20th ANNUAL SCIENTIFIC CONFERENCE OF THE
CANADIAN SPINE SOCIETY

Wednesday, February 26th - Saturday, February 29th

ABSTRACTS FOR PRESENTATION

2020

Fairmont Château Whistler  4599 Château Boulevard  Whistler British Columbia  V8E 0Z5
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: Every year the Canadian Spine Society in conjunction with the Canadian Paediatric Spine Society holds its Annual Scientific Conference. This year the CSS and the CPSS are joined by Spine Societies from the United Kingdom and Brazil. The meeting will cover both adult and paediatric spinal conditions and include etiology, clinical presentation and current treatment, both surgical and non-operative. The format is a CME approved combination of didactic lectures, symposia, poster presentations and case reviews. There are sessions specifically aimed at surgical residents and fellows debating the appropriate operative management of selected cases with senior clinicians. A particular focus is the natural history of untreated scoliosis, combining insights from both the Canadian and the Brazilian experience. Timely access to care is an ongoing concern worldwide and the knowledgeable participants will advance constructive solutions. The British Association of Spine Surgeons will hold a symposium on the diagnosis and treatment of Acute Cauda Equina Syndrome. Spine specialists in all countries face similar clinical problems but employ differing solutions depending on local resources and healthcare delivery. The program offers ample opportunity for professional contact, sharing ideas and problems. The agenda design promotes comfortable, extended interaction with the exhibitors allowing attendees the chance to inspect and assess the latest surgical equipment and implants. The collegial atmosphere enhances sharing knowledge and discourages aggressive marketing. This Annual Scientific Conference remains the most important spine meeting in Canada.
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Available online at www.spinecanada.ca
Presentation CPSS1

Spinal Insufficiency Fracture in The Geriatric Pediatric Spine

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Background

Regular corticosteroid has become standard for slowing disease progression in Duchenne Muscular Dystrophy (DMD). However, patients must contend with the insidious side effect of osteopenia and fracture; with bone density quickly approaching that of a geriatric spine. Up to 90% of DMD patients taking daily corticosteroids develop Vertebral Compression Fracture (VCF) by the age of 18. The consequent pain and immobility can lead to a downward spiral in clinical course.

Objective

To review the evidence for vertebroplasty in the DMD population affected with VCF, and to present a case of vertebroplasty for VCF in DMD.

Methods

We searched two databases (EMBASE and Medline) for any cases reported of vertebroplasty in DMD.

Results

Our search yielded only one reported case of a successful kyphoplasty in an 8-year-old with DMD. Our case presented is a 15-year-old male (JG) with DMD being treated with daily Deflazacort. He initially presented with vertebral insufficiency fractures and was treated with pain palliation and intravenous bisphosphonate therapy. Though his symptoms initially improved and he became more active, he re-presented with severe central low back pain requiring greater narcotic loads. CT scan confirmed compression fractures at L1, L3, L4 and L5 with MRI-confirmed edema from L1-L5. As JG had failed the accepted medical standard of care, he was offered and underwent percutaneous vertebroplasty from T12-L5. Pre-treatment team-mobilization identified the need for post-operative respiratory supportive therapy in the PICU. Clinical follow-up is enclosed.

Conclusion

There is a significant gap in the literature regarding the indications for and outcomes of vertebroplasty; with only one other reported case. We outline an additional case of vertebroplasty in a 15-year-old boy with DMD. With evidence of improved pain and function, this operative intervention should become part of the management plan for treatment-resistant VCFs in the DMD patient.
Presentation CPSS2

The Clinical Significance of Tether Breakages in Anterior Vertebral Body Growth Modulation: A two – Year Post-Operative Analysis

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Background

Anterior vertebral body growth modulation (AVBGM) is a technique aimed at treating skeletally immature patients with progressive idiopathic scoliosis (IS). Early results are promising, but tether breaking is a concern. Whether this subgroup has a different post-op evolution may allow us to understand and predict failures.

Objective

We aim to evaluate the first two post-op years in patients who have developed tether failures compared with patients without other major complications.

Methods

A retrospective review of a prospectively maintained database of IS patients operated with AVBGM from 2013 to 2019 was performed. Inclusion criteria were patients having at least two year radiologic and SRS-30 questionnaires completed. Patients diagnosed with tether failures based on radiological data were included. Patients excluded from this study was any diagnosis other than IS and major complications other than tether failure. Wilcoxon Rank-sum test was used to compare results between patients with and without tether failure.

Results

Sixty-two patients were identified. Twenty-two patients were identified with tether failures. One patient with tether failure required revision surgery and was excluded from this study. Including this patient, a total of 8 patients were excluded. 21 patients with tether failures and 33 patients with minor or no complications were analyzed. Average age for index surgery was 11.9 and 12 for each respective group. No significant differences (p >0.05) were seen for maximum Cobb angles, kyphosis or lordosis between both groups. Significant differences (p<0.05) were noted in SRS-30 quality of life pre-op scores between the two groups, but were not found at 2 years post-op.

Conclusions

Patients who develop tether failures may have similar post-op outcomes than patients with no post-operative complications within the first two post-operative years. Further analysis is needed to define the natural evolution of tether failures.
Presentation CPSS3

Anterior Vertebral Body Growth Modulation for Idiopathic Scoliosis: Early, Mid-term and Late Complications

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Background

Anterior vertebral body growth modulation (AVBGM) is an emerging option with evolving indications for the treatment of idiopathic scoliosis (IS). However, the spectrum and impact of the potential complications are not yet well defined.

Objective

We aim to show that complications of AVBGM for IS differ from the classic posterior fusion and that they can be clustered as early, mid-term, and late-term.

Methods

A prospective cohort of sixty-two patients (mean age 11.8±1.3y) operated for IS with AVBGM between December 2013- October 2017; all had 2 to 5-year follow-up (mean 39±9 mo). Prospective analysis of pre- and postoperative data included patient specific parameters, radiographic measurements and recording complications and their respective management. Statistical analysis used descriptive measures and independent t-tests.

Results

Tether breakage was identified in 22 patients (36%). Besides, 12 other complications were noted in 12 patients. Three Pulmonary complications and 2 CSF leaks occurred early (median=18.0±30.0 days and median=6.5±4.9 days, respectively). Three overcorrections (requiring tether removal) and 1 insufficient correction for a 75°-curve (requiring PSF) were seen at mid-term (median=19.0±7.5 months and 18.0 months, respectively). At long-term, we identified 22 tether breakages, 2 coronal decompensations, and 1 lumbar curve progression (median=32.0±6.9 months, median=32.0±6.9 months, and median=29.0±20.0 months, respectively). Reoperation rate was 13% (8/62). Furthermore, instrumenting closer to the vertebrae touched by the CSVL correlates significantly with lower overall complications (p=0.017) and a tendency towards lower tether breakage (p=0.084).

Conclusions

Complications of AVBGM differ from those of PSF in nature and timing. Pulmonary complications and CSF leak may occur in the first 90 days. Over- or under-correction likely happen within 2 years as growth is maximal during this period. Tether breakage, coronal decompensation and lumbar curve progression are rather encountered from 2-5 years. Instrumenting distally closer to the vertebrae touched by the CSVL seems to add a protective effect.
Presentation CPSS4

Ovine Model of Congenital Chest Wall and Spine Deformity With Alterations of Respiratory Mechanics: Follow-Up From Birth to Three Months

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Background

The adverse effects of spinal and thoracic deformities (STD) on respiratory mechanics have been suggested in the literature. However, most animal studies evaluated respiratory mechanics in a STD model created postnatally.

Objective

We developed an ovine model of STD induced surgically in utero to assess its consequences on lung mechanics and development.

Methods

A STD was induced in utero at 70-75 days of gestation in 14 ovine fetuses by resection of the 7th and 8th left ribs. Each untouched twin fetus was taken as control. Respiratory mechanics was studied in the first week of life and at one, two and three months postnatally. Furthermore, post-mortem respiratory mechanics and lung histomorphometry were assessed at 3 months. Mann-Whitney U-tests were performed to evaluate statistical significance.

Results

Eight out of 14 STD lambs (57%) and 14 control lambs survived the postnatal period. The causes of death included abortion (n=3), prematurity (n=1), respiratory insufficiency at birth (n=1) and stillbirth (n=1). One severe (51° Cobb angle) and 5 mild deformities were induced (2 with 13°, 2 with 10° and 1 with 7.5° Cobb angle). The inspiratory capacity was decreased at birth in STD lambs (32 vs. 35 ml/kg in controls, p=0.02), as well as the static respiratory system compliance (2.0 vs. 2.5 ml/cmH2O/kg, p=0.005). No significant differences in respiratory mechanics were seen thereafter. Finally, the alveolar surface area was significantly (p<0.05) decreased in the five STD compared to the four control lambs studied at 3 months of life.

Conclusions

This is the first study that evaluates the effects of a STD induced in utero on respiratory mechanics in an ovine model from birth to three months of age that shows significant alterations in lung histomorphometry. Our ovine model allows a closer replication of congenital spine and chest deformities.
Presentation CPSS5

Test-retest Reliability and Minimum Detectable Change of the English Translation of the Italian Spine Youth Quality of Life Questionnaire in Adolescents with Idiopathic Scoliosis

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Background

Scoliosis significantly impacts Quality of Life (QOL). Establishing measurement properties is a prerequisite for outcome measures evaluating the effects of scoliosis treatments. Current quality of life questionnaires for adolescents with idiopathic scoliosis (AIS) have limitations. The SRS-22r has ceiling effects and the SAQ asks patients to express how they look from behind, which they cannot see. A new questionnaire for measuring QOL in AIS called the Italian Spine Youth Quality of Life (ISYQOL) has been developed to address these limitations but test-retest reliability for the English translation has not yet been determined.

Objective

To determine the test-retest reliability of the ISYQOL questionnaire.

Methods

One hundred consecutive females with AIS, aged 10-18 years old, treated non-operatively were recruited from a Canadian urban pediatric scoliosis clinic. Questionnaires were computer-administered using Research Electronic Data Capture (REDCap) prior to specialist consult. Participants completed the English translation of the ISYQOL online 1 and 2 weeks after visiting their clinician. Test-retest reliability should meet acceptable standards suggested by COSMIN for measuring groups of patients (ICC = 0.7) and for individual patients (ICC = 0.90).

Results

Participants included 100 females aged 13.9 (+/-1.8 years) with 29° (+/-14°) curve angles. Test-retest reliability of the ISYQOL score 60.3 (+/-12.4) was above the minimum standards for use in groups but below the standards for use in individuals (ICC=0.88) 95% CI= 0.79-0.93. The Standard Error of Measurement (SEM) of the ISYQOL was 5.2 and the Minimum Detectable Change 95% (MDC) was 14.4.

Conclusions

According to the COSMIN criteria, results support the ISYQOL suitability for QOL research in AIS. Because of the CI of the reliability of the ISYQOL, it may still be suitable for use in individuals, taking into consideration the consequences of its use. Future research should formally examine the ability to detect changes over clinically relevant follow-up durations.
Incidence of delayed spinal cord injury in paediatric spine deformity surgery seems to be higher than previously assumed.

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Objectives

Delayed spinal cord injury (SCI) hours or days after completion of paediatric spine deformity surgery, with initial normal neurological exam, is a rare complication with an estimated incidence ranging from 1:1000 - 1:10.000 surgeries. However, based on anecdotal evidence the suspicion arose that the incidence of this complication might be higher than previously assumed. Aim of this study was to determine the incidence of delayed SCI in patients undergoing paediatric spine deformity surgery between 2007-2017 in the Netherlands.

Method

All Dutch hospitals that perform paediatric deformity surgery were contacted. From the identified patients with a delayed SCI, the following data were obtained: patient characteristics, surgical procedure, details of the SCI and management. Additionally, from the Dutch Hospital Database all surgical procedures linked to the ICD9 and ICD10 codes for paediatric deformity (scoliosis/kyphosis) were obtained to determine the number of surgeries between 2007-2017.

Results

In total, 2703 paediatric deformity surgeries were performed in the Netherlands between 2007-2017. In this period, six patients with delayed SCI were identified; 2x idiopathic, 2x neuromuscular, 2x secondary scoliosis. Median age was 15 years (range: 7-17), median Cobb angle was 70 degrees (range: 51– 130). All six patients had a documented normal neurological exam directly after surgery; neurological deficits were first diagnosed median 14 hours after surgery, ranging from 6-40 hours. Five patients had an incomplete SCI (range AIS B-C) and one patient had a complete SCI (AIS A). The calculated incidence of delayed SCI was 1:763 in idiopathic scoliosis, 1:269 in secondary scoliosis and 1:160 in neuromuscular scoliosis.

Conclusions

The current study indicates that the incidence of delayed SCI after paediatric deformity surgery might be higher than previously assumed. Strict post-operative observation for late neurologic deficit (onset often in the middle of the night, median 14 hours post-operative) is crucial for timely diagnosis and management of this devastating complication.
What is the optimal surgical method for achieving successful symptom relief in paediatric high grade spondylolisthesis?

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Objectives

Options for the surgical management of paediatric high grade spondylolisthesis include reduction with arthrodesis or fusion in situ. Which strategy yields the most successful outcome, or lowest rates of complication or revision surgery remains unclear.

Method

We conducted a retrospective consecutive case-series investigation of high grade spondylolisthesis treated surgically at our hospital between October 2006 and August 2017. Patients with an L5-S1 slip ≥ 50% treated with either posterior partial reduction and fusion (PRF) or posterior reduction and interbody fusion (RIF) between the ages of 0-18 years were included. Records were evaluated to assess post-operative complications, revision surgery, post-operative symptoms and change in radiological parameters to a minimum of 2 years.

Results

31 eligible patients were identified. The average age was 13.6 years (9-17). Mean follow up was 41 months. At presentation, the two groups showed no significant difference in age, Meyerding grade, slip angle (p = 0.27, 95% CI -19, 1), pelvic tilt (p=0.07, 95% CI -4.6, 15.7) or C7-SVA (p=0.27, 95%CI -13.2, 44.9). Presenting symptoms were similar between the groups. Of 11 in PRF, 4 showed intraoperative neuromonitoring changes of which 2 had documented post-operative weakness. All patients showed normal neurology at discharge. None underwent further surgery. Slip angle reduced by a mean of 9° (p=0.02), PT and sacral slope were unchanged and C7 SVL reduced by a mean of 42mm (p=0.17).

In RIF group, 4 sustained dural tears and 1 a laminar fracture. 9 patients showed neuromonitoring changes, of which 7 had post-operative weakness and numbness, 4 of which had resolved at discharge. 8 patients underwent unplanned further surgery, 3 for pseudarthrosis. Slip angle reduced by a mean of 15° (p< 0.001) PT and sacral slope were unchanged and C7 SVL reduced by a mean of 27mm (p= 0.016).

Conclusions

There are several ways to manage spondylolisthesis, with either strategy being associated with an appreciable risk of early and late complications.
Vertebral Body Tethering: Truly Motion Preserving or Rather Limiting?

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Objectives

To evaluate implications of anterior vertebral body tethering (AVBT) on intervertebral motion (IVM) of tethered segments in a cohort of postop patients.

Method

In this IRB approved study, motion was assessed by standardized radiographs acquired in maximum right, left and forwarding bending positions. An independent observer measured the intervertebral angles via digital radiographic measuring software at each instrumented and tethered segment. The IVM in the coronal/sagittal planes was measured by the summation of the static angle on the upright PA/lateral radiographs with the static angle on the right/left bending PA radiographs and forward bending lateral radiographs, respectively.

Results

25 patients were included with a mean f/u of 26.5mo(12-42mo). There were 21 thoracic tethers compared to 4 lumbar tethers with mean major coronal Cobb of 52.7°+-8.6° correcting to an average of 19°(0-38°) and further correction to 12°(-9°-32°) at most recent f/u. Average operation-time was 305+-74min with mean EBL of 231.7+-82.9cc. Mean number of levels tethered were 7.1+-0.9. Total forward flexion (FF) motion of the tethered thoracic segments averaged 12.5°+-3.6° and of the tethered lumbar segments averaged 16°+-6.5°. Total mean tethered IM in FF was 1.9°+-0.6° per level for thoracic tethers and 3.5°+-1.6° per level for lumbar tethers. Total average IM in lateral bend of the tethered segments was similar in bending toward the tether (right bend=10.95°+-2.2°) and away from the tether (left bend=10.14°+-3.0°) with a mean of 1.7°+-0.4° of motion per level bending toward the tether and a mean 1.6°+-0.5° of motion per level tethered bending away from the tether.

Conclusions

Following AVBT motion is preserved within the tethered segments in forward flexion, and lateral bending both toward and away from the tether. Greater IVM per level in FF is seen in lumbar tethered segments compared to thoracic, likely due to inherent differences in motion between these spine segments. AVBT may be an attractive alternative to fusion.
Fusion rates in pediatric patients after posterior cervical spine instrumentation

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Objectives

Conditions leading to cervical instability are variable and their management in children remains technically challenging. The aim of posterior cervical spine instrumentation and application of cancellous bone graft is to provide stability and avoid nonunion via solid bone fusion. We describe our interdisciplinary experience with cervical spine fusion techniques and their qualitative outcome.

Method

We performed a retrospective chart review including 36 children less than 18 years of age with cervical instability requiring instrumented or onlay bone graft fusion. Clinical data were analyzed for diagnosis, surgical fusion technique, and number of revision surgeries related to fusion or hardware failure as well as other complications. Most recent radiographs or CT images were used to assess fusion quality via the following criteria: a) stability in dynamic x-rays, b) visible Halo sign at the screw insertion sites, 3) radiographical confirmation of continuous bone fusion mass extending the instrumented area and 4) signs of hardware failure.

Results

Twenty-one patients had a minimum follow up of at least 2 years for clinical and radiographic data (mean f/u 4.65 years, range: 2.0 – 10.68 years) including 14 males and 7 females. The mean age at the time-point of surgery was 8.4 years (median 8, range 0.7 – 14 years). Indications for surgical fusion were C1/2 instability (9 patients), post laminectomy instability (2 patients), status post aneurysmal bone cyst removal with consecutive instability (3 patients), trauma (2 patients) and other etiologies (5 patients). Eighteen patients underwent rigid posterior instrumentation with application of autologous bone graft and 4 patients received onlay bone graft only. The surgery was performed by a mixed surgical team: approach and decompression were done by the neurosurgical team, cervical instrumentation and bone grafting by the orthopedic team. Revision surgery was performed in 3 patients, 2 for nonunion and 1 for increasing junctional kyphosis. Solid bone fusion was confirmed in all of the patients, including two patients with asymptomatic hardware failure. Neurological status remained unchanged postoperatively and at last f/u. The overall complication rate was 14%, which compares favorably with the 26% postsurgical complications reported in a multicenter review.

Conclusions

This series shows that diverse fusion techniques of the cervical spine were performed safely by a combined neurosurgical/orthopedic team and resulted in adequate fixation with high fusion rates and minimal complications.
Effects of eight years growth hormone treatment on the onset and progression of scoliosis in children with Prader-Willi syndrome

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Objectives

Most children with Prader-Willi syndrome (PWS) develop scoliosis. Our previous study found no difference in the onset of scoliosis and curve progression after three years of growth hormone (GH) treatment. However, long-term effects of GH treatment on scoliosis in children with PWS are currently unknown. Aim of this study is to investigate the effect of eight years of GH treatment on the onset and progression of scoliosis in children with PWS.

Method

Prospective cohort study in 34 children (preliminary data) with PWS. All patients were naïve to GH treatment at time of enrolment and received GH at a dose of 1 mg/m²/d (≈ 0.035 mg/kg/d). Main outcome measures were onset of scoliosis (determined as a Cobb angle of >10º) and the progression of the scoliotic curve during 8 years of GH. After 8 years of GH the outcomes were compared with a group of 15 children with PWS who did not receive GH.

Results

GH treatment started at a mean age of 1.3 years. Twenty patients were male, fourteen female. Median age of onset of scoliosis (>10º) was 3.7 years. After 8 years of GH treatment mean age was 9.4 and 11.9 in the control group (p < 0.001). In the GH group 78% of the patients had a Cobb angle of >10º compared to 100% in the control group. The mean cobb angle in the GH group was 15º compared to 35º in the control group (p < 0.001). The GH group was significantly taller and had a higher trunk lean body mass compared to the control group, while weight and BMI were significantly lower.

