demonstrated that compared to the “no exercise due to physical limitation” group, the “twice or more per week” exercise group showed favorable NDI and EuroQOL scores up to 24 months post-op (NDI: 24.32 vs 32.33, p=0.001) (EuroQOL: 0.76 vs 0.66, p=0.001), whereas the “once or less” group no longer demonstrated any significant difference at 24 months.

Conclusions

Self-reported exercise prior to cervical spine surgery does not predict improved long-term neck and arm pain at 2 years post-op. However, self-reported exercise does demonstrate less disability and improved health state at baseline and up to 2 years post-op and this relationship is dose dependent.
Comparing the Efficacy of Three Types of Spinal Orthoses on Balance and Walking Ability in Patients with Thoracic Kyphosis Secondary to Osteoporosis

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Objectives

Introduction: Osteoporosis is a common orthopedic condition mostly in elderly women which potentially could lead to many clinical problems such as increased risk of vertebral fracture, hyperkyphosis, poor balance, and decreased functional mobility and quality of life. Most often, different spinal orthoses are prescribed for rehabilitation after vertebral fracture and spinal kyphosis. The aim of this study was to evaluate the influence of three widely used orthoses on postural stability and gait in people with post-osteoporosis thoracic kyphosis.

Method

29 women (aged between 55 to 75) voluntarily participated in this study. Two force platforms (KISLER) were used to collect data. Outcome measures included center of pressure (COP) medio-lateral and posterior-anterior displacement, step length, step width and cadence. Tests were performed in four conditions in random sequences including using 1- no orthosis, 2- Spinomed orthosis, 3-Posture training support (PTS), 4-Posterior shell thoracolumbosacral orthosis (TLSO).

Results

All orthoses resulted in decreased COP displacement in medio-lateral and anterior-posterior directions and increased step length, step width and cadence in participants (P<0.05). Also, no significant difference was seen in gait characteristics while patients used three types of orthoses (P>0.05). However, COP displacement in both directions was significantly less using posterior shell TLSO compared to Spinomed orthosis and PTS.

Conclusions

Finding of the present study showed that all three types of orthoses could improve postural stability and gait ability in elderlies with post-osteoporosis thoracic kyphosis, although posterior shell TLSO may more affect the postural control compared with the two others.
Pediatric Spinal Cord Injury in Canada

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Objectives

The objective of this project was to describe pediatric spinal cord injury (SCI) in Canada, examine the state of pediatric SCI research, identify knowledge gaps, priorities and opportunities, and estimate pediatric incidence for future research.

Method

Stakeholders were recruited as informants on the Canadian pediatric SCI research landscape using snowball sampling. Informants were interviewed or completed a questionnaire regarding awareness, priorities, and gaps in pediatric SCI research. Both traumatic (tSCI) and non-traumatic pediatric SCI was included. A thematic analysis was performed by coding key points and collating them into themes. Administrative data from the Canadian Institute for Health Information was used to identify incident tSCI cases.

Results

The response rate was 54% (61/114); 33 participants completed an interview or questionnaire. Participants represented five provinces and included clinicians, administrators, researchers (including clinician researchers), consumers (parents) and community organizations. Very few centres conduct research in pediatric SCI. Of those conducting research, topics included: ambulation/mobility, adaptive equipment, wheelchair skills, and urological studies. There are no multi-centre studies; single centre studies include participants with other neurological conditions and adults. The incidence of tSCI in children under 4 years of age was estimated to be 1.6/million, increasing to 28.3/million in adolescence, 15 to 19 years of age.

Priority areas for research included: standards to classify injury level and severity, creation of a Canadian pediatric registry, creation of pediatric-specific outcome measures and determining impact of treatment on long-term outcomes. Acute care priorities included research on functional recovery of the cord, timing of surgical interventions and tissue engineering.

Conclusions

No pediatric SCI network exists; most individuals are unaware of what others are doing in Canada. A pan-Canadian, multi-stakeholder platform, similar to what is available for adult SCI is needed to drive evidence-based research and care. It is intended that the project will serve as a call to action for the pediatric SCI community.
Predicting the DSIC Scheme Grade using Machine Learning: A CSORN Study

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Objectives

Degenerative lumbar spondylolisthesis (DLS) is a common condition with many available treatment options. The Degenerative Spondylolisthesis Instability Classification (DSIC) scheme was proposed by Simmonds et al. in 2015 and proposes that the stability of the pathology be determined by a surgeon based on clinical and radiographic parameters. The purpose of this study is to classify DLS patients according to the DSIC scheme using machine learning, offering a novel approach in which an objectively consistent system is employed.

Method

The data, which included 224 DLS CSORN cases, was cleaned by two methods: deletion and imputation. The machine learning models, namely, logistic regression, boosted trees, random forests, support vector machines, and decision trees, were built, trained, and tested using Python-based, sklearn-learn and pandas libraries respectively. Both data sets were tested. The matplotlib library was used to graph the ROC curves, including the area under the curve.