Conclusions

Preliminary data show reassuring results: no increase in severity of scoliosis after eight years of GH-treatment compared to untreated children with PWS. On the contrary, these preliminary data suggest that GH treatment might even limit the progression of scoliosis in children with PWS.
Klippel Feil Syndrome: Clinical phenotypes associated with surgical treatment

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Objectives

Klippel-Feil Syndrome (KFS) is characterized by the congenital fusion of cervical vertebrae, however, patients often present with a variety of other spinal and extra-spinal anomalies suggesting this syndrome encompasses a heterogeneous patient population. Moreover, it remains unclear how the abnormalities seen in KFS correlate to neurological outcomes and the need for surgical intervention. This study aimed to define distinct KFS patient phenotypes that are associated with the need for surgical intervention.

Method

Principal component (PC) analysis was performed on 132 KFS patients treated at a large pediatric hospital between 1981-2018. Thirty-five variables pertaining to patient/disease-related factors were examined. Significant PCs were included as independent variables in multivariable logistic regression models designed to test associations with three primary outcomes: cervical spine surgery, thoracolumbar/sacral spine surgery and cranial surgery.

Results

Fourteen significant PCs accounting for 70% of the variance were identified. Five components, representing 4 distinct phenotypes, were significantly associated with surgical intervention. The first group consisted of predominantly subaxial cervical spine fusions, thoracic spine abnormalities and was associated with thoracolumbar/sacral spine surgery. The second group was largely represented by axial cervical spine anomalies and had high association with cervical subluxation and cervical spine surgery. A third group, heavily represented by Chiari malformation, was associated with cranial surgery. Lastly, a fourth group was defined by thoracic vertebral anomalies and associations with sacral agenesis and scoliosis. This phenotype was associated with thoracolumbar/sacral spine surgery.

Conclusions

This is the first data-driven analysis designed to relate KFS patient phenotypes to surgical intervention and provides important insight that may inform targeted follow-up regimens and surgical decision-making.
Anterior Release for Idiopathic Scoliosis: is it Necessary for Curve Correction?

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Objectives

The role of AR in AIS has been increasingly challenged. To date, literature on the effect of AR with PSIF has compared hybrid constructs to all pedicle screw constructs. AR in the setting of all pedicle screw constructs remains a point of debate. The aim of this study was to compare AR with PSIF to PSIF alone in AIS patients treated with all pedicle screw constructs.

Method

This was a retrospective review of a prospectively collected database. AIS patients treated with all pedicle screw PSIF with or without AR with a minimum 2-year f/u were identified. Using propensity score matching, patients were matched on age, gender, major coronal cobb, Ponte osteotomies, and Lenke classification. 47 matched pairs were identified and divided into two groups: PSIF alone and PSIF+AR.

Results

The mean age was comparable between the groups (14.5 +/- 2 yrs PSIF; 14.2 +/- 1.7 yrs PSIF+AR). Majority of patients were females (74.5%) in both groups with a mean f/u of 2 year. Mean major pre-op cobb was similar between groups (70.3 +/- 17 PSIF; 70.7 +/- 16.8 PSIF+AR). The mean Ponte osteotomies wasn’t statistically different between he groups (P=0.772). There was no difference in coronal cobb correction (23.9 +/- 9.9 PSIF; 22.3 +/- 9.9 PSIF+AR), thoracic kyphosis correction (23.15 +/- 8.2 PSIF; 21.85 +/- 11 PSIF+AR), and rib hump correction (46.9% PSIF; 48.6% PSIF+AR) at 2 years between the groups. The percentage of lumbar prominence correction however was significantly better in the PSIF+AR group (70.5%) compared to the PSIF group (41.1%) (P=0.047). No statistical significant difference in ORT, EBL, complication rates, as well as SRS outcome scores was noted between the groups.

Conclusions

This study demonstrated the limited value of AR for AIS in patients treated with all pedicle screw constructs, specifically for coronal and sagittal plane correction. AR can significantly enhance the axial plane correction of the lumbar spine however, without increasing perioperative morbidity or post-op complications.
Severe Scoliosis, do we know a better way? A retrospective comparative study.

Masayoshi Machida, Prof Reinhard Zeller, Prof Stephen Lewis, Prof David Lebel

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Objectives

To compare the results and safety of severe scoliosis treated with intra-operative skull-femoral traction and three rod constructs (3R) versus two rods (2R) constructs with posterior column osteotomies (PCO).

Method

59 consecutive patients with severe scoliosis (Cobb>90°) that underwent posterior spine fusion were identified in our institutional records. Inclusion criteria were minimum Cobb angle of 90°, age < 18 years at the time of surgery and a minimum 2-years of follow-up. The charts and radiographs were evaluated immediately pre-op, following surgery and at last follow up. Radiographic parameters, operative time, surgical blood loss, neuromonitoring events, ICU and hospital length of stay and post-operative short and long term complications were recorded and compared between the two groups.

Results

There were 28 patients in the 3R group and 31 in the 2R group. The groups were similar in their baseline characteristics with regards to etiology, age, gender, Risser sign and both coronal and sagittal deformity parameters. The preoperative major Cobb angle averaged 104°±12 and 101°±10 in the 3R and 2R respectively (P=0.4). The average major curve correction was 53% and 61% in 3R and 2R groups respectively (P=0.03). The postoperative thoracic kyphosis was 29°±11 and 21°±12 in the 3R and the 2R groups respectively (P=0.009). The surgical time was 516±92 min and 420±117 min in 3R and 2R respectively (P=0.002). Blood loss estimation was 875±284ml and 1368±907ml in the 3R and 2R respectively (P=0.03). Neuromonitoring recorded events were similar between the two groups. One patient had some permanent sensory deficit following surgery in the 2R group. There were two revisions in the 2R group.

Conclusions

Similar corrections and complications were noted in the 3 rod plus traction and the 2 rod plus PCOs methods utilized to correct large coronal deformities. Patient safety is a major concern, therefore surgeons should choose the method safest in their hands in dealing with these challenging cases.
Intraoperative skull femoral traction in adolescent idiopathic scoliosis: The correlation of traction with side bending radiographs

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Objectives

Numerous radiological methods have been used to determine the flexibility of the scoliosis curve preoperatively 1–9. Majority of the methods have operative dependent or patient dependent variables. We believe that one intraoperative skull femoral traction radiograph (IOSFTR) would replace the need to do the current standard side-bending radiograph (SBR) to assess curve flexibility and hence reduce the radiation and overall healthcare cost. To verify whether the IOSFTR is a comparable method to SBR in terms of measuring scoliosis curves and to predict flexibility of the curves in adolescent idiopathic scoliosis (AIS).

Method

This prospective cohort study was conducted by reviewing the radiographs of 37 cases (8 males and 29 females) of AIS who underwent posterior instrumented stabilization and fusion (PSIF) with a hybrid construct. Mean Cobb angles (CA) on upright PA radiographs, SBR and IOSFTR. Mean CA and Flexibility Index (FI) in proximal thoracic, main thoracic and thoracolumbar region were compared with paired t-test of significance.

Results

Mean CA based on SBR and IOSFTR in either PT, MT and TL/L curves. The mean CA in PT, MT and TL/L curves on SBR was 15.1 deg, 28.6 deg and 12.8 deg, while the mean CA in PT, MT and TL/L curves on IOSFTR were 16.1 deg, 30.6 deg and 16.3 deg respectively. The flexibility index in PT, MT and TL/L curves based on SBR was 24.76%, 52.46% and 36.54% respectively while based on IOSFTR was 24.77%, 52.41% and 36.41% respectively show no statistically significant difference (p>0.05).

Conclusions

Scoliosis curve flexibility with IOSFTR is comparable to the measurements on the gold standard SBR. This study is the first study in the literature where radiographs have been performed under a standardized traction weight and in a safe manner without any additional pullies, devices or belts.
Presentation B10  
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What is the effect of intraoperative halo-femoral traction on correction of adolescent idiopathic scoliosis (AIS)

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Objectives

The role of intraoperative halo-femoral traction (HFT) in AIS remains poorly defined. This aim of this study was to determine the efficacy of HFT on curve correction in AIS.

Method

A prospective, multicenter, longitudinal database identified patients with major thoracic AIS (Lenke 1-4) treated with single stage posterior only surgery with intraoperative HFT and minimum 2 year f/u. These cases were matched by Lenke curve type, age (within 6 months) and major coronal Cobb (within 5°) with cases treated similarly but without HFT (non-HFT). Periop, radiographic, and clinical outcome data at 2 years post-op were compared between the two groups.

Results

104 cases treated with HFT were matched to 104 treated without HFT. Mean age at surgery was 15.2 years and major coronal Cobb of 61° in both groups. Number of levels fused was 11.9 vs 11.7 (p=0.6) and EBL 11.7 vs 13.9ml/kg (p=0.9) for HFT and non-HFT groups respectively. HFT was associated with significantly greater ORT (339 vs 306min, p<0.001). HFT did result in significantly improved major coronal Cobb correction (71.0 vs 66.7%, p=0.006) and rib hump improvement (66.6 vs 56.2%, p=0.01) compared to non-HFT at 2 years post-op. More frequent neuromonitoring alerts were noted in the HFT group; 0.35 vs 0.05/case (p<0.001). No postoperative neurological deficit occurred in either group. A significant loss of T5-T12 kyphosis was seen in HFT group (-6.5° vs +0.5°, p<0.001) however loss of thoracic kyphosis did not correlate with either major coronal curve correction rate (r=0.04) or rib hump correction rate (r=-0.13). Change in SRS outcome scores were similar between the groups.

Conclusions

HFT can significantly improve coronal and axial plane deformity correction in AIS; however an increased rate of neuromonitoring alerts was noted with HFT. Surgeons should also pay careful attention to the sagittal plane when using intraop HFT as it may result in decreased post-op thoracic kyphosis.
Extreme long-term outcome of surgically versus non-surgically treated patients with adolescent idiopathic scoliosis

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Objectives

Reports of extreme long-term outcomes of adolescent idiopathic scoliosis (AIS) patients in dependence to the chosen treatment are rare. We report on outcomes of surgically versus (vs) non-surgically treated patients with moderate AIS after minimum of 29 years.

Method

AIS patients with a follow up ≥41 years in the surgical group and ≥29 years in the non-surgical group were included. Patients were treated surgically for primary curves ≥45° vs non-surgically for curves <45° or refusal of surgery. Groups were matched for age, gender, comorbidities and primary curve severity. Oswestry Disability Index (ODI) was used to measure clinical outcomes and standard radiography to quantify curve severity at final follow up.

Results

Sixteen patients (8 within each group, 75% female) with a median age of 14 (interquartile range (IQR) 2) years could be included and followed up after 46 (IQR 12) years. All matched variables were similar for both groups, including the primary curve Cobb angles of 48° (IQR 16°) (surgical) vs 40° (IQR 19°) (non-surgical); p = 0.17). At final follow up, the ODI was similar for both groups (15 (IQR 13) points vs 7 (IQR 15) points; p=017) with however a primary curve magnitude lower in the surgical compared to the non-surgical group (38° (IQR 3°) vs 61° (IQR 33°); p = 0.01), respectively.

Conclusions

After more than 40 years, surgical and non-surgical treatment of moderate AIS showed similar subjective outcomes, but with a relevant smaller curve magnitude with surgical treatment.
The influence of multilevel spinal deformity surgery on the clinical outcome in the elderly: a prospective, observational, multicenter study

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Objectives

This study investigated the clinical outcome after multilevel spinal deformity surgery in the elderly.

Method

Twelve different international centers prospectively enrolled 255 patients (219 met inclusion criteria) ≥60 years with spinal deformity undergoing primary instrumented fusion surgery of ≥5 segments. Different clinical outcome scores were compared between baseline preoperatively and postoperatively at 24 months. The scores were grouped into improvement from baseline (substantial (≥20%) and marginal (≥10-<20%)), similarity to baseline (within 10%), and decrease from baseline (marginal (≥10-<20%) and substantial (≥20%)).

Results

The mean age was 68 years, 176 (80%) were female, and the mean number of fused segments was 10. The numeric rating scale (NRS) of the back improved substantially in 123 (70%) patients, marginally in 21 (12%), remained similar in 22 (12%), decreased marginally in 3 (2%), and substantially in 7 (4%) (n=176). The NRS of the leg improved substantially in 93 (54%) patients, marginally in 13 (8%), remained similar in 40 (23%), decreased marginally in 9 (5%), and substantially in 17 (10%) (n=172). The EuroQol 5 dimensions (EQ-5D) improved substantially in 80 (47%) patients, marginally in 22 (13%), remained similar in 53 (31%), decreased marginally in 9 (5%), and substantially in 6 (4%) (n=170). The Scoliosis Research Society-22r Questionnaire (SRS-22r) improved substantially in 88 (61%) patients, marginally in 23 (16%), remained similar in 31 (21%), decreased marginally in 2 (1%), substantially in 1 (1%) (n=145). All SRS-22r subgroups (function, pain, self-image, mental health, and satisfaction) showed similar improvements.

Conclusions

In this prospective multicenter, international study, multiple patient reported outcome measures showed significant improvement in overall outcome scores, including pain and function, at 2-year follow up in patients ≥60 years of age undergoing multi-level spinal deformity surgery.
Demographics of a Prospective Evaluation of Elderly Deformity Surgery: A Prospective International Observational, Multicenter Study.

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Objectives

The purpose of this review was to determine the demographics of the patients deemed candidates for surgery.

Method

The demographics of the patients enrolled in a multicenter international prospective study of patients over 60 years of age, undergoing primary fusions of 5 or more levels for spinal deformity were reviewed. The pre-operative demographic data was assessed to determine criteria for candidates deemed suitable for adult deformity spinal surgery.

Results

219 of the 255 patients enrolled from 12 centers met the criteria for inclusion in the study. There were 176 females and 43 males with a mean age of 67.5 (range 60-83 years). 34 (15.5%) patients were employed or self-employed at time of surgery and 132 (60.3%) were retired. There were 124 (56.6%) Caucasians and 87 (39.7%) Asian. The mean BMI was 26.1 (range 15.7-49.3). 127 (59.1%) had depression/anxiety, 10 (4.6%) were smokers, 41 (18.7%) were ex-smokers, and 22 (10.0%) drank alcohol daily. The Charlson Comorbidity Index (CCI) for the cohort was 0.5 (median 0.0 and range 0.0 – 4.0). The mean bone density in 131 patients that had the test pre-operatively was a mean T score (total hip) -1.1 (range -3.3-2.5) and for 149 patients at the spine 0.1 (range -4.1-5.9). Pre-operative patient reported scores showed a mean SRS-22r total score of 2.8, a mean Oswestry Disability Index score of 46.3, mean EQ-5D index of 0.53, mean back pain numeric rating scale (NRS) 6.1 and mean NRS leg 4.9, and a median animal fluency test of 20 words.

Conclusions

Patients greater than 60 years of age in good health, with good bone density and moderate to severe patient reported disability as analyzed by the SRS-22r, the ODI, the NRS back and leg, and the EQ5D. were deemed candidates for spinal deformity surgery.
Timing of Conversion to Cervical Malalignment and PJK Following Surgical Correction of Adult Spinal Deformity

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Objectives

Assess conversion rate from baseline (BL) cervical alignment to post-operative cervical deformity (CD) and corresponding PJK rate in pts undergoing thoracolumbar ASD surgery.

Method

Operative pts who met ASD criteria (>18yrs, scoliosis ≥20°, SVA ≥5cm, PT ≥25° and/or TK >60°) with baseline and up to 3Y radiographs were included. Pts with no BL CD were post-operatively stratified by Ames CD criteria (TSCL>20°, cSVA>40mm) if they fulfilled >1 criteria. Severe CD was defined as TSCL>30° or cSVA>60mm. Follow-up intervals for post-ASD surgery were: 6W post-op =Early, 6W-1Y =Intermediate, 1-2Y =Late, and 2-3Y =Long. Descriptive and McNemar tests identified CD conversion rate, PJK rate (<-10° change UIV and UIV+2), and specific alignment parameters.

Results

266 surgical ASD pts(59.7yrs, 77.4%F) with complete 3Y radiographic data were included(CD Early: 38 pts, Intermediate: 26 pts, Late: 29 pts, Long: 10 pts). At conversion, Early had the highest mean TSCL and cSVA (25.4°±8.5; 33.6mm). Long had the highest mean C2-T3 angle, C2-T3 SVA and PJK rate (Table1). TSCL and cSVA conversion (>20°;>40mm) were the most common types of CD. Early had the highest rate of conversion to Severe CD: 9 pts had severe TSCL. 7 pts progressed from having only malaligned TSCL at BL (w/normal cSVA) to CD with both malaligned TSCL+cSVA by 6w, and 26 pts progressed by 1Y. Conversely, 2 pts progressed from malaligned cSVA to both malaligned cSVA+TSCL, while 20 pts progressed by 1Y. Greater thoracic kyphosis at BL predicted later conversion, while higher PI-LL, lower TK, and higher TK apex immediately post-op were significant predictors of earlier conversion compared to later(all p<0.05).

Conclusions

While the highest number of pts converted within 6w post-op, pts who converted in the Late or Long follow-up intervals trended higher rates of concurrent PJK and greater radiographic progression.
Prioritization of Realignment Associated with Superior Clinical Outcomes for Surgical Cervical Deformity Patients

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Objectives

To prioritize the cervical parameter targets for alignment

Method

Included: CD patients with full baseline (BL) and 1-year (1Y) parameters and HRQL scores (NDI); patients with cervical or cervicothoracic Primary Driver Ames type. Excluded: Both low CD cSVA (<4cm) and TS-CL (<15°). Assessed: met MCID for NDI (<-15ΔNDI). Ratios of correction found for regional parameters (cSVA, CL, T1 Slope, TS-CL, CBVA, MGS, C2-T3 SVA, C2-T3 angle, C2 Slope) categorized by Primary Ames Driver (cervical [C] or cervicothoracic [CT]). Decision tree analysis assessed cut-offs for differences associated with meeting NDI MCID at 1Y.

Results

77 CD patients included (62.1yrs, 64%F, 28.8kg/m²). 41.6% met MCID for NDI. A backwards linear regression model including radiographic differences as predictors from BL-1-year for meeting MCID for NDI demonstrated an R² of 0.820 (p=0.032) included TS-CL, cSVA, MGS, C2SS, C2-T3 angle, C2-T3 SVA, CL. By primary Ames driver, 67.5% were categorized as C, 32.5% CT. Ratios of change in predictors for MCID NDI patients (BL-1Y) for C driver patients: 260.8% MGS, 140.3% CL, 121.2% C2-T3 angle, 49.6% C2 slope, 41.1% cSVA, 20.5% TS-CL, 3.1% C2-T3 SVA. While correction in CT driver patients included: 168.7% CL, 93% MGS, 70.8% C2-T3 angle, 31.1% cSVA, 27.5% C2 slope, 24.9% TS-CL, 13.7% C2-T3 SVA. The ratios were not significant between the two groups (p=0.050). Decision tree analysis determined cut-offs for radiographic change, prioritizing in the following order (based upon ordinal regression): a correction ≤ 42.5° C2-T3 angle (OR: 5.667[1.074-29.891], p=0.041), < 35.4° CL (OR: 4.636[0.857-25.071], p=0.075), >-31.76° C2 slope (OR: 3.2 [0.852-12.026], p=0.085), >-11.57mm cSVA (OR: 3.185[1.137-8.917], p=0.027), >-2.16° MGS (OR: 2.724[0.971-7.636], p=0.057).

Conclusions

Certain ratios of correction of cervical parameters contribute to improving neck disability. Specific cut-offs of radiographic differences from baseline to 1-year were found prioritizing C2-T3 angle, CL, C2 slope, cSVA, and MGS, all strongly associated with meeting the MCID for NDI. Prioritizing these radiographic parameters will optimize patient-reported outcomes for patients undergoing CD surgery.
Objectives

To determine the outcome of multi-level spinal fusions on patients greater than 60 years of age.

Method

A multicenter international prospective study of patients over 60 years of age, undergoing primary fusions of 5 or more levels for spinal deformity were reviewed. The decision to operate and the procedure performed was made at the discretion of the treating surgeon. A central organization oversaw the study to ensure each centre complied with the study protocols and collected the data at the appropriate time intervals. Multiple outcome measures were utilized and collected at 10 weeks (Â± 6 weeks), 1 year (Â±2 months) and 2 years (Â±2 months) follow-up. Mixed effect models were applied to evaluate the outcome scores over time.

Results

219 of the 255 patients enrolled from 12 centers met the criteria for inclusion in the study. There were 176 females and 43 males with a mean age of 67.5 (range 60-83 years). 210 patients completed the 10 week, 188 completed the 1 year, and 179 completed the 2 year follow-up visits. Significant improvements were seen in the SRS-22r total score and subdomains of function, pain, self-image, and satisfaction, EQ-5D, Oswestry Disability Index, and numeric rating back and leg scales at 1 and 2 year follow-ups. Some improvement was seen at 10 week follow up with maximal improvement at 1 year that was maintained at 2 years follow-up. No difference in outcome scores was noted between age groups when comparing patients between the ages of 60-64, 65-69, 70-74, and those greater than 75 years of age.