Results

The machine learning models were all able to predict the DSIC grade. Of all the models, the support vector machine model was best, achieving an area under the curve score of 0.82. This model achieved an accuracy of 63% and an F1 score of 0.58. When comparing both data cleaning methods, the imputation method had higher areas under the curve overall, however, their accuracies, recalls, precisions, and F1 scores were similar.

Conclusions

The models were able to effectively predict physician decision making and score patients based on the DSIC scheme. The support vector machine model was able to achieve an area under the curve of 0.82 compared to physician classification. Since the data set was relatively small, the results could be improved with training on a larger data set. The use of machine learning models in DLS classification could prove to be an efficient approach to reduce human bias and error. Further efforts are necessary to test the inter- and intra-observer reliability of the DSIC scheme, as well as to determine if the surgeons using the scheme are following DLS treatment recommendations.
Surgical Simulator for Spinal Decompression

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Objectives

Spinal stenosis is a condition resulting in the compression of the neural elements due to narrowing of the spinal canal. Spinal decompression surgery requires appropriate planning and strategies depending on the specific situation. Given the potential for neural complications, there exists significant barriers to residents and fellows obtaining adequate spinal decompression experience. Virtual surgical teaching tools exist but they do not simulate the many challenges of spinal decompression.

The aim of this work was to develop a spinal decompression specific open-source 3D virtual simulator as a teaching tool to improve orthopaedic training.

Method

A spinal decompression simulator was built using 3D Slicer; an open-source software platform for medical image visualization and processing. The procedural steps include import of patient-specific imaging, fusion of Computed Tomography (CT) and Magnetic Resonance Imaging (MRI), bone threshold-based segmentation, soft tissue segmentation, surgical planning, surgical field simulation, and simulation of laminectomy, and spinal decompression. Bone and soft tissue resecting tools were developed by customizing manual 3D segmentation tools. Laminectomy simulation was enabled through bone and ligamentum flavum resection at the site of compression. Neural element decompression was simulated by interpolation of the un-deformed anatomy above and below the site of compression.

Results

The completed workflow allows patient specific simulations of decompression procedures by staff surgeons, fellows and residents. Procedural accuracy, the surgical exposure, the design of resecting tools, and modeling of the impact of bone and ligament removal was found to adequately encompass important challenges encountered in decompression surgery. Visualization of decompression, tissue resection and positioning can be evaluated after completing the virtual procedure.

Conclusions

This software development project has resulted in a well-characterized accessible tool for simulating spinal surgery that a trainee can review alone or with a preceptor to improve their skills. Future work will integrate and evaluate the simulator within existing orthopaedic resident competency-based curriculum and fellowship training instruction. Best practices for effectively teaching decompression in tight areas of spinal stenosis using virtual simulation will also be investigated in future work.
Design, Development and Testing of a Novel Stand-alone Interbody Fusion Device

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Objectives
The gold standard for posterior lumbar fusion (PLIF) involves an invasive procedure requiring four pedicles screws, two rods and two inter-body cages. We have developed a novel device for fusion, eliminating the need for pedicle screws with the aim of achieving a comparable degree of fusion inserted through minimally invasive technique.

Method
A team of experts consisting of biomedical and biomechanical engineers and surgeons was assembled to undertake this project and the stand-alone cage was designed using computer assisting drawings and manufactured in titanium by 3D printing. Biomechanical testing comparing the stand-alone cage with standard PLIF was carried out both in sawbones (n=6) and cadavers (n=8) with each model being composed of one functional spinal unit (FSU). Three range of motion loading protocols were subsequently applied to the FSUs in the form of a flexion/extension moment, an axial rotation moment, and a lateral bend moment with a constant axial load throughout. An optical tracking system was used to quantify the ROM in response to the force applied.

Results
Compared to PLIF, the stand-alone cage demonstrated no significant difference in range of flexion, lateral bend or axial rotation in sawbones; however, significant increase in range of extension was observed. Amongst cadavers, the stand-alone cage demonstrated a significant increase in range of motion (ROM) for flexion, extension, lateral bending to the right and total lateral bend ROM; but no significant increase to ROM in axial rotation.

Conclusions
Biomechanical comparability to PLIF was achieved in Sawbones testing with the exception of extension, however the significantly increased ROM observed in cadaveric testing has driven further design modifications to improve construct stability.
A Canadian Experience with Halo Vest Treatment for Cervical Spine Trauma, Risk Factors and Complications

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Objectives

Halo Vest for treatment for cervical spine problems can help avoid surgery for the appropriate patients. However, the literature is unclear about the complication rate and risk factors associated with Halo vest treatment. Here we present our experience for Halo vest treatment at our institution.

Method

We conduct a retrospective analysis of prospectively collected data for all patients treated with Halo vest as definitive treatment at our institution between January 2000 and 2018. All complications were analyzed and documented as patient characteristics that can account for high risk for complication such as past medical history, age, gender and fracture type. A logistic regression was used to identify risk factors and student T test was used to compare means.