Conclusions

Despite the magnitude of the procedures, significant improvements in patient reported outcome was observed in 4 different outcome measures at 1 and 2 year follow-up. Carefully selected healthy patients greater than 60 years old can benefit from multi-level spinal deformity surgery.
A Simpler, Modified Frailty Index Weighted by Complication Occurrence Correlates to Pain and Disability for Adult Spinal Deformity Patients

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Objectives

Develop a simplified, weighted frailty index for ASD patients.

Method

Component ASD-FI parameters contributing to overall ASD-FI score were assessed via Pearson correlation. Clinically relevant factors were regressed against ASD-FI score to generate the modified ASD-FI (mASD-FI). Component mASD-FI factors were regressed against incidence of medical complications and factor weights were calculated from regression these coefficients via Beta/Sullivan method. Total mASD-FI score ranged from 0-21, and was calculated by summing weights of expressed parameters. Linear regression and published ASD-FI cutoffs generated corresponding mASD-FI frailty cutoffs: not frail(NF,<7), frail(7-12), severely frail(SF,>12).

Results

50 ASD patients included (52±20yrs). All the following preoperative factors correlated with ASD-FI score (all p<0.039), and combined, accounted for 85.0% (p<0.001) of the variation in ASD-FI score: BMI <18.5 kg/m² or >30 kg/m² (weight: 5), depression (weight: 5), difficulty climbing stairs (3), presence of >3 medical comorbidities (2), leg weakness (2), difficulty getting dressed (1), bladder incontinence (1), and patient-reported deterioration in health within the past year (1). These factors were used to calculate the overall population’s mean mASD-FI score: 5.7±5.2. Combined, these factors comprising the mASD-FI showed a trend of predicting the incidence of medical complications (Nagelkerke R²=0.558, Cox & Snell R²=0.399, p=0.065). Overall patient breakdown by mASD-FI frailty category: NF(70%), frail(12%), SF(18%). Increasing frailty category was associated with significant impairments in validated measures of disability, including ODI score (NF: 23.4, frail: 45.0, SF: 49.3, p<0.001), SRS-22r score (NF: 3.5, frail: 2.6, SF: 2.4, p=0.001), PCS score (NF: 41.9, frail: 32.4, SF: 27.6, p<0.001), and NRS Leg Pain (NF: 2.3, frail: 7.2, SF: 5.6, p=0.001).

Conclusions

This study modifies an existing ASD frailty index and proposes a weighted, shorter mASD-FI. As increasing mASD-FI score is associated with inferior clinical measures of pain and disability, the mASD-FI may serve as a valuable tool for preoperative risk assessment.
Change in Oswestry Disability Index at 24 months following Multilevel Spinal Deformity Surgery in Patients over 60 years of age: A Multicenter International Prospective Study

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Objectives
To determine the outcome as measured by the Oswestry Disability Index (ODI) of elderly patients (>60 years of age) undergoing multi-level spinal surgery

Method
A prospective multicenter international study of patients over 60 years of age, undergoing primary fusions of 5 or more levels were reviewed. The decision to operate and the procedure performed was made at the discretion of the treating surgeon. The Oswestry Disability Index (ODI) was measured pre-operatively and at 24 months. Patients were divided into quintiles based on their pre-operative ODI score, ie. score 0-20, 21-40, 41-60, 61-80, 81-100.

Results
219 of the 255 patients enrolled from 12 centers met the criteria for inclusion in the study. There were 176 females and 43 males with a mean age of 67.5 (range 60-83 years). The mean number of levels fused was 10.4 (range 5-24). Stratifying and comparing pre-operative and 24 month follow-up ODI into quintiles, 64.1% patients had improvement in their ODI. 30.1% remained in their original quintile ODI at 24 month, while 5.8% of patients reported worsening of their ODI. Preoperatively, 58.3% patients had ODIs greater than 40% compared to only 21.1% at 24 months. Pre-operatively, 6.4% patients had ODI between 0-20%, and 35.3% between 21-40%. At 24 months, 41.0% had ODI scores between 0-20% and 37.8% scored between 21-40%. Similarly, 44.2% had pre-operative ODI of 41-60% and 14.1% had ODI of 61-80%, compared to 24 months where this was significantly decreased to 17.9% patients with ODI of 41-60% and only 3.2% with ODI between 61-80%.

Conclusions
Despite undergoing multilevel spinal deformity surgeries, in this prospective international, multicenter study, only 6% of patients showed worsening of their ODI, while 64.1% of patients improved in ODI at 24 month follow-up. Two-thirds of carefully selected healthy patients greater than 60 years old can expect to see improvement in ODI from multi-level spinal deformity surgery.
A Prospective Cohort Study Evaluating Trends in the Surgical Treatment of Degenerative Spondylolisthesis in Canada and the Utility of a Novel Surgical Decision Aid

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Objectives

A standardized clinical assessment and management plan (SCAMP) was created as a decision aid for surgeons based on the radiographic stability and clinical presentation of patients. The purpose of this study was to compare outcomes of those patients who followed the decision aid with respect to fusion/no fusion to those who did not.

Method

Patients were prospectively enrolled from eleven different Canadian institutions and followed from 2015-2019. A degenerative spondylolisthesis instability classification system (DSIC) was created using best available evidence stratifying patients into three different subtypes (1. stable degenerative spondylolisthesis, 2. potentially unstable spondylolisthesis and 3. unstable spondylolisthesis). One year changes in HRQOL, length of hospital stay (LOS), medication use and surgical time were compared between each group and in context of whether the treatment fell within the decision aid recommendation (simple decompression(type1), posterolateral fusion(type2) or inter body fusion(type3)).

Results

There were 394 patients initially enrolled and 334(84.8%) with full one year data available for comparison. There were 95 type 1, 224 type 2 and 75 type 3 patients initially classified. Baseline ODI, EQ-5D, and SF-12 MCS scores were significantly worse for type 3 patients versus type 1 patients. One hundred and eight patients were treated within the recommendations of the DSIC system (108/334, 32.3%). Surgeons performed interbody fusions in 141 patients (42%) rather than follow DSIC recommending a less invasive approach. There were no significant differences EQ-5D, SF-12 PCS/MCS, PHQ-9 or ODI at one year between patient groups. There was a trend towards shorter operating times for those patients following the DSIC system (195 non-followers versus 180min followers, p=0.078) and reduced hospital stay (4.46 days non-followers versus 3.98 followers, p=0.065).

Conclusions

There were no differences in clinical outcome at 1 year. Surgeons were more likely to perform rigid surgical constructs with stable spondylolisthesis leading to less judicious/responsible uses of hospital resources.
Presentation C20

Decompression Compared to Decompression and Fusion for Degenerative Lumbar Spondylolisthesis (DLS): a Canadian Spine Outcomes Research Network (CSORN) Study

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Objectives

Controversy remains regarding the optimal surgical procedure; decompression alone or decompression and instrumented fusion, for patients with DLS. The objective of this study is to compare patient characteristics and outcomes for patients with DLS undergoing decompression versus decompression and fusion procedures across the national setting.

Method

We conducted a multicenter review of prospectively collected data for consecutive patients with DLS enrolled by CSORN from 2015-18, who underwent 1-or-2-level decompression alone or decompression and fusion procedures. Baseline patient demographic, pain and disability measures were compared between the two groups. Patient-reported outcomes measures (PROMs) were compared at three months and one year postoperatively. A logistic regression was used to adjust for baseline differences.

Results

A total of 799 patients with DLS met inclusion criteria, with 234 patients (29.3%) undergoing decompression alone and 565 (70.7%) undergoing decompression and fusion. For patients undergoing fusion procedures, 75.9% (429/565) had interbody fusions. Patients undergoing fusion procedures were younger (Mean Age: 64.9 vs. 68.4; p<0.001) had increased back pain (Mean NRS: 7.0 vs 6.5; p=0.022), but no difference in leg pain, and were more likely to report symptoms for >2 years (75.8% vs. 64.3%; p=0.001), preoperatively. Additionally, patients undergoing fusion procedures had increased disability, (Mean ODI scores: 42.25 vs. 41.65; p=0.002), decreased physical function (Mean PCS: 32.35 vs. 34.67; p=0.001) and health-related quality of life (Mean EQ5D: 0.52 vs. 0.56; p<0.036) at baseline. After adjusting for baseline differences, patients undergoing decompression procedures reported less disability at 3 months post-operatively (Mean change in ODI score: -18.3 vs. -15.8; p=0.020). At one-year postoperatively, there were no differences in PROMs.

Conclusions

Our findings suggest that patients undergoing fusion procedures for DLS have a more advanced disease state at baseline, with slightly greater pain and disability. Additionally, patients undergoing decompression alone procedures may report improved short-term functional outcomes. Future research should include a cost-utility analysis of these surgical techniques.
Lumbar degenerative spondylolisthesis: factors impacting decision to fuse

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Objectives

The aim of this study is to assess which factors influence the decision of a Canadian spine surgeon to perform a fusion for lumbar degenerative spondylolisthesis (LDS).

Method

This study utilized 241 consecutive patients prospectively enrolled in a multi-centred study designed to evaluate the assessment and management of LDS. Inclusion criteria: radiographic evidence of LDS and neurogenic claudication or radicular pain, undergoing posterior decompression or decompression and fusion between 2015-2018. Patient demographics, patient-rated outcome measures, and imaging parameters were recorded in the Canadian Spine Outcomes Research Network (CSORN) database. Surgeon factors were retrieved by survey. Multivariate backward logistic regression was used to identify the factors associated with the decision to perform a fusion.

Results

Patients that had a fusion were younger (65.3±8.3 vs. 68.6±9.7), had worse ODI scores (45.9±14.7 vs. 40.2±13.5), a smaller average disc height (6.1±2.7 vs. 8.0±7.3 mm), Grade II spondylolisthesis (31% vs. 14%) and a non-lordotic disc angle (26% vs. 17%). The rate of fusion varied by individual surgeon and academic centre (P<0.001). Surgeons that were fellowship trained in Canada more frequently fused than those who fellowship trained outside of Canada (76% vs. 57%). Surgeons on salary fused more frequently than surgeons remunerated by fee-for-service (80% vs. 64%). Multivariate analysis revealed that for each 5-year decrease in age, 1 mm decrease in disc height, and 10-point increase in ODI the odds of fusion increase by 20%, 8% and 23% respectively. Grade II spondylolisthesis, non-lordotic disc angle, fellowship training in Canada, and salaried remuneration had a 3.2-, 2.0-, 2.1- and 2.9-times the odds of having a fusion.

Conclusions

The decision to perform a fusion for LDS is multifactorial. Although patient and radiographic parameters are important in the decision making process, multiple surgeon factors appear to influence the decision to perform a fusion for LDS. This demonstrates the need for further implementation of evidence-based decision making.
Patient reported outcomes following surgery for lumbar disc herniation: comparison of a universal and multitier health care system

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Objectives

Canada has a government funded universal health care system and access to spinal surgeons requires a referral. In contrast, the United States utilizes a combined public and private payer system where patients may directly access specialists. The purpose of this study is to investigate whether there are differences in clinical outcomes between those surgically treated for lumbar disc herniation in Canada as compared to the United States.

Method

Surgical lumbar disc herniation patients enrolled in the Canadian Spine Outcome Research Network prospective multicenter registry were compared with the surgical cohort enrolled in the Spine Patients Outcome Research Trial (SPORT) study. Patient reported outcomes were compared at 3 months and 1 year post-operatively.

Results

The CSORN cohort consisted of 443 patients and the SPORT cohort was made up of 573 patients. The rate of females in each cohort was similar (47.2% vs. 46.4%, p=0.78) Patients in the CSORN cohort were older (46.2 ± 13.2 vs. 41.6 ± 10.9, p<0.001), had a higher rate of smoking (32.0% vs. 22.8%, p<0.001), and were more likely to be employed (66.9% vs. 61.3%, p=0.034). The CSORN cohort had a slightly lower Oswestry Disability score at baseline (50.5±15.1 vs. 55.7± 19.6, p<0.01) but had a higher proportion of patients with a symptom duration greater than 6 months (44.5% vs. 21.1%, p<0.0001). The CSORN cohort demonstrated significantly greater rates of satisfaction after surgery at 3 months (74.8% vs. 65.3%, p=0.003) and 1 year (81.4% vs. 68.7%, p<0.001). Improvements in back and leg pain followed similar trajectories between the two cohorts. Membership in the CSORN cohort was a significant independent predictor of patient satisfaction at 1 year on multivariable logistic regression (OR 1.3, 95%CI 1.29-1.49, p<0.001).

Conclusions

Patients undergoing surgical treatment for lumbar disc herniation in Canada (CSORN) reported higher rates of satisfaction at 3 months and 1 year post-operatively compared to the United States cohort (SPORT) despite having longer durations of symptoms.
Do patients with recurrent lumbar disc herniations fare worse with discectomy than primary operations? A Retrospective Analysis from the Canadian Spine Outcomes Research Network

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Objectives

To determine if functional, self-reported outcomes differ between patients undergoing primary lumbar disc surgery and those undergoing revision discectomy for radiculopathy.

Method

Data was retrospectively analyzed based on a national database (CSORN). Revision surgeries involving fusions were excluded. Cohorts were examined to investigate the differences between those who underwent surgery for the first time, and those having a revision discectomy. Variables included demographics (age, BMI, smoking and sex), and outcome questionnaires (EQ5D, NRS Back/Leg, ODI, health scale and SF-12). These questionnaires were obtained at baseline, three months, one-year post-surgery. Categorical data were analyzed with Chi-Square tests, whereas continuous variables were compared with one-way ANOVA or the Mann-Whitney U test. Significance was taken at p≤0.05.

Results

There were 935 patients included in this analysis, where 888 were first operations, and 47 were revisions. There were 517 men and 418 women, with there being no statistical difference between men and women having had previous surgery (p=0.131). There were also no significant differences regarding age (p=0.378), smoking (p=0.149) or BMI (p=0.443). For patient reported outcome measures, the one-year ODI score differed between primary and revision surgery. Those who had not undergone previous surgery had an average ODI of 20.65, and those who had prior surgery had an average ODI of 29 (p=0.036). The mean absolute change in ODI was 28.13 for first time surgery and 19.14 for revision surgery (p=0.043). The EQ5D at one year was also significantly different, with an index of 0.80 for those who had not undergone previous surgery, and an index of 0.71 for those who had (p=0.02).

Conclusions

Demographic characteristics were not different between those who have had previous surgery and those who did not. However, functional outcomes were inferior in those patients undergoing revision lumbar disc surgery at 1 year postoperative.
A Province Wide Assessment of the Appropriateness of Lumbar Spine MRI

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Objectives

To determine the province wide appropriateness of ordering lumbar spine MRI, based on geographical and demographic differences, as well as physician specialty.

Method

An algorithm was developed based upon Choosing Wisely Canada and best practice guidelines to determine appropriateness of ordering lumbar spine MRIs. Utilizing the provincial PACS, two reviewers retrospectively examined the requisitions for all patients who underwent a lumbar spine MRI between January 1st, 2018 and December 31st, 2018. Chi-Square test was used to determine the impact of all outcome variables on the appropriateness of ordering a lumbar spine MRI.

Results

Family doctors accounted for (66%) of all MRIs ordered. Just over half (54.6%) of requisitions reviewed were determined appropriate. Age was a significant factor when determining if ordering the MRI was appropriate or not (p<0.001), whereas sex was not significantly different (p=0.498). Neither physician specialty, nor location of imaging were predictive of appropriateness, with p=0.125 and 0.224 respectively.

Conclusions

Almost half of all lumbar spine MRI’s ordered throughout the province were considered inappropriate. Age was significantly different when it came to determining appropriateness, with older individuals having a higher proportion of appropriately ordered MRI’s than their younger counterparts. Appropriateness was not influenced by physician specialty nor hospital location. There was no observed difference in appropriateness of MRI requisitions before or after the publication of the Choosing Wisely statements. This study illustrates the opportunity for further education to improve resource utilization.
Surgical Site Infection Reduction – a 10 year Quality Improvement Journey

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Objectives

In 2007, the spine surgical site infection (sSSI) rate at our Canadian quaternary referral center was 8.1% As a result, a multidisciplinary team was created to identify and initiate quality improvement (QI) strategies to reduce this unacceptably high sSSI rate. This abstract outlines the institutional and divisional QI strategies that have been central to our ongoing efforts to reduce the incidence of sSSI.

Method

A framework for evaluating surgical safety, based on that proposed by Mirza, was adopted to identify risk factors for sSSI at our institution. Surgical [midline lumbar approach, Odds Ratio (OR) 4.2], microbiological [UTI, OR 5.8], patient [DM, Odds Ratio (OR) 4.2] and process [ICU, OR 1.75] factors were explored. A predictive model for sSSI was developed with an AUC of 0.88. Numerous QI initiatives were introduced and their effect on sSSI monitored by the institutional Infection Prevention and Control (IPAC) group.

Results

From 2008, the Wiltse approach was used, in favour of midline, for one and two level decompression and fusion of the lumbar spine. Total sSSI rate fell from 8.1% to 7.2%. Routine use of intra-operative navigation from 2009 did not adversely effect the sSSI rate. From 2011 to 2014, photodynamic nasal decolonization and chlorhexidine skin decontamination (PDT/CHG) was applied to all elective and emergency spine cases, with the sSSI rate falling from 7.2% to 2%. With routine use of intra-wound vancomycin power in posterior instrumented cases from 2016, total sSSI rates further reduced from 2% to 1.6%. With the routine use of silver coated indwelling urinary catheters in patients with acute traumatic SCI, sSSI rates were reduced to 0.8% by early 2019 and have remained <1% since.

Conclusions

We present our experience in addressing sSSI through risk identification and prophylactic quality improvement initiatives. We highlight the importance of a multidisciplinary team approach, the value of a safety framework model and the importance of continued use of the Plan-Do-Study-Act cycle model.
The impact of frailty on patient reported outcome measures following elective thoraco-lumbar spine surgery

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Objectives

Frailty has been shown to be a risk predictor for peri-operative adverse events (AEs) in patients undergoing various type of spine surgery. However, its relationship with Patient Related Outcome Measures (PROMS) remains unknown. The primary objective of this study was to determine the impact of frailty on PROMS in patients undergoing surgery for thoraco-lumbar degenerative conditions. The secondary objective was to determine the association between frailty and baseline PROMS.

Method

This is a retrospective study of a prospective cohort of patients >55 years old who underwent surgery between 2012 and 2018. Patient data and PROMS (EQ-5D, SF-12, ODI, back and leg pain NRS) were extracted from the Canadian Spine Outcomes and Research Network registry for a single academic centre. Frailty was retrospectively calculated using the modified frailty index (mFI) and patient were classified as frail, pre-frail and non-frail. Patient characteristics and outcomes were analyzed using ANOVA or Kruskal-Wallis test for continuous variables and Chi square or Fisher’s exact test for proportions. A generalized estimating equations (GEEs) regression model was used to assess the association between patients’ baseline frailty status and PROMs measures at 3 and 12 months.

Results

293 patients were included with a mean age of 67± 7 years. Twenty-two percent of the patients (n= 65) were frail, 59 % (n=172) were pre-frail and 19% (n=56) were non-frail. At baseline, the 3 groups had similar PROMS, except for the PCS which was worse in the frail group (mean difference [95% CI], -4.9 [-8.6;-1.1], p= 0.0083). The improvement in the EQ-5D, PCS, MCS, ODI, back and leg pain NRS scores was not significantly different between the 3 groups (p> 0.05). The was no difference in the evolution of the PROMS at 3 and 12 months between the three groups (p> 0.05).

Conclusions

Although frailty is a known predictor of AEs, it does not predict worse PROMS after spine surgery in that population.
Moving toward better health: exercise practice is associated with improved outcomes after spine surgery

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Objectives

Degenerative lumbar conditions are more common as one ages. When conservative treatment is ineffective, spine surgery is commonly performed. Recovery and rehabilitation following surgery can take many months, and understanding what patients can do to facilitate recovery is beneficial. The present work examines the role of exercise in recovery trajectories after elective spine surgery.

Method

This prospective longitudinal cohort study included adult patients that were diagnosed with a lumbar degenerative spinal condition and underwent spinal decompression and/or fusion surgery. Participants completed the following patient-reported outcome (PRO) measures: Rand-36 (to generate physical- and mental-component scores; PCS and MCS); Oswestry Disability Index (ODI); Numeric Rating Scale for pain (NRS); and the PROMIS Pain Interference (PROMIS) short-form. Exercise practice was determined based on patient response to questions at baseline and over the course of follow-up about the frequency of muscle-strength exercises, non-stop aerobic activity, and yoga or Pilates. Random effects models investigated the relationship of exercise, follow-up time, and their interaction in predicting each PRO over time, with and without sociodemographic covariates.

Results

The study sample included 168 people (mean age 61, 50% female) with data pre-surgery and up to 12 months post-surgery. Analysis revealed modest, statistically significant main effects of exercise on the PCS, MCS, ODI, and PROMIS Pain Interference; and main effects of time on all outcomes. The exercise-by-time interaction was significant in predicting the ODI and MCS trajectories. When full models were adjusted for education and employment status, interaction effects were no longer significant but Exercise main effects remained significant for the ODI.

Conclusions

Patients who engage in exercise before and after spine surgery have slightly better recovery trajectories than those who do not. Exercise maintained long-term was associated with slightly better spine-specific disability scores, even after covariate adjustment. These findings support encouraging patients to exercise within their pre-operative limitations and as soon as they are able after surgery, and maintain it long-term.
Pre-operative decolonization does not adversely affect the microbiologic spectrum of spine surgical site infection

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Objectives

In 2011, a pre-operative decolonization program was introduced for all spine patients, using intranasal photodisinfection therapy, in addition to chlorhexidine-impregnated body wipes (PDT/CHG). This intervention resulted in an absolute risk reduction of 5.2% [spine surgical site infection (SSI) reduction from 7.2% to 2% from 2011-2014]. It is unknown whether such decolonization affects the microbiological spectrum of subsequent surgical site infections, as this could have profound treatment implications. The purpose of this study was to investigate the effect of PDT/CHG on the microbiology of subsequent surgical site infections.

Method

Data was prospectively collected by our institutional SSI surveillance program and our Spine SAVES2 system. We examined SSI organism types for a period prior to PDT/CHG (2010 to August 31st, 2011), and a period post PDT/CHG (2015 to 2018). Cultures from infected sites within a week of symptom onset, as well as within a week before and after a source control procedure, if applicable, were examined for the implicated organism(s).

Results

Of 37 SSIs pre-implementation, 54% of patients had mono-microbial infections with gram-positive organisms (85% were staphylococci), 13% had mono-microbial gram negative infections (all were Enterobacteriaceae), 16% had poly-microbial infections, and the remaining 17% had no growth or no specimens available for analysis.

Among 34 SSIs post-implementation, 59% (n=20) had gram positive organisms (90% were staphylococci), 20% (n=7) had gram negative organisms, 15% (n=5) had polymicrobial infections, and 6% (n=2) had no cultures collected.

Conclusions

In conclusion, based on this small cohort of spine surgery patients, the microbiological spectrum of SSIs was similar pre and post implementation of PDT/CHG. Contrary to other methods, including nasal mupirocin and intra-wound antibiotics, PDT/CHG does not adversely affect the microbiologic spectrum of subsequent infections, while resulting in significant reduction in SSI rates.
Feedback: Reducing after-hour spine cases using an encrypted messaging system

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Objectives

After hours bookings for urgent/emergent spine surgery is controversial because surgery performed outside of regular hours is associated with increased morbidity and mortality. We implemented routine use of a cross-platform messaging system (CPMS; WhatsApp Inc., Mountain View, California) for spine surgeons to critically examine indications for after-hours cases prior to booking. The purpose of this study is to determine if real-time, interdisciplinary quality care discussion affects the number or type of after-hour spine surgery.

Method

We retrospectively compared the number, type and length of after-hour spine surgery over three time periods: (A) June 1, 2016-May 31, 2017 (baseline control); (B) June 1, 2017-May 31, 2018 (implementation of quality care spine rounds); (C) June 1, 2018-May 31, 2019 (implementation of CPMS). Data were analyzed and compared using ANOVA and student T-test. A secondary outcome was an analysis of discussions from CPMS, including rates of differences in opinion with respect to timing or type of surgery.

Results

The mean number of after-hour spine cases/month over the three study periods (A, B, C) was 10.83, 9.75, and 7.58 (p=0.014); the length of surgery was 41.82, 33.14, and 25.37 hours/month (p=0.001). The largest area of controversy was booking “E3” cases, defined as those which should be done within <24 hrs. Over the three study periods, E3 cases reduced by mean 6.75, 4.92 and 3.83 cases/month (p=0.005). The timing of surgery agreement with the on-call spine surgeon booking was 87.1% overall and was highest for the most urgent types of indications. The type of procedure was disputed in 23.6% of cases.

Conclusions

Prospective (rather than retrospective) quality care discussion of after-hours spine surgery via CPMS reduces both the number and extent of cases.
Complex spine surgery is safe and effective in the extremely elderly age group; results from an ambispective study of 722 patients over 75 years old from a single institution.

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Objectives

To investigate the variance in outcomes and complications of complex spine surgery in the extremely elderly age group (over 75).

Method

Prospectively-collected database records from a single tertiary spine care center were retrospectively interrogated from January 1st 2005 until July 31st 2018 to identify all patients over the age of 75 years. Descriptive demographics were collected, including type of surgery, region of surgery, operated levels, perioperative complications and patient reported outcome measures, amongst others. Multivariate regression analysis was performed to compare increasing age with the change of complications by region, number of levels, rate of revision surgery, and outcomes at 1 month and 1 year.

Results

722 patients were included, with an age range of 75 – 92 years old (mean 78.36). 57% underwent lumbar region surgery, 27% cervical and 16% thoracic/occipital. In total, 412 cases (57%) underwent instrumented fusion surgery, with the most common indication being degenerative stenosis. 43% of all cases were 1 or 2 level surgery, with 57% including 3 or more levels. Perioperative complications (total) occurred in 16% of cases, with 93 (13%) revision cases performed in the follow up period. Multivariate analysis demonstrated an increasing likelihood of fewer levels of surgery as age increased (p=0.009). The rate of complications at 1 year did not vary with region of surgery (p=0.773) and did not increase with increased number of levels (p=0.265), however, increasing age was associated with increased risk of revision surgery (adjusted for region and number of levels; p=0.009).

Conclusions

Complex spine surgery at any anatomical region, including instrumented fusion surgery, can be effectively administered in the extremely elderly patient population. However, increasing age is associated with an increased risk of revision surgery and this should be considered during pre-operative decision making.
Clinical predictors of achieving Minimal Clinically Important Difference after surgery for Cervical Spondylotic Myelopathy: An external validation study from the Canadian Spine Outcomes and Research Network

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Objectives

Recently identified prognostic variables among patients undergoing surgery for cervical spondylotic myelopathy (CSM) are limited to two large international datasets. We evaluated which pre-operative clinical factors are significantly associated with improvement on the modified Japanese Orthopaedic Association (mJOA) scale by at least the Minimum Clinically Important Difference (MCID) 12 months after surgery among patients from CSORN.

Method

We performed an observational cohort study with data that were prospectively collected by participating surgeons between 2015 and 2017. We tested candidate variables using univariate and multivariate binomial logistic regression and performed multiple sensitivity analyses to test assumptions about the nature of our statistical models. We implemented validated mJOA MCIDs that varied according to baseline CSM severity.

Results

Among 205 CSM patients, there were 64 (31%) classified as mild, 86 (41%) as moderate, and 55 (26%) as severe. Overall, 52% of patients achieved MCID and the mean change in mJOA at 12 months post-surgery was 1.7 points (SD 2.6, p<0.01), but the subgroup of patients with mild CSM did not significantly improve (mean change 0.1, SD 1.9, p=0.8). Univariate analyses failed to identify significant associations between achieving MCID and gender, BMI, living status, education, smoking, disability claims, or number of comorbidities. After adjustment for potential confounders, the odds of achieving MCID was significantly reduced with each of older age (OR 0.7 per decade, 95% CI 0.5 to 0.9, p<0.01), and higher baseline mJOA (OR 0.8 per point, 95% CI 0.7 to 0.9, p<0.01). The effects of symptom duration (OR 1.0 per additional month, 95% CI 0.9 to 1.0, p=0.3) and smoking (OR 0.4, 95% CI 0.2 to 1.0, p=0.06) were not statistically significant.

Conclusions

Surgery is effective at halting the progression of functional decline with CSM, and approximately half of all patients achieve the MCID. Data from CSORN confirmed that older age is independently associated with poorer outcomes, but novel findings include that patients with milder CSM did not experience meaningful improvement, and that symptom duration and smoking were not important.
The natural history of degenerative cervical myelopathy: an ambispective longitudinal cohort study

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Objectives

Degenerative cervical myelopathy (DCM) is the most common pathology affecting the spinal cord, but its natural history is poorly characterized. Mild DCM is often managed non-operatively, but surgical treatment is recommended if neurological deterioration occurs. This study investigates the natural history of DCM patients that are managed non-operatively and the utility of quantitative clinical measures to detect myelopathic progression.

Method

Patients with 1) a new diagnosis of DCM or 2) recurrent myelopathy after previous surgery were enrolled prospectively and retrospective chart reviews were also performed. Patients that did not undergo surgery or had multiple clinic visits prior to surgery were included. Standard clinical assessments by the treating surgeons were used as the clinical case definition of neurological deterioration. A battery of quantitative neurological assessments were performed at one or more visits, including mJOA, QuickDASH, GRASSP-myelopathy (motor, sensory, and dexterity), grip dynamometer, Berg Balance, gait stability ratio, and gait variability index; a deterioration of 10% in any of these measures was considered significant (e.g. a 2-point decrease in mJOA). Anatomical MRI scans were assessed for evidence of worsening compression or spinal cord signal change.

Results

116 DCM patients were included (94 newly diagnosed, 22 recurrent myelopathy). Over a mean follow-up of 2.2 years, 57% (95% CI = 47-67%) of newly diagnosed and 73% (95% CI = 52-87%) of recurrent DCM patients deteriorated neurologically. The most sensitive quantitative measures to detect deterioration were grip strength (60%), GRASSP dexterity (60%), and gait stability ratio (50%). mJOA and anatomical MRI had relatively low sensitivity (33%, 28%, respectively). A composite score of clinical measures had sensitivity=81% and specificity=82%.

Conclusions

DCM has a poor natural history with a high rate of neurological deterioration. Longitudinal monitoring of patients should include grip strength, dexterity, and gait analysis. A lack of worsening on anatomical MRI or mJOA should not be considered evidence of clinical stability.
Quantitative Assessment of Gait Characteristics in Degenerative Cervical Myelopathy (DCM): A Prospective Study

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Objectives

There are challenges discriminating the early presentation of Degenerative Cervical Myelopathy (DCM) as well as sensitively and accurately distinguishing between mild, moderate, and severe levels of impairment. Gait dysfunction is one of the cardinal symptoms of DCM, but requires detailed assessment to sensitively detect changes in function. Accurate assessment of gait dysfunction is a potentially useful clinical evaluation tool in the DCM population. The objective of our study was to characterize gait in the DCM population through the use of spatio-temporal parameters, assessed on a gait pressure surface and to determine the discriminative and evaluative properties of this form of gait assessment in DCM.

Method

In a cross-sectional observational study, one hundred forty study participants presenting with one or more signs of DCM were prospectively recruited along with 37 non-myelopathic subjects. Study participants were stratified based on DCM severity, as measured using the mJOA scale. Demographic information and the neurological status of each participant were also collected. GAITRite and the ProtoKinetics Zeno Walkway (Haverton, Pennsylvania, USA) were used to conduct all gait assessments. SPSS Version 21.0 was used to perform the statistical analysis.

Results

Significant differences (p ≤ 0.05) were observed between healthy normative data and the mild DCM study participants for multiple spatio-temporal parameters. Several parameters were also noted to be discriminative (p ≤ 0.05) between at least two DCM severity groups. Step length, stride velocity, single stance ratio, and the enhanced gait variability index (eGVI) demonstrated the greatest discrimination between DCM severities. Parameters collected during fast-paced walking demonstrated similar discrimination as compared to self-selected pace.

Conclusions

The single stance ratio and eGVI were the most discriminative and evaluative out of all the spatio-temporal parameters, and differentiated between normative ranges and the DCM study participants (all severities).
Prognostic factors in degenerative cervical myelopathy (DCM) for patients managed operatively and non-operatively

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Objectives

Degenerative cervical myelopathy (DCM) is the most common pathology affecting the spinal cord, but few factors have been identified that predict outcomes with or without surgery. This study investigates baseline clinical and MRI data for 1) prediction of deterioration in DCM patients managed non-operatively, and 2) prediction of post-operative recovery.

Method

Patients with a diagnosis of DCM were enrolled prospectively. In patients managed non-operatively, a binary outcome variable of neurological deterioration was defined based on comprehensive assessment by the surgeon, including modified Japanese Orthopedic Association (mJOA), physical exam, and subjective factors. For post-operative recovery, the mJOA recovery ratio was used as the outcome variable. Baseline data were analyzed for univariate associations with the outcome variables using Chi-squared, T, and Pearson correlation tests. Logistic and linear regression models with backward stepwise elimination were used for multivariate analysis.

Results

In 117 patients, deterioration was more common with lower baseline GRASSP-dexterity (non-dominant hand: p=0.001; dominant: p=0.006), lower mJOA (p=0.003), clumsy hands (p=0.008), numb hands (p=0.01), unsteady gait (p=0.01), longer follow-up (p=0.02), smoking (p=0.03), depression (p=0.03), and decreased grip strength (dominant: p=0.04); trends were also seen with higher QuickDASH score (p=0.06), Hoffman sign (p=0.07), obesity (p=0.09), and increased age (p=0.10). In 71 patients, post-operative recovery was improved with stronger baseline grip strength (p=0.01 non-dominant), cord compression at C4-5 (p=0.01) and no cord compression at C2-3 (p=0.02); trends were observed with the presence of diabetes (p=0.07), no cardiac dysfunction (p=0.08), younger age (p=0.10), and no previous myelopathy (p=0.10). Multivariate analysis found independent predictors of mJOA (p=0.02), follow-up duration (p=0.02), and smoking (p=0.04) for non-operative deterioration, and grip strength (non-dominant: p=0.02) and C4-5 cord compression (p=0.03) for post-operative recovery.

Conclusions

Patients with more severe baseline neurological dysfunction, smoking, depression, and longer follow-up appear more likely to deteriorate without surgery, whereas those with preserved grip strength and C4-5 cord compression have better post-operative recovery potential. These variables may be useful to inform surgical decision-making and improve outcomes.
Efficacy of Surgical Decompression in Patients with Cervical Spondylotic Myelopathy: Results of the Canadian Prospective Multi-Center Study

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Objectives

Recent evidence suggests that patients with cervical spondylotic myelopathy (CSM) benefit from surgical intervention regardless of pre-operative disease severity. The goals of this study are (1) to validate previous results and (2) to assess the impact of surgery on outcome measures at twelve months after surgery.

Method

In this multi-center, prospective cohort study, patients were recruited by thirty-five surgeons from seven Canadian centers from 2015-2018. Outcome measures include mJOA score, NDI, EQ-5D, and SF-12. These were assessed at baseline and at twelve months after surgery. Outcome measures at twelve months were compared to baseline for the whole cohort and were further analyzed based on pre-operative disease severity: mild (mJOA ≥ 15), moderate (mJOA 12 – 14), and severe (mJOA < 12).

Results

378 patients have been enrolled in the study and undergone surgery with one-year follow-up data on mJOA scores available for 224 patients (59%). Mean age is sixty, and males comprise 62% of the cohort. 104 patients (28%) had mild myelopathy, 153 (40%) moderate, and 107 (28%) severe; data were missing on 14 patients (4%). At baseline, patients with severe myelopathy were older and more disabled with lower HRQoL scores. For the whole cohort, there was significant improvement in all outcome measures at twelve months (p<0.001) with mean mJOA scores improving from 13.1 to 14.9 (p<0.001). Patients with severe myelopathy saw a mean mJOA improvement of 3.8 (p<0.0001), and patients with moderate myelopathy improved by 1.9 (p<0.0001). Patients with mild myelopathy demonstrated no meaningful or statistically significant improvement (0.12) in mJOA score.

Conclusions

This study validates the results of previous studies that demonstrated improved outcomes with surgical decompression in CSM. Patients with mild myelopathy, however, did not improve significantly compared to patients with moderate and severe disease. These findings highlight the controversy in management of patients with mild cervical myelopathy and support a more conservative approach with close follow-up in neurologically stable patients.
Inter-observer reliability of the modified Japanese Orthopedic Association (mJOA) score in degenerative cervical myelopathy

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Objectives

The modified Japanese Orthopedic Association (mJOA) score has become widely accepted as the most important assessment in degenerative cervical myelopathy (DCM); this score has been utilized in clinical practice guidelines to directly influence treatment recommendations, but its reliability has not been established. This study aims to determine the inter-observer reliability of the mJOA in a large cohort of DCM patients.

Method

This prospective cross-sectional study involved administration of a refined version of the mJOA to DCM patients by 2 or more experienced clinicians that were blinded. The reliabilities of subscores and total score were analyzed using intra-class correlation (ICC) and concordance. Subgroup analyses were performed by mJOA severity (mild: 15-17, moderate: 12-14, severe: <12). Data were also analyzed using ANOVA for differences by assessor, assessment order, previous surgery, age, and sex.

Results

115 DCM patients underwent 245 assessments. ICC was 0.66 for upper extremity motor, 0.70 for lower extremity motor, 0.57 for upper extremity sensation, 0.65 for sphincter function, and 0.71 for total mJOA. The average difference in mJOA was 0.90 points between assessors. Identical scores (across all 4 subscores) were observed in 21%, differences of >= 2 points occurred in 19%, and disagreement between mild and moderate severity occurred in 14% of patients. Lower extremity motor score was lower during 2nd assessments, p=0.02). Other variables that were analyzed did not demonstrate significant relationships with mJOA scores.

Conclusions

The inter-observer reliability of the mJOA is moderate, and disagreement occurs in the vast majority of patients. These findings suggest that the mJOA should be interpreted with caution and considered in conjunction with additional measures, particularly when the total score falls near the threshold between severity categories or when a patient is monitored longitudinally for deterioration, as small differences can alter management. Further efforts to standardize the mJOA are needed to improve its reliability and help deliver optimal management of DCM.
Continuous optical monitoring of spinal cord hemodynamics during the first 7 days post-injury in a porcine model of acute spinal cord injury

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Objectives

Current clinical guidelines recommend augmenting the mean arterial pressure (MAP) in acute spinal cord injury (SCI) patients to increase spinal cord perfusion and potentially improve neurologic function. However, it is difficult for clinicians to hemodynamically manage acute SCI patients without real-time physiologic information about the effect of MAP augmentation within the injured cord. In this study, we investigated the feasibility and validity of using a customized optical sensor, based on near-infrared spectroscopy (NIRS), to non-invasively monitor spinal cord tissue oxygenation and hemodynamics during the first 7 days post-injury in a porcine model of acute SCI.

Method

Six Yucatan mini-pigs received a weight-drop T10 contusion-compression injury. A multi-wavelength NIRS system with a custom-made optical sensor was placed directly onto the dura at T9. Using NIRS, the spinal cord tissue oxygenation (Hbdiff) and concentrations of oxygenated (O₂Hb), deoxygenated, and total hemoglobin (THb) were monitored before and after SCI. To validate the NIRS measures, an invasive intraparenchymal (IP) combined PO₂/blood flow (SCBF) sensor was inserted into the spinal cord adjacent to the NIRS sensor at T11. Episodes of MAP alterations and hypoxia were performed acutely after injury, 2 days, and 7 days post-injury to simulate the hemodynamic changes SCI patients experience post-injury.

Results

Non-invasive NIRS monitoring identified changes in spinal cord hemodynamics and oxygenation levels during the MAP alterations and hypoxia. Changes of THb followed similar patterns of perfusion changes measured by the IP SCBF sensor, and changes of Hbdiff and O₂Hb showed significant correlations with oxygenation changes measured by IP PO₂ (p<0.0001).

Conclusions

Our novel NIRS sensor is feasible as a non-invasive technique to monitor real-time changes in spinal cord oxygenation and hemodynamics 7 days post-injury. Further development of this method would allow a clinically applicable device spine surgeons could place on the dura at the time of surgical decompression to monitor spinal cord tissue hemodynamics post-injury.
Development of a Prediction Model for Central Cord Syndrome: An Evaluation of Motor Recovery and the Effectiveness of Early Surgery in a Prospective, Multi-center Cohort

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Objectives

There is a paucity of data on the outcomes of central cord syndrome (CCS) and their predictors in the modern era. Further, the efficacy of early surgical decompression in this setting remains unclear. In patients with CCS, we therefore sought to: 1) develop a clinical prediction model for neurological outcome; and 2) evaluate the effect of time to decompressive surgery on neurological recovery.