Results

This section presents preliminary results to finalize. A total of 750 patients were identified in our database. 347 were males and 403 females with average age of 63 (range 18-91). The average complication rate was 19% and 16% were minor and 3% were major. The majority of minor complication were pin site infection and pin loosening in approximately 50% of minor complications. Failure of Halo treatment requiring surgical intervention was seen in approximately 10% of reviewed cases. Different risk factors were analyzed with logistic regression and will be presented at the conference. Age and co morbidities were analyzed.

Conclusions

Here we present results for Halo Vest treatment used as definitive management at our institution. At our institution we have bi weekly follow-ups for patients with Halo Vest and show that complication rates can be lower than shown in the literature, 19% in our study with the majority being minor complications. Therefore, although no definite conclusion can be made, our results shows that Halo Vest can be used routinely with low complication rates if adequate follow-up is maintained.
Comparing the Prognostic Performance of Area under the Curve and F1-Score using a National Surgery Database

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Objectives

Commonly, the Receiver Operator Characteristics Curve with the associated Area under the Curve (AUC) is used to assess the performance of prediction models developed on large, multi-centric databases. However, it has been found that a precision-recall curve with the associated F1-score could provide a more realistic analysis for these models. The purpose of this project was to determine if there exists any differences between the AUC vs. F1-score using a national surgical database for the prediction of complications during spine surgery.

Method

In order to develop the logistic regression (LR) model used to predict a complication during spine surgery, 26 variables were selected by three Orthopedic spine surgeons from the NSQIP registry. Diagnostic performance of the model was then assessed by determining both the AUC and the F1-score, which were then compared to the AUC and F1-score for the down-sampled dataset.

Results

Within the NSQIP database, 52787 spine surgery cases were identified in which only 10 percent of these cases had complications during surgery. Applying the LR model, there was a statistically significant difference between the AUC (0.86) and the F1 score (0.45) for the original dataset (p<0.05). However, there was no statistically significant difference between these two values when we balanced the dataset and then reapplied the LR model (p>0.05).

Conclusions

The F1-score was found to have a significantly lower performance for the prediction of complications when using the imbalanced data, but improved to the AUC level when balancing techniques were utilized. This is most likely due to a low precision score when there are a lot of false positive classifications, which is not identified when using the AUC value. Therefore, it is the recommendation of this paper to use the F1-score on large, prospective databases when the data is imbalanced due to a large amount of negative classifications.
Exposure to a Motor Vehicle Collision and the Risk of Future Neck Pain: A Systematic Review and Meta-Analysis

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Objectives

Neck injury resulting from a motor vehicle collision (MVC) is associated with a high rate of chronicity with 50% still reporting neck pain (NP) a year after initial injury. These statistics are difficult to interpret due to the high prevalence of NP in the general population without a history of MVC-related injury. The purpose of this study is to review the literature that has examined the association between an MVC-related neck injury and future NP in comparison with the population that has not been exposed to neck injury from an MVC.

Method

We performed a systematic review of the literature using five electronic databases, searching for NP risk studies published from 1998 to 2018, describing adults 16 years of age and older exposed to a MVC. The outcome of interest was future NP. Eligible risk studies were critically appraised using the Quality in Prognosis Studies (QUIPS) instrument. The results were summarized using best-evidence synthesis principles and a random effects meta-analysis was performed with the pooled data.

Results

The search resulted in the identification of 8955 potentially related articles, of which eight were sufficiently relevant for critical appraisal, and seven of these were found to have low risk of bias. Six of the seven studies reported a positive association between a neck injury in an MVC and future NP. Pooled analysis of the six studies indicated an unadjusted relative risk of future NP in the MVC exposed population with neck injury of 2.3 (95% CI [1.8, 3.1]), which equates to a 57% attributable fraction. In two of the seven studies that examined exposure to a rear-end collision in which the participants were either not injured or injury status was unknown, there was no increased risk of NP in comparison with the control group.

Conclusions

There was a consistent positive association among studies that have examined the association between MVC-related neck injury and future NP. These findings are of potential interest to clinicians, insurers, patients, governmental agencies, and the courts.
Patterns and Predictors of Functional Recovery from the Subacute to the Chronic Phase Following a Traumatic Spinal Cord Injury: A Prospective Study

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Objectives

To determine the extent of functional recovery between 6- to 12-months following a traumatic spinal cord injury (tSCI) and to identify individuals achieving a small clinical functional improvement during that period.

Method

Design: A prospective cohort study

Setting: A single Level-1 trauma center specialized in SCI care

Subject: 125 patients sustaining tSCI

Interventions: Not applicable

Main measures: The Spinal Cord Independence Measure (SCIM) version III at 6- and 12-months post-injury

Results

The observed functional improvement for the total cohort did not reach a clinically significant level between 6- and 12-months post-injury. However, 30.4% of individuals achieved this level (≥4 points in the SCIM-III total score) during that period. A significant number of them (50.6%) sustained a motor-complete SCI (AIS grade A or B). Longer duration of intensive functional rehabilitation was the main factor associated with reaching a small clinically important improvement in the SCIM-III total score.