Method

Patients with CCS (LEMS–UEMS≥5) were identified from four prospective, multi-center SCI datasets (NACTN; STASCIS; Sygen; NASCIS III). A clinical prediction model was developed by multiple linear regression; the outcome was ASIA motor score (AMS) at 1 year. Covariates were chosen a priori based on literature support and hypothesis: 1) age (continuous, yrs); 2) baseline AMS (continuous); 3) baseline AIS grade (dichotomous, C vs. D); 4) time to surgery (continuous, hrs); and 5) time to surgery ´ AIS grade. Time to surgery was log transformed given skewness in distribution. Effect sizes were summarized by β coefficients. Internal validation was performed by bootstrapping.

Results

A total of 264 patients were eligible. β coefficients were significant for all variables in the model: age (−0.21, P<0.01); baseline AMS (0.28, P<0.01); baseline AIS grade D (−11.68, P=0.04); log time to surgery (−3.40, P<0.01); baseline AIS grade D ´ log time to surgery (4.22, P<0.01). The mean $R^2$ value across bootstraps was 0.40. In patients with AIS grade C injury, shorter time to surgical decompression was significantly associated with superior motor recovery; by contrast, time to surgery did not observably impact motor outcome in patients with AIS grade D injury.

Conclusions

Motor recovery after CCS may be predicted by age, AMS, AIS grade, and time to surgery. These data support expeditious surgical decompression in patients with AIS grade C acute traumatic central cord syndrome.
Spinal cord dynamics under different clinical configurations of thoracolumbar burst fractures through numerical simulations

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Objectives

Primary injury of traumatic spinal cord injury (TSCI) involves a direct transfer of energy from vertebral fragments to the spinal cord. Unfortunately, imaging performed after the accident only depicts the residual pattern of thoracolumbar burst fracture and spinal cord compression, providing little insight on its dynamics. Knowledge of underlying mechanisms could be helpful in determining the severity of the primary injury, hence the extent of spinal cord damage and associated potential for recovery. Numerical modeling is often used to study dynamic processes but have never been used to specifically simulate different configurations of thoracolumbar burst fractures.

Method

A comprehensive finite-element model of a T11-L1, including two typical fragments, was developed and validated. Sixteen clinical cases of T12 burst fracture were simulated in a full factorial design under the following conditions: presence/absence of comminution of the superior fragment (delta fragment consisting of the postero-superior border of the vertebral body), upward rotational displacement of the upper fragment, presence/absence of a retropulsed inferior fragment (postero-inferior portion of the vertebral body), low or high retropulsion velocity of fragments. Severity of the spinal cord damages was quantified by its sustained peak strain, stress and pressure.

Results

Fragment velocity was the most significant (p<0.05) and influential factor (+26.7 % strain, +82.4 kPa stress, and +127.7 kPa pressure). Fragments upward rotation and presence of an inferior fragment significantly increased pressure (+55.2 and +18.3 kPa respectively), but rotation decreased strain (-10.1 %). Although significant for the peak strain, comminution of the superior negligibly affected the severity of damages sustained by the spinal cord (-2.7 %).

Conclusions

This study is the first to dynamically simulate spinal cord compression for varying configurations of thoracolumbar burst fractures. Our results suggest that higher fragment velocity highly affect the stress, strain and pressure sustained by the spinal cord. Presence of an inferior fragment and fragment upward rotation should raise the suspicion of a severe primary injury.
Predicting the Heterogeneity of Outcome following Sensorimotor Complete Cervical Spinal Cord Injury: Trajectory Based Analysis of 655 Prospectively Enrolled Patients.

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Objectives

While prognosis for recovery following sensorimotor complete cervical spinal cord injury (SCI) remains poor, there is individual heterogeneity in outcomes. Using a novel approach, we aimed to characterize unique temporal patterns of neurological recovery post injury and to identify patient, injury and treatment variables that predict such patterns.

Method

Subjects with cervical ASIA Impairment Scale (AIS) grade A SCI were pooled from four prospective multicenter cohort studies. Group based trajectory modeling (GBTM) was applied to model trajectories of recovery over the initial 12-months post-injury. Measures of neurological function included: Upper Extremity Motor Score, Total Motor Scores and AIS grade improvement. Within the GBTM framework, multinomial logit regression was applied to identify characteristics associated with recovery trajectories.

Results

The GBTM categorized subjects (N=655) into three distinct trajectories of recovery. These included: (1) Marginal recovery trajectory: characterized by minimal or no improvement in motor strength or change in AIS grade (remained grade A); (2) Moderate recovery trajectory – characterized by low baseline motor scores that improved by approximately 10 points; or AIS conversion of one grade point; (3) Good recovery trajectory – characterized by motor scores in the upper quartile at baseline that improved to near maximum values within three months of injury. Subjects following this trajectory, on average, improved 2 AIS grades within three months of injury. Subjects following the moderate or good recovery trajectories were of younger age, had more caudally located injuries, a higher degree of preserved motor/sensory function at baseline examination and exhibited a greater extent of motor and sensory function in the zone of partial preservation.

Conclusions

Subjects with cervical complete SCI can be classified into one of three distinct trajectories for neurological recovery. This analysis may serve as a starting point to define unique clinical phenotypes based on potential for recovery, rather than baseline severity of injury alone.
Mortality in the year following discharge to the community from in-patient care for acute traumatic spinal cord injury: when and why?

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Objectives

Individuals with traumatic spinal cord injury (tSCI) have an increased rate of death following injury secondary to the neurological and functional sequelae of their injury. Our objectives were to investigate mortality within the first-year of community living post-discharge from in-patient care, to inform the optimization of health care delivery, self-management, education, and to identify risk factors.

Method

The study cohort of 4625 acute SCI patients admitted to an acute care facility in British Columbia over a 23-year period from 1995-2017 was composed by scanning all Hospital Discharge Abstract Datasets using ICD-9 and 10 codes. We examined time of death following discharge, the main cause of death, the place where death occurred, and rehospitalization in the year following discharge from initial in-patient care. Demographics and details regarding time and cause of death, and readmissions to acute care were obtained from the Consolidation File, Vital Statistics-Deaths and the Hospital DAD, respectively.

Results

Of the 4352 individuals who survived and were discharged to community, 203 (4.7%) died within one-year of discharge. Of those who died, mean age at injury was 70.7 years (SD=17.3), and 140 (69.0%) were male. Median time of death post-discharge from in-patient care was 100 days (range 2-366). Over half of those who died (117/203, 57.6%) were readmitted to acute care at least once prior to death; 11.8% died at home. The most elderly (75+ years, mean 83.4 SD5.5) represented 14.4% of the entire cohort, and 51.2% (104/203) of those who died. Most common causes of death included falls, lung cancer, athlerosclerotic heart disease, myocardial infarction, and stroke.

Conclusions

There is a high risk of mortality within the year following initial discharge to the community following tSCI in the elderly, and most die in care. Falls and comorbid conditions are leading causes of death. Given this further understanding of mortality-related factors can help with prevention strategies and help clinicians with decision-making around goals of management and communication of prognosis to patients and families.
A Novel Method to Classify Patients with Cervical Incomplete SCI based on Potential for Recovery: A Group-Based Trajectory Analysis using Prospective, Multicenter Data from over 800 Patients

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Objectives

The outcomes of cervical incomplete spinal cord injury (SCI) are heterogeneous. Using a novel technique, this study sought to dissociate subgroups of cervical incomplete SCI patients with distinct longitudinal trajectories of upper limb motor recovery.

Method

Patients with cervical incomplete SCI (AIS B-D; C1-C8) were identified from four prospective, multi-center SCI datasets (NACTN; STASCIS; Sygen; NASCIS III). A group-based trajectory model was fit to upper extremity motor scores out to 1-year follow-up. Multivariable multinomial logistic regression was performed to identify baseline features that characterize each trajectory group.

Results

In total, 801 patients were eligible. Four distinct trajectory groups were identified:

1. ‘Poor outcome’: Severe neurological injury with very minimal, gradual recovery.
2. ‘Moderate recovery’: Moderate-to-severe neurological injury with moderate recovery.
3. ‘Good recovery’: Moderate neurological injury with good recovery.
4. ‘Excellent outcome’: Mild neurological injury with good recovery by 3 months.

On adjusted analyses, older age was associated with lower likelihood of an ‘excellent outcome’ (P=0.020). Compared to AIS B injuries, AIS C injuries were associated with ‘moderate recovery’ (P<0.001), ‘good recovery’ (P<0.001), and ‘excellent outcome’ (P<0.001), and AIS D injuries were significantly associated with ‘good recovery’ (P<0.001) and ‘excellent outcome’ (P<0.001). Mid cervical injuries occurred more frequently in ‘moderate recovery’ (P<0.001), ‘good recovery’ (P<0.001), and ‘excellent outcome’ (P<0.001) groups, as compared to upper cervical injuries. The presence/absence of central cord syndrome did not predict temporal recovery profile. Early surgical decompression (<24 hrs) was independently associated with an increased propensity for ‘good recovery’ (P=0.039) and ‘excellent outcome’ (P=0.048).

Conclusions

Patients with cervical incomplete SCI demonstrate distinct trajectories of recovery in upper limb motor function. The trajectory a patient is likely to follow may be predicted by baseline characteristics. The presence of central cord syndrome does not impact prognosis, whereas early surgery may support conversion to a more favorable recovery trajectory.
Responsiveness of standard spine outcome tools: Do they measure up?

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Objectives

Given the challenges of maintaining high-quality data in clinical research studies, it would be important to evaluate the contribution of each patient-reported outcome (PRO) to confirm that they merit the respondent burden. This study aimed to examine the spine PROs’ association with clinically important change, and relative responsiveness in explaining variance in patients’ global assessment of change (GAC).

Method

This prospective longitudinal cohort study included adults recruited from three active spine surgery practices at a Toronto-based hospital. Patients were diagnosed with a degenerative spinal condition and underwent spinal decompression and/or fusion surgery. Participants completed the Rand-36 (to generate the physical- and mental-component scores; PCS, MCS); Oswestry Disability Index (ODI); Numeric Rating Scale for pain (NRS); PROMIS Pain Interference (PROMIS); and a GAC item. Random effects models investigated the relationship of each PRO in predicting GAC over time, and responsiveness (i.e., PRO main effects and PRO-by-time interactions, respectively). Pearson correlations investigated the association between PRO trajectory scores derived from the random effects models to assess overlap in information gained.

Results

The study sample included 209 people (mean age 60, 48% female) with pre- and up to 12 months post-surgery data. Random effects models revealed significant main effects for all the PROs. Significant time-by-PRO interactions were detected for the PCS, PROMIS, ODI, and NRS (p<0.01, 0.05, 0.001, and 0.05, respectively); but not for the MCS. There were large effect-size correlations among the trajectory scores for the ODI, PCS, NRS, and PROMIS (r ranged from 0.57-0.69).

Conclusions

All of the PROs currently included in the spine outcome core measures are associated with patients’ subjective assessment of clinically important change, and all but the MCS is responsive to clinically important change. Four measures show substantial overlap in predicting clinically important change. Based on these findings, the core spine PROs could be reduced if the focus is on detecting patients’ subjective assessment of clinically important change.
Patient Outcomes: Important Psychological Measures

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Objectives

To elucidate which baseline psychological measures add to the prediction of patient reported outcomes two years following thoracolumbar surgery.

Method

A prospective observational study of elective thoracolumbar surgery patients (N=195) who participate in the CSORN registry. Patients were given additional baseline psychological measures: Pain Catastrophizing Scale (PCS), Tampa Scale for Kinesiophobia (TSK), Multi-Dimensional Scale for Perceived Social Support (MSPSS) and the Chronic Pain Acceptance Questionnaire (CPAQ). Outcome variables of interest were the modified Oswestry Disability Index (ODI) and Numeric Rating Scales for back/leg pain (NRS-B/ NRS-L) two years post-surgery. Outcome variables were collapsed based on achieving a minimum clinically important difference (MCID). A binary logistic regression was run. Independent variables included the psychological measures of interest as well as the CSORN variables: Mental Health Component Summary Score (MCS), comorbid depression, demographic variables and clinical/health history variables. Significance was set at α<0.05.

Results

A total of 60.3% of the sample achieved a MCID for ODI two years post-surgery. The final regression model for ODI included baseline MCS, ODI score and CPAQ Pain Willingness with the model correctly predicting 68.9% of cases (χ²(3)= 29.482, p<0.001). A total of 68.2% of the sample achieved a MCID for NRS-B two years following surgery. The regression model for NRS-B included baseline MCS, NRS-B score and principle pathology with the model accurately predicting 77.7% of cases (χ²(5) = 60.598, p<0.001). A total of 70.5% of the sample achieved a MCID for NRS-L two years post-surgery. The regression model for NRS-L included baseline ODI, NRS-L score, CPAQ Pain Willingness, PCS Magnification, MSPSS Category, and comorbid depression with the model correctly predicting 82.7% of cases (χ²(6)= 52.719, p<0.001).

Conclusions

The addition of psychological measures increases a surgeon’s ability to predict the likelihood of not meeting MCID on outcomes following surgery. In particular, the MCS, CPAQ Pain Willingness, PCS Magnification, and MSPSS were found to contribute to the prediction and could provide value in making surgical decisions.
Accuracy of surveillance for surgical site infections after spine surgery: a Bayesian latent class analysis using four independent data sources

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Objectives

Surgical site infections (SSIs) are morbid and costly complications of spine surgery. Understanding the impact that interventions have on reducing the risk of SSIs requires appropriate surveillance. Unfortunately, valid approaches to conducting SSI surveillance in the spine surgery population are lacking because of varying SSI case definitions and the lack of a gold-standard definition for SSIs. We aimed to assess the accuracy of 4 data sources that capture SSIs after spine surgery while estimating a measurement error-adjusted SSI incidence, without relying on a gold-standard definition.

Method

We assessed the accuracy of SSI surveillance algorithms across the following 4 data sources for patients undergoing spine surgery at the Vancouver General Hospital in 2017: 1) the discharge abstract database (DAD), 2) the National Surgical Quality Improvement Program (NSQIP) database, 3) the Infection Prevention and Control Canada (IPAC) database, and 4) our local Spine Adverse Events Severity (SAVES) database. A Bayesian latent class model was used to assess the sensitivity/specificity of each data source to identify SSI and to estimate a measurement-error adjusted incidence, without relying on a gold-standard SSI definition.

Results

A total of 976 patients underwent spine surgery during the study period. The most sensitive data source was the DAD (0.77, 95% CrI 0.54,0.95), while the least sensitive was the NSQIP database (0.51, 95% CrI 0.32,0.71). The most specific data source was the IPAC database (0.997, 95% CrI 0.993,1.000), while the least specific was the DAD (0.970, 95% CrI 0.957,0.981). The measurement error-adjusted SSI incidence was 0.034 (95% CrI 0.021,0.051).

Conclusions

Adjustment for the measurement error of various spine surgery SSI surveillance data sources is achievable using the accuracy measures provided in this study. Thus, high-quality spine surgery SSI surveillance and research can now be feasibly conducted in a timely fashion using the most readily available data sources to stakeholders.

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Objectives

Finite resources require accurate prediction models of surgical costs rather than the common practice of applying mean cost to heterogenous patients. We aimed to develop a patient-level spine surgical cost calculator.

Method

A retrospective review of patients undergoing surgery for degenerative lumbar spine conditions over a two-year period at a tertiary care centre (Toronto Western Hospital) was undertaken to create a predictive model of surgical costs. The economic perspective was that of the hospital. Total costs were based on individual patient level micro-case costed data. Prospectively collected, pre-operative patient and planned surgery variables were scrutinized, as potential predictors of total episode of care costs. Alternative prediction models were compared based on residual values, corresponding graphical plots and where appropriate R-squared or Akaike¹’s Information Criterion values.

Results

Two-hundred and eighty-four patients met inclusion criteria. The average per procedure total cost was $10,420 CAD (SD:10,684). A log-transformed linear regression model was found to best fit the data. This model identified seven independent predictors of total cost out of eight factors entered in the model. Pre-operatively, patients with American Society of Anesthesia physical status classification scores of four had significantly higher costs than those with a score of one (p<0.001). Increased patient age (p=0.014) and BMI (p=0.002) were also predictive of higher total costs. Day surgery (p<0.001) and minimally invasive procedures (p=0.003) were associated with lower costs, whereas, fusion (p<0.001) and multilevel (>1 level) procedures (p<0.001) were associated with significantly higher costs. This model accounted for a large proportion of the variance of total costs, with an R-squared value of 0.82.

Conclusions

This seven-factor model may help to predict individual patient hospital incurred costs for patients undergoing surgery for degenerative lumbar spine conditions and be beneficial for budgetary planning and resource allocation. Validation of the model in larger and different patient samples is required to hone its precision and determine its generalizability, respectively.
The Economic Impact of Non-Reimbursable Events in Open, Minimally Invasive, and Robot Assisted Lumbar Fusion Surgery

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Objectives

Investigate the rates of economic impact of non-reimbursable events in lumbar spine fusion surgery.

Method

Patients ≥18yo undergoing lumbar fusion surgery included. Patients categorized into 3 groups based on procedure type: open, MIS, robotic. Open included posterior spinal fusion. MIS included TLIF or LLIF with percutaneous screws. Robotic included robot-assisted interbody fusion. Propensity score matching (PSM) between all groups for number of levels fused. Rates of postop complications and non-reimbursable events assessed for each group. Non-reimbursable events: surgical site infection (SSI), urinary tract infection (UTI), pulmonary embolism or deep venous thromboembolism (PE/DVT). Costs of non-reimbursable events calculated using PearlDiver database. For robotic cases, costs reflective of operational fees and initial purchase costs. Complications and comorbidities (CC) and major CC (MCC) assessed according to CMS.gov manual definitions.

Results

360 propensity matched patients (120 open, 120 MIS, 120 robot) were included. Descriptive statistics for the cohort were: age 58.8 ± 13.5, 50% women, BMI 29.4 ± 6.3, op time 294.4 ± 119.0, LOS 4.56 ± 3.31 days, EBL 515.9 ± 670.0 cc, and 2.3 ± 2.2 average levels fused. Overall, rates of post op complications were significantly higher in robotic cases versus open and MIS (43% vs. 21% and 22% for open and MIS, p<0.05). When compared to open and MIS, robotic cases had higher rates of non-reimbursable events (12.0% robotic vs. 8.0% open, and 7.0% MIS, both p<0.001), as well as baseline surgery costs (($60,047.01 vs. $42,538.98 open and $41,471.21 MIS). On average, non-reimbursable events costs $20,299.07. The overall costs of care for patients who experienced non reimbursable events was significantly higher for robotic patients compared to open and MIS ($79,094.35 robot vs. $63,902.18 open and $61,957.87 MIS, both p<0.05).

Conclusions

Matching for levels fused, robot-assisted patients had 30% higher costs of surgery and rates of never-events compared to MIS and open spine surgery patients. Further longitudinal research is needed to fully assess the impact of non-reimbursable events in lumbar spine surgery.
Are There Gender Differences in Pre-operative Health Status and Health Care Delivery for Patients Undergoing Scheduled Lumbar Surgery? An Analysis from the Canadian Spine Outcomes Research Network.

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Objectives

Gender differences in pre- and post-operative clinical assessment scores have been described for patients undergoing scheduled lumbar spine surgery for degenerative disease. Given this, our objective was to identify gender differences in pre-operative health status, lifestyle, expectations of surgery and utilization of healthcare resources using a national spine database.

Method

Data were derived from the CSORN prospective, multicentre registry for patients undergoing lumbar surgery for degenerative disease. Demographic variables, patient visits to healthcare professionals, use of diagnostic testing, physical activity level, analgesia use, and other surrogate markers of health status were analyzed. ANOVA and chi-square tests were used for continuous and categorical variables, respectively.

Results

Data was analyzed for 5039 patients (2642 males and 2397 females). No pre-operative gender differences were identified for age, BMI, smoking status, use of diagnostic imaging, or time with condition. Females were more likely to take over the counter drugs (p<0.001), anti-inflammatories (p=0.03), anti-depressants (p<0.001) and neuroleptics (p=0.002). Females were more likely to be on medication for greater than a year (p=0.041) and visit their family doctor (p<0.001), emergency department (p=0.035), a naturopath (p=0.019), or massage therapist (p<0.001). A great proportion of males reported not taking medications for their back pain (p<0.001) and had a Worker’s Compensation claim (p<0.001). Females were more likely to be widowed and males more likely to be married (p<0.001). Females were more likely to live alone and males more likely living with a partner (p<0.001). A greater proportion of females were homemakers and males employed (p<0.001), particularly in jobs requiring heavy lifting (p<0.001).