Conclusions

Functional status between 6- and 12-months following a tSCI may be considered clinically similar, regardless of the level of injury. However, many patients showed a small clinical functional improvement in the return to community phase, particularly individuals sustaining severe deficits, which may highlight the importance of functional compensation and support during that period.
Machine Learning to Predict a Single Patient Clinical Course: How Will Your Life Change After a Diagnosis of Degenerative Cervical Myelopathy?

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Objectives

Machine learning (ML) algorithms provide a powerful conceptual and analytic framework capable of integrating multiple data types and sources which may more effectively model neurobiological components of the pathophysiology of Degenerative cervical myelopathy (DCM). We have developed a ML algorithm to predict the clinical course of 120 patients with DCM.

Method

Patients with DCM were enrolled in the prospective CSORN (Canadian Spine Outcomes Research Network) registry, limited to a single centre (Calgary) over the past 2 years. An ML algorithm was developed using CSORN patient derived clinical data. Due to the small sample size, a leave-one-out cross validation approach was implemented. The performance of several machine learning algorithms were compared, including random forest, support vector machine, neural network and decision tree. The analysis was then run to attempt to predict improvement (score difference>1) vs stable (score difference between 0 and 1 included) vs deterioration (score difference<0) in the modified Japanese orthopaedic association score (mJOA).

Results

Of 158 patients (107 male; mean age 59.54 ±12.64 years), 125 (79%) underwent surgery. Baseline assessment showed a mean mJOA of 13.25 (95%CI 12.88, 13.63). At 3 months follow-up, 120 (76%) patients were available for functional assessment. Forty seven percent of the patients improved, 37% stayed stable and 16% deteriorated. Preliminary results favor the neural network algorithm with a performance accuracy of 50%. Subsequent attempts at refining the model resulted in a predictive capability of 59%, suggesting that the current model is unable to differentiate sufficiently between those patients who improve and those that remain stable.

Conclusions

We have developed a machine learning algorithm using only baseline clinical characteristics. Clinical features and operative details alone do not reliably predict clinical course in DCM. To improve our ability to predict clinical course, we are in the process of extracting features from baseline clinical images. This will include image segmentation and then extracting metrics from the segmented regions.
Anterolateral Cervical Kyphoplasty for Metastatic Cervical Spine Lesions

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Objectives

Even though the spine overall is the third most common site of metastasis, the cervical spine is affected the least with an incidence of 10-15%. Surgical decompression is highly challenging because of the proximity of neural and vascular elements. Kyphoplasty for cervical spine metastasis was described in small case reports with promising results. The objective of this retrospective study is to evaluate the clinical and radiological efficacy of anterolateral kyphoplasty for cervical spinal metastasis.

Method

Retrospective analysis of a prospective collected single center spine metastasis database was done for cervical kyphoplasty cases. Demographic data included age, sex and origin tumor diagnosis. Other variables included modified Tokuhashi score, SINS score, preoperative VAS score, analgesic medication of the patients and opioid use. Postoperative data included postoperative day 1 VAS, duration of hospitalization, self-reported functional outcome, last follow-up VAS.

Results

11 patients with cervical spine metastases were treated with 15 levels kyphoplasty with a mean age of 62.5 years. Tokuhashi score was 8.1 and SINS score was 7.85. Preoperative pain was 7.1 and the number of preoperatively consumed analgesics was 1.8 with 82% of patients using opioids. Total bleeding volume was 100 ml. Mean complication free length of stay was 2.6 days with a decrease of postoperative pain (VAS=2.8; p<0.05). There was a 56% decrease of opioid dosage and the number of consumed analgesics (1.09; p=0.004). 82% of the patients reported excellent improvement on last follow-up self-assessment.

Conclusions

This series represents the largest series of vertebral augmentation using balloon kyphoplasty for cervical spinal metastasis. This technique is associated with low postoperative complication, significant decrease in patients’ pain, use of opioids and shorter hospital length of stay. The main indications for vertebral kyphoplasty are: lytic lesions of the cervical spine and painful lesions refractive to medical treatment.
Pedicle Screw Resistance: A Crucial Component for Intraoperative EMG Neuromonitoring

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Objectives

Evoked (AKA “triggered”) electromyographic (EMG) monitoring of pedicle screws has been shown to be an effective adjuvant to image guidance or direct visualization of pedicle screw placement. In this technique, electrical stimulation is delivered to the head of the pedicle screw at various intensities until a compound muscle action potential is evoked. This practice is based on the fact that the electrical resistance of bone is greater than that of fluid or soft tissue, such that an intact pedicle effectively shields nerve roots from the electrical stimulus. Several factors have been debated that may affect the interpretation of results; however, to the best of our knowledge, the electrical resistance of modern manufactured pedicle screws and stimulation devices has not been studied. The objective of this study was to determine if pedicle screw resistances allows for triggered EMG to be a useful test.

Method

Samples of the most commonly implanted pedicle screws in Canada were obtained, with diameters ranging from 4.5 to 7 mm. The resistance between the screw head and thread and core at the midpoint and tip of the screw was recorded using a Fluke Multimeter (Fluke Corporation, Singapore) in accordance with IEEE (Institute of Electrical and Electronics Engineers) standards. For screws with variable threads, the midpoint was considered the point at which the thread pitch changed. We also tested 5 types of pedicle probes, including the associated cables. The average of five measurements was used to determine the resistance in Ohms.

Results

All screws had low impedances when tested at the point of the screw, but much higher when the cup is tested. The resistance of different manufactures’ screws was significantly different, ranging from 0.514 to 2156 Ohms. The probes and cables also have some resistance, each tested low (about 0.01 Ohms) and differences were not significant.

Conclusions

Despite differences in resistance, most screws had resistances in ranges that allow for triggered EMG pedicle integrity testing.
Prognostic Factors of Lumbo-Sacral Spinal Metastasis: Single Center Experience

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Objectives

Spinal metastases are seen in 10-30\% of cancer patients. Twenty percent of these metastases occur in the lumbo-sacral spine. Lumbo-sacral spine has different mechanical properties and encloses the cauda equina. Few studies take interest in this spinal segment. The objective of this study is to evaluate prognostic factors of lumbo-sacral spinal metastasis treated in our center.

Method

We retrospectively reviewed 376 patients who were operated in our center from 2010 to 2018. Eighty-nine patients presented lumbo-sacral metastases and thus were included. Data collected included age, smoking, tumor histology, American spinal injury association (ASIA) score, modified Tokuhashi score, modified Bauer score, ambulation status and adjuvant treatment.

Results

The mean population age was 60.9 years old (35-85). The tumor histology was predominantly lung (19 patients, 21.3\%), breast (13 patients, 14.6\%), kidney (11 patients, 12.4\%) and prostate (9 patients 10.1\%). Twenty-two patients (24.7\%) were unable to walk preoperatively. Seventy-nine patients (88.8\%) underwent a posterior open approach with corpectomy in 65 patients (73\%). Eighteen patients regained ambulation post-operatively (81.8\%). The mean survival was 24.03 months (CI95\% 17.38-30.67; Range 0-90) and the median of survival was 9 months (CI95\% 4.38-13.62). Better preoperative ASIA score had a significant favorable effect (p=0.03) on survival. Patients who regained their ability to walk had better survival (25.1 months (CI95\% 18.2-32.0) VS 0.5 months (CI95\% 0-1.1). Postoperative radiotherapy had a benefic effect on survival (p=0.019): Survival Increased from 10.5 months (CI95\% 2.4-18.7) to 27.6 months (CI95\% 19.5-35.8). The modified Tokuhashi and the modified Bauer scores underestimated the survival of the patients with lumbar-sacral metastases.

Conclusions

Lumbosacral spinal metastases has better survival than expected by Tokuhashi and Bauer score. Surgical procedures have an important impact on survival and the ability to walk.
Development of an Unsupervised Machine Learning Algorithm for the Prognostication of Walking Ability in Spinal Cord Injury Patients

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Objectives

The van Middendorp logistic regression model for the prediction of walking recovery following spinal cord injury (SCI) has been validated within multiple different countries. However, it has been found that this model’s prognostication is lower for ASIA Impairment Scale (AIS) B and C patients. Also, unsupervised machine learning algorithms have improved predictive performance compared to logistic regression. The purpose of this project was to develop an unsupervised machine learning algorithm for the prediction of walking recovery using a Canadian multi-centre database.

Method

All patients enrolled between 2004-2017 with complete neurological examination and Functional Independence Measure (FIM) outcome data at ≥1 year follow-up or could walk at discharge were included. The prognostic variables included were: age (dichotomized at ≥65 years old); AIS grade; and individual motor, light touch, and pinprick score from L2-S1. Performance of this algorithm was assessed using \( k \)-mean clustering to determine the confusion matrix and the diagnostic performance of the model was assessed by determining the associated AUC and F1-score. Comparison was made to the van Middendorp model.

Results

The AUC scores for all AIS grades, AIS A+D, B+C, A, B, C, and D were 0.89, 0.95, 0.73 0.79, 0.69, 0.72, and 0.46, respectively and for F1-scores were 0.89, 0.96, 0.74, 0.67, 0.70, 0.79, and 0.87, respectively. There existed no statistical differences between the AUC or F1-scores between our model and the van Middendorp model (\( p>0.05 \)). Also, no differences were found when comparing the AUC to the F1-score (\( p>0.05 \)).

Conclusions

There exists no difference when adding more neurological information and using an unsupervised learning algorithm for the prediction of walking recovery in spinal cord injury patients, as compared to the current standard. Therefore, future work should focus on determining if using other clinically relevant features would improve the prediction accuracy for all AIS grades.
Initial Canadian Evaluation of a Novel System for Lumbar Herniated Disc Repair

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Objectives

Repair of annulus fibrosus defects at the time of discectomy has been proposed as a potential means of reducing the rate of recurrent disc herniations. Our translational bench-to-clinic research group previously validated ex- and in-vivo pre-clinical (animal) performance of a 2-0 non-absorbable-polyethylene suture based implant designed for this purpose. In the present study we report initial clinical feasibility of the technology on Canadian patients.