Conclusions

Females were more likely to utilize pre-operative allied healthcare professionals and analgesia to treat their back pain. Gender differences in marital status, employment, and living arrangements were identified. This study identifies differences in care between genders and further study is required to better understand the reasoning behind these observations.
Patient Phenotypes Associated with Functional Outcomes after Spinal Cord Injury: A Principal Component Analysis in 1119 Patients

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Objectives

Spinal cord injury (SCI) patients frequently experience significant disability and loss of functional capacity. However, the variables that best predict functional impairment after SCI are incompletely understood. Here, we use Principal Component Analysis (PCA) to determine patient phenotypes that predict functional outcomes post-SCI in a large prospective series of SCI patients.

Method

This is an ambispective analysis of 1119 patients from the NACTN registry and the NASCIS-3 and STASCIS trials. The dataset comprised 158 baseline predictor variables. The primary outcomes were complete independence in 14 functional domains from the functional independence measure (FIM) 1-year post-SCI. PCA was performed on the dataset by computation of a covariance matrix among the predictor variables, followed by eigen decomposition. The significant principal components (eigenvalues > 1) were used for multivariate logistic regression analyses for each outcome. Odds-ratios were evaluated for each principal component (PC) to determine which PCs were strongly associated with each outcome.

Results

We identified nine significant PCs accounting for 87% of variance in the data. The first PC (PC1), dominated by the overall light touch and pinprick scores, had a significant positive correlation with all outcomes. PC4 was mainly derived from the overall motor scores, and also showed a significant positive correlation with all outcomes. Thus, patients with better neurological function at baseline are most likely to achieve functional independence at 1 year. PC2 contained positive contributions from lower extremity neurological scores and negative contributions from upper extremity neurological scores. It was positively associated with independence in lower extremity functions and negatively associated with upper extremity functions. PC2 may represent the central cord syndrome phenotype, where patients have worse upper extremity function than lower extremity function.

Conclusions

Data-driven techniques such as PCA have the ability to distinguish the effects of demographic and neurological factors and accurately compile them into meaningful phenotypes that guide clinical management and inform patient selection in research trials.
Early versus Late Surgical Decompression for Acute Traumatic Spinal Cord Injury: A Pooled Analysis of Prospective, Multicenter Data in 1,548 Patients

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Objectives

The effect of time to decompression on neurological recovery following acute traumatic spinal cord injury (SCI) remains unclear. This study leverages high-quality prospective data from over 1,500 acute SCI patients to compare sensorimotor recovery with early (<24 hrs) versus late (≥24 hrs) surgical decompression.

Method

Patients with acute SCI who underwent surgical decompression were identified from four prospective, multicenter SCI datasets (NACTN; STASCIS; Sygen; NASCIS III). Patients were dichotomized into early (<24 hrs) and late (≥24 hrs) surgery groups. The primary end point was change in ASIA motor score (AMS) at 1-year. Secondary outcomes included AIS grade and change in ASIA light-touch and pin-prick scores at 1-year. One-stage meta-analyses comparing outcomes for early versus late surgery were performed by hierarchical mixed-effects regression using a stratified intercept to account for clustering of patients within individual studies. Fixed-effect covariates were specified for baseline score, age, injury mechanism, AIS grade, neurological level, and steroids.

Results

A total of 1,548 patients were eligible. Patients who underwent early surgery had greater improvements than the late surgery group at 1-year for AMS (MD 4.0, 95% CI 1.7-6.2, P=0.001), light-touch score (MD 4.6, 95% CI 1.9-7.2, P=0.001), and pin-prick score (MD 4.2, 95% CI 1.5-6.9, P=0.003). Further, on ‘shift analysis’, the early surgery group achieved a more favorable distribution of AIS grades at 1-year (cOR 1.46, 95% CI 1.14-1.87, P=0.003). The effect of early surgery was strongest for cervical SCI (P=0.003); however, there was a trend toward improved recovery with early versus late surgery for thoracic SCI as well (P=0.088).

Conclusions

In an individual patient data meta-analysis adjusting for confounders, we found early surgery, within 24 hours of injury, to be associated with superior sensorimotor recovery at 1-year following acute SCI, as compared with late surgery. These findings will inform clinical practice guidelines for acute SCI.
Clinical Outcome Correlation of DTI and MRI values: A Systematic Review

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Objectives

Standard imaging for spinal cord injury (SCI), conventional MRI, can only evaluate macroscopic spinal cord changes. Comparatively, micro-structural changes can be addressed by diffusion tensor imaging (DTI). We aim to determine if DTI is a valid biomarker in SCI patients, and if it correlates better than MRI with clinical outcomes (CO).

Method

Literature search was performed in Pubmed, Medline, and Web of Science. Eligibility criteria: traumatic or acute SCI evaluated by MRI, DTI and CO with imaging values correlated with CO. Exclusion criteria: post-mortem patients, patient death upon arrival, non-traumatic SCI, lumbar SCI, chronic or degenerative myelopathy, autoimmune disorders, infection, case reports, narrative reviews, stem cell trials, animal studies, lack of CO evaluation, MRI quantitation, or MRI/DTI correlation with CO. Levels of evidence were determined based on pre-defined criteria.

Results

Literary search yielded 3444 studies (1317 duplicates), 2027 were screened, 341 were assessed, and seven were selected. Four high quality studies (HQS) identified conflicting associations between measures of DTI and various CO. However, multiple consistent studies present strong evidence that DTI FA measures (subgroup) are correlated with various CO. Limited evidence from one low quality study (LQS) demonstrated DTI measures do not correlate better with ASIA score than MRI. Moderate evidence from one HQS and one LQS supports that DTI does not have a greater correlation with ISNCSCI sensory scores than MRI. Moderate evidence from one HQS demonstrated that lateral funicle FA had greater correlation with FIM mobility scores compared to MRI. This should be interpreted with caution as it is the only relationship of many that we identified DTI being significantly greater than MRI. Additionally, most studies involve small numbers therefore posing the risk of Type II error.

Conclusions

Strong evidence supports DTI FA as a valid biomarker for CO, yet no consistent evidence indicates better correlation than MRI. Further study, with larger numbers is required to determine if specific types of DTI in addition to MRI improves prognostic classification.
A numerical study on the pathogenesis of central cord syndrome

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Objectives

The pathogenesis of the central cord syndrome is still unclear. There is a consensus that hyperextension is the main traumatic mechanism leading to this condition, however, the underlying mechanism of spinal cord injury is still debated. The aim of this study is to assesses the impact of intervertebral disc bulging and ligamentum flavum hypertrophy on the pathogenesis of central cord syndrome using numerical simulations.

Method

A detailed finite element model of the cervical spine and spinal cord was used to simulate high-speed hyperextension. Four typical case scenarios of pre-existing spondylotic cervical stenosis were modeled to study the impact of hypertrophic ligamentum flavum and intervertebral disc bulging on the von Mises stress and strain in the cord.

Results

During hyperextension, the downward displacement of the ligamentum flavum and associated reduction in spinal canal diameter (up to 17 %) led to dynamic compression of the spinal cord. Ligamentum flavum hypertrophy was associated with stress and strain (peak of 0.17 Mpa and 0.26 respectively) in the lateral corticospinal tracts which is consistent with the histologic pattern seen with a central cord syndrome. Intervertebral disc bulging alone led to a higher stress in the anterior and posterior funiculi (peak 0.22 Mpa). Combined with hypertrophic ligament flavum, it increased the stress and strain in the corticospinal tracts and in the posterior horn (peak of 0.3 Mpa and 0.3 respectively).

Conclusions

Pre-existing stenotic features (location and geometry) greatly influence the stress and strain distribution resulting from hyperextension. According to the results of this study, ligamentum flavum hypertrophy is a main feature contributing to central cord syndrome.
Feasibility And Utility Of Machine Learning In Prediction Of Bladder Outcomes After Spinal Cord Injury: Analysis of 1250 Patients from the EMSCI Registry

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Objectives

Neurogenic bladder dysfunction is a common and devastating consequence of spinal cord injury (SCI), making the early prediction of bladder function important in facilitating timely urologic management. The goal of this work is to demonstrate the feasibility and utility of machine learning (ML) as a superior tool in the prediction of independence in bladder function after SCI.

Method

Data from 1250 patients enrolled in the European Multicenter Spinal Cord Injury (EMSCI) registry were analyzed. Important predictors included baseline demographic features and neurological scores. The primary outcome measure was independence in bladder function 1-year post-injury, determined using item 6 of the Spinal Cord Independence Measure. Multiple ML models were trained and optimized on the dataset using 10-fold cross-validation. A previous logistic regression model was compared to the ML models using a separate 111-patient validation dataset from the EMSCI registry. The calibration and area under the receiver operating characteristic curves (AUC) were used to compare model performance.

Results

The extreme gradient-boosted decision tree exhibited excellent discrimination on the training set, with an AUC of 0.948. This exceeded the AUC of 0.932 that the logistic regression model showed on the same dataset. Additionally, when evaluated on the testing set, the ML model had an AUC of 0.981 (sensitivity: 89%, specificity: 98%), compared to an AUC of 0.965 of the logistic regression model. The calibration curves for the ML model also showed good concordance between the actual and predicted probabilities. Our ML models showed that an increased baseline lower extremity motor score, intact anal contraction, and pinprick sensation at S3 were the most important predictors of independence in bladder function 1 year after SCI.

Conclusions

We demonstrated that ML models provide excellent prediction of independence in bladder function after SCI. As a result, machine learning can serve as a valuable and practical tool for clinicians managing SCI.
Interventions to optimize spinal cord perfusion in patients with acute traumatic spinal cord injuries: A systematic review

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Objectives

Interventions to optimize spinal cord perfusion via support of mean arterial pressure (MAP) or spinal cord perfusion pressure (SCPP) are thought to play a critical role in the management of patients with acute traumatic spinal cord injuries, but there is ongoing controversy about efficacy and safety. We aimed to determine the effects of optimizing spinal cord perfusion on neurological recovery and risks for adverse events.

Method

We searched multiple databases for published and unpublished reports. Two reviewers independently screened articles, extracted data, and evaluated risk of bias. We synthesized data and evaluated confidence in anticipated treatment effects according to the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach.

Results

We identified 20 eligible observational studies and 1 eligible randomized controlled trial. According to low or very low quality evidence, the effect of MAP support on neurological recovery after acute traumatic spinal cord injury is uncertain, and the use of vasopressors to support MAP may be associated with increased rates of predominantly cardiac adverse events. Increased SCPP might be associated with improved neurological recovery, but SCPP monitoring via intradural catheters at the anatomical site of injury may involve increased risks of cerebrospinal fluid leakage requiring revision surgery or pseudomeningocele. No study directly compared the effects of specific MAP targets, SCPP targets, SCPP monitoring techniques, or durations of treatment. Very low quality evidence suggests that norepinephrine may have less risk of adverse events than dopamine.

Conclusions

The current literature is insufficient to make strong recommendations about interventions to support spinal cord perfusion via MAP or SCPP goals in patients with acute traumatic spinal cord injuries. Data are compatible with a variety of treatment decisions, and a nuanced approach may be optimal. Further investigation to clarify the risks, benefits, and alternatives to MAP or SCPP support in this population is warranted.
The effect of posterior lumbar spinal surgery on passive stiffness of rat paraspinal muscles 13 weeks post-surgery

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Objectives

Paraspinal muscle is a key spine stabilizer and iatrogenic muscle damage may lead to postoperative functional disability. The influence of surgery on paraspinal muscles is important, but few biomechanical studies have been done. The purpose of this study is to evaluate the passive mechanical properties of paraspinal muscle after posterior spinal surgery in an animal model.

Method

12 Sprague-Dawley rats were divided equally into 2 groups, sham and surgical injury. For the surgical injury group, the paraspinal muscles were detached from the vertebrae, per normal surgical procedure. After 13 weeks, multifidus and longissimus were biopsied at L1, L3 and L5 levels. Passive stiffness of 4 fiber bundles and 3 fibers of each muscle were tested biomechanically.

Results

220 fibers and 279 fiber bundles were tested. The passive stiffnesses of the multifidus and longissimus muscle fibers, as well as the longissimus fiber bundles, were not statistically different between the surgery and sham groups, (p>0.01). However, the stiffness of the multifidus muscle fiber bundles was significantly greater in the surgical injury group (p<0.01)

Conclusions

Posterior spine surgery changes the passive mechanical properties of multifidus fiber bundles. Fibrotic changes that result in stiffer muscle are likely important in the post-operative compensation of the spine. Future work will address the changes in muscle properties in people with spinal deformity.
a computed tomographic based morphometric analysis of the axis in adult population

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Objectives

Fractures of the Odontoid process of axis have been a matter of extensive research as it constitutes 10% of all cervical spine injuries. Odontoid screw placement although technically challenging, is the ideal treatment in indicated cases. Thorough knowledge of the dimensions of odontoid process is necessary prior to surgical endeavor, more so when planning double odontoid screws.

Method

A prospective morphometric analysis of retrospective data of 250 patients was acquired using Somatom Definition edge 128 slice 64 row detector Seimens CT Scanner. The dimensions of the odontoid process were measured at the waist (narrowest portion), widest diameter and just 2mm below the tip both in antero-posterior and transverse diameters. The dimensions of the C2 vertebra were also measured at the level of superior and inferior endplate both in the coronal and sagittal plane.

Results

A total of 250 patients were evaluated, with age ranging from 18-80 years. Males constituted 174(69.6%) while 76(30.4%) were females. Mean transverse diameter (TD) at odontoid waist (narrowest diameter) was 8.84 mm and 8.47 mm in males and females respectively (P = 0.016). Mean TD at the widest point of odontoid was 9.93 mm in males and 9.42 mm in females (P =0.002). Mean TD at C2 base was 15.07 mm in males and 13.64 mm in females (P<0.001). Mean antero posterior (AP) diameter 2.5 mm away from the midline in left side at the level of waist was 9.87 mm in males and 9.15 mm in females (P < 0.001). Mean AP diameter at C2 base was 15.82 mm in males and 14.83mm in females (P <0.001). Mean AP diameter at C2 body superior surface was 11.82 mm in males and 11.199 mm in females (P <0.001).

Conclusions

Double odontoid screw insertion is feasible in only 36% of population in the transverse plane while 98.4% of the odontoids can accommodate double screws in the sagittal plane by changing the orientation of the screws.
Is There Value to Flexion-Extension X-rays for Degenerative Spondylolisthesis? A Multi-Center Retrospective Study

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Objectives

Flexion-Extension views are frequently used to assess motion in patients with degenerative spondylolisthesis. However, they expose patients to additional radiation and potential increased cost. The aim of this study is to determine if flexion-extension x-rays provide additional information not seen on upright lateral x-rays and supine MRI that may guide surgical decision-making.

Method

From the Quality Outcomes Database, patients who had surgery for grade 1 degenerative spondylolisthesis were identified. Magnitude of slip on pre-op supine MRI, upright neutral, flexion and extension x-rays were measured. Additional motion was defined as >3mm slip difference between films. For the purpose of this analysis, patients with a slip >7mm on upright neutral were assumed to require a fusion.

Results

One hundred and ninety-one patients were identified. Mean age was 61.6 years (114 females, 60%). Only 12 patients (6%) had additional motion on flexion-extension views but not on upright x-rays vs supine MRI. Of these 12 patients, 8 had slips <7mm on upright x-ray, generating equipoise for fusion.

Conclusions

Flexion-extension x-rays may play a limited role in management of degenerative spondylolisthesis. In over 94% of spondylolisthesis cases, information utilized for surgical planning may be ascertained by comparing motion between supine MRI and upright lateral x-rays. The subset of patients for which flexion-extension views were most likely to provide value were patients with smaller slips (<7mm) with no evidence of motion on standing x-rays vs MRI.
The novel “7/20 EMG protocol” in combination with O-arm image-guided navigation for accurate lumbar pedicle placement while minimizing diagnostic radiation exposure.

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Objectives

Three-dimensional image navigation (e.g., O-arm, Stealth) has largely supplanted freehand methods and plain x-rays for accurate placement of lumbar pedicle screws. The current imaging is of such high quality that the role of electromyography (EMG) as an adjunct for safety has been questioned. Many surgeons perform “final check” O-arm imaging of screws, but this repeat patient radiation exposure may be unnecessary. The objective of this study was to validate a standardized intraoperative EMG protocol as an adjunct to O-arm image-guided navigation to reduce diagnostic radiation exposure.

Method

We are conducting a prospective cohort analysis of all patients undergoing elective lumbar instrumentation. Inclusion criteria includes age >18, elective procedure, and degenerative spinal etiology. All screws were placed using a standard “7/20 EMG protocol”, O-arm image-guided navigation, and “final check” O-arm assessment of screw placement. The primary outcome is prediction of any potentially clinically relevant pedicle breach at any stage of the procedure.

Results

Information on 45 patients and 282 pedicle screws has been collected so far. Eight screws were revised intraoperatively; four because of abnormal 7mA stim, one due to screw depth on fluoro, two due to palpable defect, and one due to 20mA stimulation. Sensitivity of 7mA stimulation is 0.8, with specificity of 0.96, and false positive rate 64%. Mann-Whitney U test found p=0.03 for 7mA stim in prediction of screw breakthrough.

Conclusions

7mA stimulation was the most common reason for intraoperative screw revision. O-arm imaging and 20mA stimulation had equal results in the setting of false positive 7mA stimulation. These findings suggest that O-arm guided navigation supplemented with EMG may render “final check” O-arm imaging of screws unnecessary.
Comparative biomechanical study of 2 types of transdiscal fixation implants for high-grade L5/S1 spine spondylolisthesis in a porcine model.

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Objectives

High-grade lytic spondylolisthesis is fused through a variety of surgical techniques, but there is little biomechanical comparison between techniques in the literature. This biomechanical study compares two transdiscal fixation techniques for high-grade spine spondylolisthesis in an in-vitro porcine lumbar spine model.

Method

Twelve lumbar-sacral porcine spines were divided into two groups. Soft tissues were removed while preserving the ligaments and discs. Segments were potted in cement at L3 and S1. Baseline range of motion (ROM) and stiffness testing was performed on intact specimens using a pure moment protocol for 3 cycles. Afterward, a high-grade isthmic spondylolisthesis was created and surgically stabilized according to the proposed technique. The transdiscal screw (Screw) technique connected L4 pedicle screws to transdiscal screws starting in S1 and crossing into the L5 vertebral body. The transdiscal fibula (Fibula) graft technique joined L4 to S1 pedicle screws associated with a transdiscal fibula strut graft. The same stiffness and ROM protocol were performed. Analysis used unpaired two-tail student T-test; significance was determined as p < 0.05.

Results

Compared to intact, both techniques had significantly less flexion-extension (FE) (p<0.001) and lateral bending (LB) (p<0.02) but no significant difference in axial rotation (AR). Screw technique had significantly less motion in FE compared to Fibula, but not in LB and AR. There was no difference in stiffness between Screw technique and intact. While, Fibula technique had significantly higher LB (p<0.001) stiffness, lower AR stiffness (p=0.017) and no difference in FE stiffness compared to intact. Screw technique was significantly stiffer than Fibula in AR (P=0.004), but not different in FE or LB stiffness.

Conclusions

Both fixation techniques limit motion and increase stiffness compared to intact. Screw is stiffer and has reduced ROM compared with Fibula.
The effects of fiber bundle size and vertebral level on passive stiffness of the lumbar paraspinal muscles in a rat model

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Objectives

Passive mechanical properties of the paraspinal muscles are important to the biomechanical functioning of the spine. In most computational models, the same mechanical properties are assumed for all paraspinal muscles, which may be untrue. Further, most studies assume that the fiber bundle stiffness is proportional to cross-sectional area, but this assumption may not completely address the effect of bundle size. The objectives of this study are (1) to explore whether passive stiffness of a fiber or a fiber bundle in paraspinal muscles depends on the spinal level and (2) to explore if the size of a fiber bundle has an influence on its passive stiffness.

Method

The left paraspinal muscles of 13 Sprague-Dawley rats were exposed under anesthesia. Six muscle biopsies were collected from each rat: three from multifidus (one per each of the L1, L3, and L5 levels) and similarly three from longissimus. From each biopsy, two to three fibers and two to six fiber bundles were mechanically tested in passive state.