Method

Procedures were completed at two Canadian surgical centres between 29-Jan-2017 and 16-May-2018. Eligible patients were offered the suture repair or not based on clinical considerations including patient and MRI factors. Intra-operatively, repair was attempted using the AnchorKnot® Tissue Repair Kit if the annulus fibrosus tissue defect appeared competent and accessible for functional repair. Repair was considered successful if the defect margins were approximated and the suture was knotted in place. Routine post-surgical follow-up was completed at 6 weeks to assess for symptoms or other complications.

Results

Twenty-eight patients were considered for herniated disc repair. Implant delivery was attempted in 18 patients and was successful in 15 (83%). Repair was not attempted for 10 patients based on intraoperative assessment of the defect. Reasons for not attempting or failing to complete a repair included; narrow disc height, annular detachment from the endplate, inaccessible defect margins, and friable tissue at the defect margin. There were no adverse events reported through 6 weeks.

Conclusions

Anatomic, tissue and defect characteristics appear to be key considerations during intraoperative assessment of potential reparability. The average time to deploy the implant was approximately 5 min (6 ± 3 min). Our initial Canadian experience suggests that this herniated disc repair strategy is feasible when applied to appropriate patients based on preoperative and intraoperative evaluation. We recognize that a comprehensive evaluation will require ongoing clinical follow-up to assess disc reherniation rates from both an imaging and clinically relevant perspective in regards to recurrent radicular leg symptoms. Further study is planned to investigate the impact of this technology on imaging, re-herniation and surgical revision rates.
Neck and Arm Pain After Surgery for Cervical Myelopathy: Outcomes and Predictors of Improvement

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Objectives

This study aims to describe the change in neck and arm pain in response to surgical decompression in patients with cervical spondylotic myelopathy (CSM)

Method

This is an ambispective study of data collected through the Canadian Spine Outcomes and Research Network, including patients with CSM who underwent surgical decompression. Outcome measures were the visual analogue scales for neck and arm pain (VAS-NP and VAS-AP) and the neck disability index (NDI) at baseline as compared to that at 3 and 12 months postoperatively. The thresholds for minimum clinically important differences (MCIDs) for VAS-NP and VAS-AP were determined to be 2.6 and 4.1, respectively, as per the literature.

Results

402 patients with mean age of 59.7±12.3 years and 35.6% being females were included. VAS-NP improved significantly from mean score of 5.6±2.9 at baseline to 3.6±2.4 and 3.8±2.7 at 3 and 12 months, respectively (P<0.001). Similarly, VAS-AP improved from 5.8±2.9 to 3.3±2.8 and 3.5±3.0, respectively (P<0.001). The MCIDs for VAS-NP and VAS-AP were also reached at 3 and 12 months. Based on the NDI (n=370), patients were grouped into those with mild pain/no pain (33%) versus moderate/severe pain (67%). NDI data were available for 331 and 213 patients at 3 and 12 months, respectively. At 3 months, a significantly high proportion of patients with moderate/severe pain (45.8%) demonstrated an improvement into mild/no pain, whereas 27.2% of patients with mild/no pain had worsening into moderate/severe pain (X²=20.5, P<0.001). At 12 months, only 17.4% with mild/no pain experienced worsening of their NDI versus sustained improvement in 45.3% of patients with moderate/severe pain (X²=26.3, P<0.001). Male gender and higher baseline VAS-NP were significant predictors for 1 point improvement in VAS-NP at 12 months.

Conclusions

This study suggests that neck and arm pain responds to surgical decompression in patients with CSM and reaches the MCIDs for VAS-AP and VAS-NP at 12 months postoperatively.
**Surgical Intervention for Patients with Spinal Metastasis from Lung Cancer**

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**Objectives**

Spine is the most common site of metastatic lesions in patients with lung cancer. The prognosis of these patients is worse than other cancers. There were few studies about prognostic factors and benefits of surgical intervention in lung cancer patients with spinal metastases.

The objective of this study is to evaluate prognostic factors of spinal metastasis from lung cancer operated in our center.

**Method**

we retrospectively reviewed 74 lung cancer patients with spinal metastases who were operated in our center from 2008 to 2018. 45 patients with full follow up were included. Data collected included age, smoking, American spinal injury association (ASIA) score, modified Tokuhashi score, ambulation status and adjuvant treatment.

**Results**

The mean population age was 62.38 years old (36-79). 36 patients (80%) underwent a posterior open approach with corpectomy and 9 patients (20%) underwent laminectomy and resection of the tumor without corpectomy. The mean survival was 11.12 ± 6.76 months (range 0.33-97.63). Better preoperative ASIA score had a significant favorable effect (p=0.015) on survival. 14 patients (31.1%) improved their walking ability post-operatively. Patients who were independent in walking post-operatively had better survival (25.70 months VS 5.45 months (p<0.001)). Better SINS score had better prognosis on survival time (p=0.049). Better modified Tokuhashi score had better prognosis on survival time (p<0.001).

**Conclusions**

The modified Tokuhashi score and SINS score may be useful tools for the prognosis of survival in patients suffered from spinal metastases from lung cancer. Surgical intervention may help to improve their survival and walking ability.
Factors Influencing the Restoration of Lumbar Lordosis in Adult Degenerative Scoliosis Treated with Lateral Transpsoas Interbody Fusion

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Objectives

Lateral lumbar transpsoas interbody fusion (LLIF) has been used with success as a surgical option to generate lumbar lordosis (LL) and does so with fewer complications than a traditional open procedure. The aim of this study was to study whether variability in patient or surgeon factors affected ability to generate lumbar lordosis in LLIF during multiple cage insertion in adult degenerative scoliosis (ADS)

Method

ADS patients undergoing LLIFs of L1 to L5 (±T12) and had second stage percutaneous instrumentation and had a minimum 6 month follow up were included in our study. All LLIFs implants used were of a fixed AP width and lordosis (6°). Digital Cobb technique was used for measuring segmental and regional angles. We studied whether LLIF improved segmental sagittal balance (SSB) and decreased the mismatch between pelvic incidence (PI) and LL. Secondly, we determined the role of degree of anterior cage placement (DACP), disc height (dh), and the ratio between cage to vertebral body length (CL-VB) in lordosis creation though multivariate regression analysis

Results

LLIF significantly increased LL (-36.5±12.5°preoperatively, -47.6±10.5°) and decreased the mismatch between PI and LL (21.8±13.6°preoperatively, 11.0±12.5°postoperatively). Preoperative SSB (p=0.036), CL-VB (p=0.015), and DACP (p=0.003) were all significant variables in change in SSB, as per regression analysis. When the variables were modeled in combination, it resulted in increasing DACP and decreased preoperative SSB as the most significant factors correlating to increased change in SSB. When SSB was held at zero and DACP was assumed to be zero (maximum anterior placement of the cage), the model predicted the maximum lordosis at every level was greater than 6°(p<0.05)

Conclusions

LLIF in combination with percutaneous instrumentation can increase LL and decrease PI-LL mismatch in primary ADS. The most significant technical factor under the surgeon’s control is cage placement. Increasing anterior placement of the cages was the most significant variable in increasing lordosis postoperatively, particularly at the lower lumbar levels
Chronic Hip Abductor Tendon Tears and Pelvic Obliquity in Patients with Adult Degenerative Scoliosis

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Objectives

The objective of this study was to evaluate the association between chronic hip abductor tears and adult degenerative scoliosis (ADS). Hip abductor tears (HATs) are common among patients with degenerative lumbar disease, however their role as a contributing or consequential factor of the pelvic obliquity among scoliosis patients has yet to be recognized or established.

Method

A retrospective observational study was performed to evaluate the association among patients with chronic abductor tendon tears (diagnosed by MRI) and ADS. Twelve patients were identified with chronic hip abductor tears and pelvic obliquity. Clinical and radiographic factors were collected to characterize their hip and spinal pathologies. Statistical analysis was performed using SPSS (IBM, V22.0).

Results

Average patient age was 73 years with an average follow up of 5.9 years and a female predominance of 83%. Approximately two-thirds of patients (n=8) had documented scoliosis prior to their hip pathology or symptoms. The average Cobb angle was 57° with an average apex at L2 to the left (levoscoliosis), a truncal shift of 3.9 cm, pelvic obliquity of 8.3°, Lumbar lordosis of 35.7°, and a pelvic incidence of 59.6°. Approximately 83% of patients received steroid hip injections and the right hip was more commonly involved (RR=34%, P>0.05). Myotomal weakness of L5 or S1 nerve root was found in only 17% of patients but the presence of a Trendelenburg gait or sign was present among half of the patients. No relationship was identified between the type of scoliosis curve, location of the truncal shift, pelvic-obliquity, and hip-side involved.

Conclusions

Hip abductor tears may be an under-recognized cause of chronic hip pain and abductor weakness among degenerative scoliosis patients. While easily attributed, Trendelenburg weakness in ADS patients may not always be due to L5 root weakness but commonly due to HAT. The effect of spino-pelvic fusions in ADS patients with HATs deserves clarification and theoretically, may contribute to dysfunction by limiting compensatory mechanisms.
Robotic Assessment of Sensorimotor and Postural Control in Patients with Cervical Stenosis

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Objectives

Cervical spondylotic myelopathy (CSM) is a clinical condition arising from chronic compression of the spinal cord which can result in neurologic deterioration. Surgical decompression has been associated with improved outcomes, however, guidelines for treatment are difficult to institute given variations in the natural history of CSM when managed non-operatively.

Robotic assessment has shown promise in evaluating neurologic dysfunction. KINARM is one such tool which has been used previously to quantify neurologic disturbances in patients with stroke. KINARM has not been used to assess such alterations in patients with cervical stenosis.

Our objective is to compare clinical assessment with KINARM sensorimotor and postural assessment in a series of patients with cervical stenosis. The goal is to ascertain whether the KINARM robot can predict the course of cervical stenosis and quantify the effects of treatment.