Results

182 fibers and 246 fiber bundles were tested. In both muscle groups, neither the fibers nor the fiber bundles showed a significant difference in passive stiffness among the three spinal levels (for fibers: p=0.9 multifidus, p=0.08 longissimus; and for fiber bundles: p=0.13 multifidus, p=0.49 longissimus). There was a significant effect of fiber bundle size on its passive stiffness, with lower stiffness associated with larger bundles (p<0.001).

Conclusions

This study highlighted that the passive stiffness of the lumbar paraspinal muscles is independent of spinal level in a rat model. This finding provides the basis for the assumption of similar mechanical properties along a paraspinal muscle group. We found that the size of a fiber bundle influences its passive stiffness, even after normalizing for cross-sectional area. This finding emphasizes that fiber bundle sizes should be consistent when compared between different groups.
A Self-Assembling Peptide Biomaterial to Enhance Human Neural Stem Cell-Based Regeneration of the Injured Spinal Cord

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Objectives

Human induced pluripotent stem cell-derived neural stem cells (hiPS-NSCs) are a promising therapeutic approach for regeneration after traumatic spinal cord injury (SCI). Unfortunately, most patients are in the chronic phase of injury where ex vacuo microcystic cavitation forms a formidable barrier to regenerative cell migration and neurite outgrowth. QL6 (K2(QL)3K2; Medtronic Inc.) is a novel, biodegradable, peptide biomaterial which self-assembles into an extracellular matrix (ECM)-like lattice in vivo. It has previously been shown to reduce inflammation and support endogenous and exogenous mouse cell survival. However, its ability to support translationally-relevant hiPS-NSCs continues to be a critical knowledge gap.

Method

Nonvirally-derived hiPS-NSCs were cultured on QL6 biomaterial versus a Geltrex ECM control. The mechanism of adhesion was assessed by EDTA assay and qPCR. hiPS-NSC survival, proliferation, and neurosphere formation were extensively characterized in vitro through immunohistochemistry and scanning electron microscopy techniques. T-cell deficient RNU rats (N=60) capable of supporting a human graft were given a clinically-relevant C6-7 clip-contusion injury or sham surgery. In the chronic injury phase, animals were randomized to: (1) vehicle, (2) hiPS-NSCs, (3) QL6, or (4) QL6+hiPS-NSCs. All rats received delayed daily treadmill rehabilitation. A subset of animal cords underwent high throughput single-cell RNA sequencing (scRNAseq).

Results

hiPS-NSCs proliferated robustly on self-assembled QL6 vs control as demonstrated by Ki67+/DAPI+ immunocytochemistry (29% vs 6%; p<0.01). EDTA adhesion assay demonstrated that human NSC binding to QL6 is largely driven by calcium-independent mechanisms. Importantly for NSCs, QL6 enhanced the formation of adherent neurospheres, the native conformation of NSCs. SEM imaging demonstrated an interwoven human NSC-biomaterial interaction in vitro. Blinded sensorimotor assessments of transplanted rats are ongoing with a 22-week post-injury endpoint. Early scRNAseq differential gene expression analyses demonstrate enhanced mature oligodendrocyte marker expression (MBP, MAG) by the graft when co-transplanted with QL6.

Conclusions

This work provides key proof-of-concept data that QL6 self-assembling peptide can support translationally-relevant human iPS-NSCs for use in traumatic SCI.
Measuring Demyelination, Axonal Loss and Inflammation after Human Spinal Cord Injury with Quantitative Magnetic Resonance Imaging and Histopathology

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Objectives

Magnetic resonance imaging (MRI) is commonly utilized to characterize spinal cord damage after acute traumatic injury. Objective MRI biomarkers could help define injury severity and prognosticate outcome after spinal cord injury (SCI). While MRI features have been correlated to injury severity and used to predict outcome, it is typically not possible to relate MRI features with the actual histopathology within the injured spinal cord. Here, we took advantage of post-mortem spinal cords obtained from acute SCI patients to relate specific quantitative MRI features with the actual histology of the injured spinal cord.

Method

Eleven whole formalin-fixed spinal cords from the International SCI Biobank had high-field 7 Tesla MRI to assess myelin (inhomogeneous magnetization transfer, ihMT) as well as axons, intracellular water, extracellular water and free water (diffusion basis spectrum imaging, DBSI). Time from SCI to death was 1-60 days. After MRI, the cord was sectioned and stained with H&E (nuclei/cytoplasm), luxol fast blue (myelin phospholipids), phosphorylated neurofilament (axons) and fibrinogen (blood-spinal cord barrier breakdown). Ascending sensory and descending motor tracts were examined.

Results

Histology showed axonal spheroids in H&E and phosphorylated neurofilament stains, and blood-spinal cord barrier breakdown through fibrinogen leakage. ihMT was significantly correlated with myelin staining \( R^2=0.731, p<0.001 \). ihMT and DBSI-measured axon fiber fraction were 20-30% lower in downstream areas, consistent with demyelination and axonal loss due to Wallerian degeneration. In the same areas intracellular water increased by 20%, possibly due to greater density of inflammatory cells. Extracellular and free water increased up to 50% near the injury epicentre, consistent with edema and tissue structure breakdown.

Conclusions

ihMT was established as a biomarker for myelin in human spinal cord tissue. DBSI and ihMT MRI techniques detected microstructural changes in downstream areas consistent with Wallerian degeneration in acute and subacute lesions in SCI. This is the first study to correlate these quantitative MRI measures with actual histopathologic findings in acute human SCI.
Characterization of ubiquitin C-terminal hydrolase L1 (UCH-L1) as a fluid biomarker of human traumatic spinal cord injury

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Objectives

A major obstacle for translational research in acute SCI is the lack of biomarkers that can be utilized to objectively stratify injury severity and predict outcome. Given the pathophysiologic similarities of neurotrauma in the brain and spinal cord, we hypothesize that TBI biomarkers will also be useful as diagnostic and prognostic biomarkers of SCI. UCH-L1 is a neuron-specific enzyme that has been proposed as a diagnostic biomarker in TBI, with FDA-approval granted in 2018 for its use as a screening tool in mild TBI.

Method

CSF and serum samples were collected as part of an ongoing multicenter clinical initiative in acute SCI patients with prospectively collected neurologic outcomes at 6 months post-injury (ClinicalTrials.gov NCT01279811). UCH-L1 concentration was measured using the Quanterix Simoa platform in 10 laminectomy controls and 32 SCI patients and correlated to injury severity, time and neurologic recovery.

Results

CSF UCH-L1 was significantly elevated 10-100-fold over laminectomy controls in an injury-severity-dependent manner following SCI, with sustained elevations observed in the most severely injured patients up to 5 days. While initial levels of CSF UCH-L1 were not significantly different between those SCI patients who improved an AIS grade over 6 months versus those who did not improve, categorizing subjects based on the trajectory of CSF UCHL-1 over the first 5 days post injury was 80% accurate in predicting AIS conversion in AIS A subjects. Further, 24-h post-injury CSF UCH-L1 concentrations were negative correlated with motor score change over 6 months. There was a weak to moderate correlation between serum and CSF UCH-L1; however, no change between acute SCI and control was observed.

Conclusions

Our first evaluation of UCH-L1 in acute SCI shows promise as a biomarker in CSF to reflect injury severity and predict outcome in acute SCI. Further assay development to increase sensitivity is required to translate utility to serum analysis.
Utility and Role of Virtual Reality-based Simulation Models in Spinal Decompression Training

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Objectives

Surgical simulation is a valuable educational tool for trainees to practice in a safe, standardized, and controlled environment. Interactive feedback-based virtual reality (VR) has only recently moved to the forefront of spine surgery training, with the majority of commercial products focused on pedicle screw placement. A paucity exists of learning tools to understand anatomy, pathology, and principles of treatment in spinal stenosis. The purpose of this study was to evaluate the efficacy of VR simulation models and its educational role in decompression surgery.

Method

A VR simulation module was designed using the Samsung Odyssey user interface and incorporated patient-specific 3D-interactive models of lumbar spinal stenosis. A surgical toolkit allowed users to perform decompression procedures. Orthopaedic and neurosurgical trainees were prospectively enrolled. Subjects underwent a pre-test on anatomical knowledge and critical information on spinal stenosis, followed by performing VR spinal decompression. A post-test and exit questionnaire was administered to assess module utility as a learning device.

Results

A total of 15 trainees were enrolled (12-orthopaedic, 3-neurosurgery). Pre-test scores on spine anatomic knowledge progressively improved and showed strong positive correlation with year in training (Pearson’s r = 0.78). Following simulation, the average improvement in post-test scores was 11.7% in junior trainees (PGY-I-II), and 2.9% in senior trainees (PGY-III-Fellows). 93% of participants found the VR module useful in understanding the pathology of spinal stenosis. 80% found it useful in learning to perform a decompression. 100% believed it had utility in preoperative planning with patient-specific models.

Conclusions

Simulations play a vital role in medical-training and can be influential as surgical curriculums become more competency-based. Our original VR spinal decompression module has shown to be overwhelmingly positively received amongst trainees as both a learning module of patho-anatomy and patient-specific preoperative planning, with particular benefit for junior trainees. With further integration of haptic and acoustic-feedback, VR-based training modules will be instrumental in the future of surgical education in a way that is interactive, safe, and immersive.
Investigating the determinants for predicting surgical patient outcomes through the application of machine learning methods.

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Objectives

The Calgary Spine Assessment Score (CSAS) is a surgical spine referral scoring system, consisting of clinical, pathological and radiological criteria. Using machine learning methods, we sought to determine the subset of features from the CSAS and patient reported scores that may predict surgical outcomes.

Method

145 retrospective, surgical patients with degenerative lumbar conditions were included. Initial dataset contained demographic data, CSAS, pre/post-operative SF-12 PCS, ODI and VAS. Waikato Environment for Knowledge Analysis (WEKA) was utilized. Feature selection was performed using information gain ratio. Classification models based on decision tree (C4.5), support vector machine with stochastic gradient descent (SVM-SGD) and logistic regression with stochastic gradient descent (Log-SGD) algorithms were trained on selected features to predict SF-12 PCS. Classification performance was evaluated with 10-fold cross validation following 10 runs, and statistically compared against a baseline classification model, based on the zero-rule (ZeroR) algorithm, using a corrected resampled paired t-test (significance level=0.05).

Results

An information gain ratio of 0.005 was determined to be appropriate for feature selection in predicting SF-12 PCS related surgical outcomes, resulting in a reduction from 9 to 3 clinical, 7 to 4 pathological, 10 to 4 radiological Assessment Score features, as well as a reduction from 73 to 43 total dataset features. Assessment Score features with the highest information gain ratio, and therefore relevance, were indeterminate pathology (0.1918), radiological instability (0.1677), and congenital pathology (0.1216). Baseline mean and maximum classification accuracies were 62.24% and 62.24% respectively for ZeroR. Mean and maximum classification accuracies were 80.70% and 82.56% for C4.5, 76.24% and 80.45% for Log-SGD, 77.64% and 81.22% for SVM-SGD.

Conclusions

Information gain ratio resulted in an acceptable initial selection of a subset of features from the Assessment Score, SF-12 PCS, ODI, and VAS most relevant to predicting SF-12 PCS and ODI related surgical outcomes. C4.5, Log-SGD, and SVM-SGD models resulted in statistically significant improvements over the baseline model for predicting SF-12 PCS related surgical outcomes.
Comparison of screw design and technique on cervical lateral mass screw fixation

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Objectives

The goal of this study is to determine the best screw type, insertion depth and trajectory for achieving optimal mechanical strength of the bone-screw interface for cervical lateral mass screws.

Method

Two lateral mass screw designs, two surgical techniques, and three purchase depths are being tested and compared for lateral mass screw fixation. This includes: 1) cortical versus cancellous thread-types, 2) Roy Camille versus Magerl trajectory, and 3) depth of fixation: bicortical, backed-out bicortical, and unicortical.

Screws are being tested in laminated cortical-cancellous-cortical artificial bone blocks of similar material properties to cortical and cancellous bone found in the cervical spine. Static axial pull-out tests are being performed using a controlled load frame apparatus, where screw fixation is defined as maximum force to pull-out failure. Six replicates will be tested per sample group. Group means and standard deviations are to be reported and compared between sample groups to assess the variables of screw fixation strength in cervical spinal fusion.

Results

Preliminary pull-out strength results demonstrate that regardless of insertion trajectory, bicortical purchase depth is stronger than both unicortical and backed-out bicortical purchase depths (Roy-Camille: 666±50N vs 522±37N vs 582±19N) (Magerl: 462±55N vs 338±28N vs 354±31N). Furthermore, no difference is seen between unicortical and backed-out bicortical purchase depths.

Additionally, regardless of purchase depth, the Roy-Camille technique demonstrates stronger pull-out strengths than Magerl (bicortical: 666±50N vs 462±5N, backed-out bi-cortical: 522±37N vs 338±28N, unicortical: 582±19N vs 354±31N).

No difference is seen between cancellous and cortical screw types.

Expected date of completion for testing is December 2019.

Conclusions

Preliminary results demonstrate stronger pull-out strength in bicortical compared to both unicortical and backed-out bicortical purchase depths, as well as Roy-Camille compared to Magerl insertion techniques. No difference is found between unicortical and backed-out bicortical purchase depths, or cancellous and cortical screws for cervical lateral mass fixation.
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 EQ5D scores. Internal validation involved 200 bootstrap iterations; calibration and discrimination were evaluated.

Results

Higher SF-36 physical component score (PCS) (HR: 0.96) was associated with longer survival 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 associated with shorter survival (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.
Sarcomas of the Spine; A 20-Year Survey of Disease and Treatment Strategy in Ontario, Canada.

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Objectives

Spinal sarcomas are a rare, heterogeneous group of mesenchymal tumors and current literature reporting demographic variables and survival information is limited to small case series. We report on all spinal sarcomas diagnosed over a 20 year period in Ontario, Canada with regards to 5 and 10 year survival, as well as treatment strategies over time.

Method

Utilizing population-based data from the Institute for Clinical Evaluative Sciences (ICES) between 1993 and 2015, ICD codes were searched and available data extracted for the purposes of reporting basic demographic information and calculation of Kaplan Meyer survival curves. Databases used include the Ontario Cancer Registry, Discharge Abstract Database, Ontario Health Insurance Plan, National Ambulatory Care Reporting System, Registered Persons DataBase (death) were linked.

Results

122 spinal sarcomas were diagnosed. The most common diagnosis was Ewing’s sarcoma (39.34% of spinal sarcomas), followed by chondrosarcoma (27.45% of diagnoses), followed by osteosarcoma (20.49% of diagnoses). The poorest survival was seen with spinal osteosarcoma with a 5 and 10-year survival of 36% and 30.9%, respectively. Ewing’s sarcoma had a 48.1 and a 44.9% survival for 5 and 10 year survival, respectively. Chondrosarcoma had a 77.2% and 64.2% survival for 5 and 10 years respectively. Four percent of patients encountered between 1993-2003 had surgery compared to 21.4% of patients between 2004-2015.

Conclusions

The reported survival is within the published ranges for all tumors, except for spinal chondrosarcoma, which was well above the previously reported 55-65% reported in all smaller case series. The reason for this is ultimately unknown, but attributed to advancements in surgical care over the last 20 years in spinal surgery, as well as the variability in treatment strategies which have developed over the last 20 years. This is the largest series of spinal sarcomas published to date and offers insight into treatment outcomes.
Metastatic spine disease: Should patients with short life expectancy be denied surgical care? An international retrospective cohort study.

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Objectives

Despite our inability to accurately predict survival in many cancer patients, a life expectancy of at least three months is historically necessary to be considered for surgical treatment of spinal metastases. The primary objective of this study was to compare health related quality of life in patients surviving < 3 months after surgical treatment to patients surviving > 3 months to assess the validity of this inclusion criteria.

Method

Patients who underwent surgery for spinal metastases between August 2013 and May 2017 were retrospectively identified from an international cohort study. HRQOL was evaluated using generic and disease specific outcome tools at baseline and at 6- and 12-weeks post-surgery. The primary outcome was the HRQOL at 6 weeks post treatment measured by the SOSGOQ.

Results

A total of 253 patients were included; 40 patients died within the first three months after surgery and 213 patients survived more than 3 months. Patients surviving < 3 months after surgery presented with lower baseline performance status. Adjusted analyses for baseline performance status did not reveal a significant difference in HRQOL between both groups at 6 weeks post treatment. No significant difference in patient satisfaction at 6 weeks with regards to their treatment could be detected between both groups.

Conclusions

When controlled for baseline performance status, quality of life 6 weeks after surgery for spinal metastasis is independent of survival. To optimize improvement in HRQOL for this patient population, baseline performance status should take priority over expected survival in the surgical decision-making process.
Nanoparticle-Functionalized Poly-methyl Methacrylate Bone Cement for Sustained Chemotherapeutic Drug Delivery

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Objectives

Studies have shown that drugs loaded unto poly-methyl methacrylate (PMMA) cement are released in small bursts in the first 48-72 hours, the remaining drug is trapped without any significant release over time. The objective of this study is to develop a nanoparticle-functionalized PMMA cement for use as a sustained doxorubicin delivery device. We hypothesize that PMMA containing mesoporous silica nanoparticles will release more doxorubicin than standard PMMA.

Method

High viscosity SmartSet ™ PMMA cement by DePuy Synthes was utilized. The experimental group consisted of 3 replicates each containing 0.24 g of mesoporous silica nanoparticles, 1.76 g of cement powder, 1ml of liquid cement monomer and 1 mg of doxorubicin. The control group consisted 3 replicates each containing 2.0 g of cement powder, 1ml of liquid cement monomer and 1 mg of doxorubicin. The experimental group contained an average of 8.18 ± 0.008 % (W/W) mesoporous silica nanoparticles. Each replicate was casted into a cylindrical block and incubated in a PBS solution which was changed at predetermined intervals for 45 days. The concentration of eluted doxorubicin in each solution was measured using a florescent plate reader. The mechanical properties of cement were assessed by unconfined compression testing. The effect of the doxorubicin released from cement on prostate and breast tumor cell metabolic activity was assessed using the Alamar Blue test.

Results

After 45 days the experimental group released 3.24 ± 0.25 % of the initially loaded doxorubicin which was more than the 2.12 ± 0.005% released by the control group (p 0.03). There was no statistically significant difference in Young’s modulus between groups (p 0.53). Nanoparticle functionalized PMMA suppressed the metabolic activity of prostate cancer by more than 50 percent but did not reach statistical significance. Nanoparticle functionalized PMMA suppressed the metabolic activity of breast cancer cells by 69 % (p < 0.05).

Conclusions

Nanoparticle-functionalized PMMA cement can release up to 1.53 times more doxorubicin than the standard PMMA.
Development of the Spine Oncology Study Group Outcomes Questionnaire – 8 Domain (SOSGOQ-8D)

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Objectives

AOSpine Knowledge Forum Tumor developed the spine oncology-specific outcome composite measurement scale known as the SOSGOQ2.0, which has been demonstrated to be a valid and reliable tool for measuring patient reported health related quality-of-life (HRQOL), but no mapping to utilities exists. The ability to calculate quality-adjusted life-years (QALYs) for metastatic spine disease would enhance treatment decision making and facilitate economic analysis.

Method

SOSGOQ responses obtained from the Epidemiology, Process and Outcomes of Spine Oncology (EPOSO) and Metastatic Tumor Research and Outcomes Network (MTRON) studies were used in a hybrid concept-retention and factorial analysis shortening approach. Confirmatory factor analysis was used to identify candidate items from the physical function, pain, mental health and social function domains. Poisson regression was used to identify the optimal combination of items.

Results

All 4 neurologic function single questions (leg weakness, arm weakness, bladder dysfunction, bowel dysfunction) were retained to maintain content validity and clinical relevance. CFA demonstrated adequate model fit and confirmed the structure of non-neurologic SOSGOQ2.0 domains. All items were clinically relevant (factor loadings > 0.50). The highest loading items were: limitations in activities of daily living and travelling from home (physical function); mobility limitation from pain and overwhelming pain (pain); impaired concentration and relationships (social function). Poisson regression models for all combinations of candidate questions provided excellent fit. The regression model with the lowest rank sum consisted of SOSGOQ2.0 items 3, 13, 16, and 19.

Conclusions

We have developed an eight-item questionnaire by formally shortening SOSGOQ2.0, which can be used to facilitate mapping of utilities. Analysis indicates that in addition to the neurologic single items from the SOSGOQ2.0, the SOSGOQ-8D should include the following SOSGOQ2.0 items:

- “Does your spine limit your ability to care for yourself?”
- “How much has your pain limited your mobility (sitting, standing, walking)?
- “Have you felt depressed?”
- “Do you feel that your spine condition affects your personal relationships?”
Presentation K72

Abstract ID 6

Treatment expectations of patients with spinal metastases; what do we tell our patients?