Method

Participants underwent KINARM robotic assessment before surgical treatment, and after surgery at six to nine months post-operatively. In non-operative cases, patients were assessed at initial referral and again six to nine months later. All patients underwent clinical assessment by a spine surgeon and were tested using a modified Japanese Orthopaedic Association (mJOA) assessment tool at both assessment intervals.

Results

Initial data shows a trend between lower mJOA scores, indicating severe myelopathy, and decreased KINARM performance. Subgroup analysis will be used to determine which cluster of KINARM tasks will be most useful in detecting neurologic deficits within this patient population. Perfect correlation between KINARM testing and mJOA scores is not expected given that the mJOA tool includes lower extremity and gait scores whereas the KINARM utilizes the upper extremities exclusively for its assessment.

Conclusions

KINARM is a rapid and objective tool that can quantify sensorimotor and postural control abnormalities in patients with cervical stenosis including measuring response to surgical treatment, detection of subclinical myelopathy, and in monitoring for deterioration when managed non-operatively. Preliminary results show that the KINARM is a feasible and objective tool for rapid quantification of neurologic abnormalities in patients with cervical stenosis.
Effect of Tobacco Smoking on Outcomes of Complex Spine Deformity Correction: Analysis of 270 Patients from the Prospective, Multi-Center SCOLI-RISK-1 Study of Complex Adult Spinal Deformity Surgery

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Objectives

To determine the effect of Tobacco smoking on the baseline and post-operative functional and quality of life (QOL) outcomes in patients undergoing complex adult spinal deformity surgery in the SCOLI-RISK 1 study.

Method

The Scoli-RISK-1 study enrolled 272 patients from 15 centres who underwent surgery for high-risk adult spinal deformity, with a 2 year follow up. Outcome measures (SF36, SRS-22, Oswestry Disability Index [ODI] scores, and Back/Leg pain Numerical Rating Scale [NRS]) in smokers (n=26) were compared to the non-smokers (n=244) using a mixed effects model for repeated measures with an unstructured covariance or the Wilcoxon rank sum test.

Results

Number of levels or complexity of surgery were matched in both cohorts. At 6 weeks post-surgery non-smokers demonstrated a significantly higher SF36 mental component score (44.6, 95% CI [42.8 – 46.4]) compared to the smoking group (37.7[32.2-43.3]; p=0.021), but this effect was not maintained at 6 or 24 months (p=0.248, p=0.605). ODI scores were not significantly different between both groups at 6 weeks (p=0.802), 6 months (p=0.377) and 24 months (p=0.281). The mean change in scores from baseline between groups for all outcome measures was not significantly different at any follow up interval. Median leg pain NRS scores were significantly lower in non-smokers at 6 weeks (1.00 vs 3.50; p=0.020), but this effect was not present at 6 or 24 months (p=0.103, p=0.206). The median change in leg pain NRS scores was not significant between the groups at any follow up interval.

Conclusions

Both groups reported similar outcome scores at baseline and all follow up intervals. At 6 weeks smokers had significantly worse scores for 2 outcome measures, but the changes in scores from baseline for all measures were not significant at any follow up interval. In conclusion, short-term outcomes may be adversely affected by smoking, where long-term outcomes appears similar between both groups.
Trends in Opioid Usage Two Years Following Thoracolumbar Spine Surgery

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Objectives

Opioid overdose results in 116 deaths per day in the United States. It is estimated that 21-29\% of patients misused opioids prescribed for chronic pain. The Canadian Orthopedic Association released a statement that stressed the importance of timely access to musculoskeletal care in order address the underlying causes of pain and curb the epidemic of opioid misuse. This study aims to evaluate the effect of undergoing surgery on patient opioid usage. We hypothesize that patients who undergo surgery to address their underlying spine pathology will reduce their opioid usage and improve their quality of life.

Method

We conducted a retrospective review of prospectively collected data within the CSORN database for patients who underwent thoracolumbar procedures by the McGill Spine group. All adult patients who underwent thoracolumbar procedures and completed their 2 year follow up were included. Fisher exact test was used to analyze categorical variables. ANOVA was used to analyze continuous variable and significance was \( p < 0.05 \).

Results

Forty-five patients met the inclusion criteria. Twenty-nine patients reported that they did not use opioids on initial assessment. Of the 29 patients who were not using opioids at initial assessment, one patient reported usage at two-year follow-up. Of the 16 patients who were using opioids at initial assessment, seven had completely stopped all usage representing a 37.5 \% reduction in the number of patients using opioids (\( p \ 0.0016 \)). Opioid users reported a reduction of 2.69 ± 2.09, 2.94 ± 3.42 and 18.50 ± 15.28 points while non-opioid users reported a reduction of 4.17 ± 3.12, 3.62 ± 3.94 and 17.55 ± 18.91 points on the back-pain scale, leg pain scale and Oswestry Disability Index respectively. There were no statistically significant differences in these measures between the groups.

Conclusions

Chronic pain and opioid misuse continue to be significant challenges that are affecting the quality of life of patients. This study highlights the significant impact that addressing patients’ underlying pathology can have on quality of life and opioid usage.