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Objectives

Recent research has demonstrated that patients with advanced lung and colon cancer are often overly optimistic regarding the outcomes of their cancer treatment. Realistic treatment expectations are important, as health related quality of life (HRQOL) following treatment has been associated with meeting pre-treatment expectations. Patients develop these expectations largely on the information provided by their physician. The purpose of this study was to explore the information provided by physicians to patients with spinal metastases scheduled for surgery and/or radiotherapy. In addition, the goal was to explore how physicians verify treatment expectations with their patients.

Method

A qualitative study using semi-structured interviews with spine surgeons, radiation and medical oncologists, and rehabilitation specialists was conducted. Physicians were asked about the content and extent of information they provide to patients with spinal metastases regarding treatment options, risks and treatment outcomes. In addition, physicians were asked whether they verify patient expectations, how they cope with unrealistic expectations and possible solutions to improve patient expectations. Interviews were transcribed and analyzed by two researchers to identify common themes.

Results

Risks of treatment, disease status and the overall goal of treatment are generally discussed during the consult of patient with spinal metastases. Other topics including prognosis, pain, physical and neurological function; are discussed yet to a limited extent. Interviewed physicians reported a lack of insight into the expectations of patients regarding treatment outcomes. Suggestions to improve treatment expectations included improving the multidisciplinary care approach for patients with spinal metastases and giving more detailed treatment information.

Conclusions

Currently, physicians involved in the care of patients with spinal metastases generally do not verify treatment expectations with their patients. Information about goals of treatment, risks and disease status is provided. On the other hand, limited information regarding post-treatment pain, physical and neurological function is given. Improving communication regarding treatment expectations, thereby establishing realistic expectations is essential, as it may further improve patient self-perceived outcomes.
Factors related to risk of opioid abuse in primary care patients with low back pain

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Objectives

While patients with low back pain (LBP) are often prescribed opioids, the risk of opioid abuse has not been well characterized in the primary care LBP population. The objective of this study is to identify factors associated with increased risk of opioid abuse as measured by the Opioid Risk Tool (ORT) among primary care LBP patients.

Method

Patients referred from primary care to an interprofessional LBP program completed the ORT at intake. Patients at moderate or high risk of opioid abuse were compared with patients at low risk on a range of patient-reported factors.

Results

The sample comprised 1908 patients (55% female, mean age 50.4 years). Overall, 15% of patients were at increased (i.e. moderate/high) risk of opioid abuse, and 22% reported current opioid use. 31% of the increased-risk group reported current opioid use versus 20% of the low-risk group (p<0.001). Factors associated with increased risk of opioid abuse included Percocet use (p<0.001), higher back pain severity (p<0.001), worse Oswestry Disability Index (p<0.001), lower resilience (Connor-Davidson Resilience Scale-2, p<0.001), lower self-efficacy (Self-Efficacy for Managing Chronic Disease, p<0.001), increased back pain chronicity risk (STarT-Back, p=0.001), being unemployed or on disability benefit (p<0.001), smoking (p=0.001), and more comorbid health conditions (p=0.001). Gender, body-mass index, leg pain severity, and anatomical LBP pattern were not associated with opioid abuse risk.

Conclusions

Over 1 in 5 primary care LBP patients were current opioid users, and one-fifth of these patients were at increased risk of opioid abuse. Furthermore, 1 in 7 non-users were at increased risk of abuse. Given the high prevalence of clinical LBP, these estimates suggest that careful consideration is warranted around use and abuse of opioids in LBP, including awareness that use may be associated with poorer LBP outcomes.
QI/QA of a Transitional Outpatient Pain Program for Spine

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Objectives

Pre-operative opioid use has been identified as a concern in surgical patients, with reported rates of 15-30% in the spine population. Pre-operative opioid use is one of the biggest risk factors for chronic post-operative use, and has been linked to worse outcomes. Strategies to decrease opioid use have been mandated federally and provincially. We have implemented a novel Transitional Outpatient Pain Program for Spine (TOPPS) at a single institution.

This quality improvement study describes the TOPPS program, and evaluates its success on tapering opioids, and its impact on pain catastrophizing and disability for the first 22 patients.

Method

TOPPS was offered to elective spine surgery patients with a history of chronic non-malignant pain and on chronic daily opioid therapy (>3 months). Patients underwent opioid tapering prior to surgery and after surgical intervention. They also had acceptance and commitment therapy (ACT) with the goal of reducing pain catastrophizing, and participated in an individualized exercise program to reduce kinesiophobia.

Opioid use was measured as morphine equivalents daily (MED). Catastrophizing was measured using the Pain Catastrophizing Scale (PCS). Disability was measured using the Pain Disability Index (PDI).

Pre and post TOPPs opioid use and outcome measures were compared using the Wilcoxon matched-pairs signed-ranks test. Patients who started the program prior to surgery (GROUP 1 n=12) and those who started the program after surgical intervention (GROUP 2 n=12) were analyzed separately.

Results

Patients showed a significant reduction in opioid use following completion of the TOPPS program (Group 1 median MED 0 vs 84, p=0.0029; Group 2 median MED 0 vs 38.75 p=0.0051). Our results also demonstrate a significant improvement in the Pain Catastrophizing Scale (Group 1 median PCS 11 vs 30, p=0.0076) and Pain Disability Index (Group 1 median PDI 25 vs 44, p=0.0086; Group 2 median PDI 18 vs 38, p=0.0086).

Conclusions

This study suggests that opioid tapering and treatment within an interdisciplinary pain management program reduced opioid use and improved outcomes for surgical spine patients.
The effect of pre-operative opioid use on hospital length of stay in patients undergoing elective spine surgery

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Objectives

The relationship between pre-operative opioid use and hospital length of stay (LOS) remains unclear. Our aims were 1) to determine the impact of pre-operative opioid use on LOS in adult patients undergoing elective spine surgery at our institution; 2) to evaluate the impact of pre-operative opioid dose on LOS.

Method

A retrospective chart review was conducted on consecutive adult patients admitted following elective spine surgery and seen by the acute pain service at a single institution for one year. Post-operative LOS, demographic variables and pre-operative analgesics used (including dose) were obtained. The maximum prescribed opioid dose was converted to oral morphine equivalents (MEQ) and patients whose daily dose was ≥ 90 MEQ were considered high opioid users. Multivariate logistic regression analyses were performed to assess the effect of opioid use and dose on LOS, while adjusting for confounders.

Results

A total of 220 patients were included in the analysis; 111 (50.5%) were not prescribed opioids pre-operatively (non-opioid group), while 109 (49.5%) were prescribed opioids pre-operatively (opioid group). The median maximum prescribed daily dose was 30mg oral morphine equivalent (OME) (range 1.2-480mg OME). A moderate correlation was found between LOS and opioid dose (R = 0.21, p = 0.0019). When the patients were categorized based on amount of pre-operative opioids, high opioid users (>90mg OME) had significantly longer LOS compared to the other two groups (p < 0.05).

Conclusions

High-dose pre-operative opioid use was associated with increased LOS in patients undergoing elective spine surgery requiring admission at our single tertiary care centre. These findings provide support for implementation of interventions to decrease opioid use and LOS in spine surgery patients. Future research should assess the costs and benefits of such interventions.
Disability or Pain; which best predicts patient satisfaction with surgical outcome? A CSORN Study

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Objectives

Because the experience of pain, and its effect on quality of life, varies by individual, this study examined whether self-reported improvement in disability has a greater effect than pain reduction on satisfaction with spine surgery.

Method

The CSORN registry was queried for patients who received surgery for degenerative lumbar disease and provided 12-months post-operation Oswestry Disability Index (ODI), pain and satisfaction data. ODI, back, and leg pain improvements were assessed as to which better predicted satisfaction with surgery. Secondary analysis examined EuroQoL and SF-12 PCS relationship to satisfaction as alternative measures of quality of life and 3- and 24-month data for effect durability over time. Analysis was conducted together and separately for each diagnosis (Spondylolisthesis, Disc Herniation, Disc Degeneration, Deformity, and Stenosis).

Results

Patient satisfaction with surgery was similarly correlated with reductions in back pain (rho = -0.42), leg pain (rho = -0.39967), and ODI (rho = -0.4368826) when all diagnoses were combined. This association was found on both univariate and multivariate analysis (p<0.00001). The ODI correlation with satisfaction ranged across diagnoses from rho = -0.41 (Spondylolisthesis) to -0.50 (Degenerative Disc Disease) whereas the correlation between back or leg pain improvement and satisfaction varied much more across diagnoses (rho = -0.24 to -0.56).

Conclusions

Although degenerative spine patients often present with the primary complaint of pain rather than disability, improvement in disability appears to be similarly predictive of patient satisfaction with surgery in general as does improvements in pain. However, as the location of the pain being targeted by surgery (back vs leg) varies by diagnosis, mirrored by the variable correlation between a given pain location and satisfaction, ODI may be a better choice if a standard metric of surgical success is desired across multiple diagnoses.
Rapid access to interventional pain management for lumbar nerve root pain through collaborative interprofessional provider networks.

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Objectives

A pilot collaborative agreement between two separately funded programs, the rapid access Interprofessional Spine Assessment and Education Clinics (ISAEC) and the Toronto Academic Pain Medicine Institute (TAPMI), was created to reduce wait-times for targeted nerve injections (NIs). The objective of this study was to assess the impact of this collaborative network approach on wait-times for lumbar nerve injections for appropriately selected patients.

Method

A retrospective review of prospectively collected data from a single ISAEC site. Prior to the ISAEC-TAMPI collaborative approach, ISAEC patients where referred for nerve injections (NI) through existing regional institutional options (interventional radiology or anaesthesia pain clinics). The ISAEC-TAMPI pilot collaborative facilitated dedicated NI slots for ISAEC patients meeting appropriate agreed upon criteria. The following wait-times were collected prior to and after implementation of ISAEC-TAMPI collaboration: 1) Primary Care Provider to ISAEC – community based Advance Practice Provider assessment (PCP-APP); APP to ISAEC-centralized Speciality Practice Lead assessment (APP-PL); and PL to NI procedure (PL-NI). Descriptive statistics were utilized.

Results

There were 67 and 76 patients the pre and post collaboration groups respectively. The average age was 50 years with 40 females in the pre and 57 years with 41 females in the post group. Mean PCP-APP wait was 19 vs. 21 days and the mean APP-PL wait was 23 vs. 25 days in the pre vs. post group respectively. The mean PL-NI wait was 125 (43-426) vs. 42 (1-120) days in the pre vs. post group respectively. The median PL-NI was 106 vs. 40 days in the in the pre vs. post group respectively. From the perspective of the TAMPI interventional pain specialist, referral appropriateness from ISAEC was 98%.

Conclusions

Our study demonstrates that synergist networked collaborations can improve appropriateness and significantly reduce wait-times for specific limited access interventions. Consideration should be given to more formal assessment of the efficiencies and cost-effectiveness of such models.
Chronic pre-operative opioid use associated with higher peri-operative resource utilization and complications in adult spinal deformity patients

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Objectives

Prior to surgical consultation, patients are frequently started on opioid medications despite growing evidence discouraging this practice. Chronic opioid use has been reported in 15 to 30% of patients with degenerative pathology, but is poorly reported in the adult spinal deformity (ASD) population.

This study quantifies the effect of pre-operative opioid use on peri-operative resource utilization and complications in ASD patients undergoing surgery.

Method

Single center study of consecutive ASD patients. Patients were enrolled in a registry where demographics, HRQLs, surgical metrics, and complications were recorded prospectively. Opioid use and resource utilization were collected through chart reviews. The impact of opioid use on peri-operative resource utilization and complications was examined using multivariate regression accounting for confounders, or univariate analysis as appropriate.

Results

139 patients were included, and divided into two groups based on pre-operative opioid use: opioid naive n=52, and chronic opioid n=87. Among chronic opioid users, average pre-operative opioid use was 122.5 MED, with 43% on doses >90 MED. The chronic opioid were more frequently revisions (68.3% vs 50%, p=0.039). The groups were similar in regards to baseline demographics, magnitude of deformity, and surgical invasiveness.

The chronic opioid group had more frequent involvement of the acute pain service (48.2% vs 7.84%, p=0.0001), and more frequent use of ketamine (36.4% vs 7.84%, p=0.0001) and lidocaine (14.1% vs 0%, p=0.005) infusions. Pre-operative MED correlated with PCA duration (r=0.29, p=0.0018). The chronic opioid group had higher post-operative opioid requirements (POD1 MED 388.6 vs 178.83, p=0.004 – POD7 MED 198.92 vs 86.23, p=0.0066), and had a higher incidence of peri-operative complications (IRR 1.53, p=0.029). Patients in the chronic opioid group showed a trend towards more frequent non-routine discharge (home hospital / rehabilitation / skilled nursing facility) (30.4% vs 16.6%, p=0.07).

Conclusions

63% of ASD patients were on chronic opioid analgesia prior to surgery. Opioid use was associated with increased peri-operative resource utilization, higher rates of complications, and more frequent non routine discharge.
Cervical Disc Arthroplasty versus ACDF: A Longitudinal Analysis of Reoperations

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Objectives

Anterior cervical discectomy and fusion (ACDF) is an effective treatment for cervical spondylosis. A shortcoming of ACDF is the risk of adjacent-segment degeneration (ASD), owing to arthrodesis of a motion segment. Cervical disc arthroplasty (CDA) has garnered attention in effort to mitigate ASD; yet, compelling evidence of reduction in ASD requiring subsequent operation is lacking. This systematic review and meta-analysis sought to compare longitudinal adjacent-level reoperation rates with CDA versus ACDF for symptomatic one- or two-level cervical spondylosis out to long-term follow-up.

Method

An electronic literature search was conducted. Eligible studies were multi-center RCTs comparing CDA with ACDF for one- or two-level symptomatic cervical spondylosis. The primary outcome was adjacent-level reoperation. Index-level reoperation was examined as a secondary outcome. Outcomes were evaluated at 1-year intervals from the index operation to last reported follow-up by random-effects meta-analyses.

Results

Eleven RCTs were eligible. For one-level cervical spondylosis, there was no difference in the rate of adjacent-level reoperation between CDA (2.3%) and ACDF (3.6%) at 2 years. However, a very large difference favoring CDA became evident at 5 years and persisted at 7 years (4.3% vs. 10.8%, P<0.001). Significantly fewer patients who underwent CDA required index-level reoperation at all time points out to 7 years (5.2% vs. 12.7%, P<0.001). Similar to one-level operations, there was no significant difference in adjacent-level reoperations with two-level CDA (1.7%) versus two-level ACDF (3.4%) at 2 years. At 7 years, a significant difference favoring CDA became apparent (5.1% vs. 10.0%, P=0.014). Two-level CDA also resulted in fewer index-level reoperations out to 7 years (4.2% vs. 13.5%, P<0.001).

Conclusions

In this meta-analysis, the short-term rate of adjacent-level operation was similar with CDA or ACDF. However, around 5 years, a statistically significant divergence emerged, where the rate of adjacent-level operation rose steeply for ACDF. Index-level reoperations were less frequent with CDA in both the short- and long-term. These data indicate CDA may have a superior longevity to ACDF.
**Preliminary Results of Randomized Controlled Trial Investigating the Role of Psychological Distress on Cervical Spine Surgery Outcomes: A Baseline Analysis**

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**Objectives**

Determine the effectiveness of brief psychological intervention on outcomes in cervical spine surgery.

**Method**

35 patients age >18 with symptomatic cervical degenerative disease have been enrolled in the study. If patients met psychological distress criteria, they were in the treatment group: DRAM >17 and <33, FABQ >49/66, PCS >30/52 or OEQ ≤2 (randomized to CBT or placebo). CBT and sham treatment groups had 6 sessions prior to surgery. The control group had no intervention prior to surgery. Baseline and 3M changes were assessed for all outcome measures.

**Results**

35 patients enrolled (53.9yrs, BMI 28.7 kg/m²). 22 patients met psychological distress criteria and were randomized into a treatment group (13 CBT vs. 9 placebo). 13 patients in the control group, with 5 having too high of DRAM scores to be CBT candidates. At enrollment, the average DRAM was 34.55, with the DRAM observational group, Placebo, and CBT all having higher scores than control patients (45.6 vs 13.4, P<0.001). Treatment patients had higher baseline FABQ scores than controls (45.9 vs 20.4, P=0.004). The overall OEQ score was 3.78, with all controls scoring 5 and CBT/Placebo patients answering 3-4 out of 5. At 3M postop, all groups showed improved outcomes in all measurements. Between CBT, placebo, and control patients, CBT had greater postop improvement in all questionnaires compared to non-treatment groups (DRAM: 34.9→30.8 CBT, 35.2→22.4 placebo, 11→10 no risk controls, FABQ: 40.8→35.2 CBT, 38.3→37.8 placebo, 19→21 no risk controls, PCS: 31.8→17.4 CBT, 32.8→11.6 placebo, 15→6 no risk controls, OEQ: Disagree→Strongly Agree CBT, Disagree→Agree placebo, Strongly Agree→Strongly Agree, no risk controls).

**Conclusions**

Preliminary results of this randomized controlled study showed that patients who received cognitive behavioral treatment before surgery had better improvement in all psychological-related questionnaires compared to non-treatment patients. Long-term follow up will assess the impact of psychological intervention for at risk patients.
Operative versus Non-Operative Treatment of Geriatric Odontoid Fractures: A Study of North American Trauma Centers

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Objectives

With the aging population, the optimal management of geriatric type 2 odontoid fractures has become an increasingly relevant clinical problem. This study sought to perform a head-to-head comparison of the inpatient outcomes of non-operative treatment versus posterior C1-2 fusion for type 2 odontoid fractures in elderly patients (≥65 yrs).

Method

Data were derived from the American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP) database for 2016. Patients ≥65 years old with an acute type 2 odontoid fracture were identified by ICD-10-CM codes. Cases of posterior C1-2 fusion were identified by ICD-10-PCS codes. Propensity score matching of non-operative versus operative treatment was performed in 1:1 ratio adjusting for age, sex, race, comorbidities, mechanism of injury, and ISS. The primary outcome was inpatient mortality. Secondary outcomes included inpatient morbidity (MI, cardiac arrest, DVT, PE, AKI, stroke, sepsis, VAP), hospital length of stay (LOS), and discharge destination. Kaplan-Meier survival curves were created for inpatient mortality by treatment group, and these were statistically compared by the log-rank test.

Results

A final cohort had 506 elderly patients with an acute type 2 odontoid fracture (mean age, 77.8 yrs). Baseline characteristics were balanced between matched non-operative (N=253) and operative (N=253) treatment groups. Inpatient mortality was significantly greater in the non-operative treatment group (8.7% vs. 2.4%, P=0.004). Kaplan-Meier analysis revealed significantly shorter survival among patients treated non-operatively (P<0.001). There were no differences in inpatient complications between treatment groups. Patients treated operatively had a longer inpatient hospital stay on average (11.6 vs. 6.3 days, P<0.001). Most patients who underwent posterior C1-2 fusion were discharged to either a rehabilitation (28.1%) or skilled nursing (41.1%) facility.

Conclusions

These data support a short-term survival advantage among elderly patients with an acute type 2 odontoid fracture who are treated operatively with posterior C1-2 fusion, over those managed non-operatively.
Clinical Outcome of Posterior Cervical Foraminotomy vs. Anterior Cervical Discectomy and Fusion

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Objectives

Cervical radiculopathy is a common cause of significant distress in patients. Anterior cervical discectomy and fusion (ACDF) is a well known and effective treatment option, but posterior cervical foraminotomy (PCF) allows for a non-fusion surgical option, possibly being less invasive and limiting the risks of surgery. However, insufficient data exists to determine the superior option. The purpose of this study was to determine which procedure leads to better patient outcomes in terms of arm and neck pain in a Canadian, multi-centre data-set.

Method

The Canadian Spine Outcomes and Research Network (CSORN) was utilized to identify all patients that underwent ACDF (n=251) or PCF (n=41) for cervical radiculopathy. Pain outcomes were then compared between the two groups at 6-18 weeks (ACDF n=210; PCF n=34), 12 months (ACDF n=121; PCF n=20), and 24 months (ACDF n=69; PCF n=11) post-operatively, as well as patient satisfaction and complication rates.

Results

Patients significantly improved in arm and neck pain scores regardless of surgery type (Wilcoxon Signed Rank test; P<0.02). There were no significant differences between arm and neck pain scores pre-operatively or at any follow-up period between the surgical groups (Mann-Whitney; all p>0.05); however, patient satisfaction was higher for ACDF at 6-18 weeks (Mann-Whitney; p=0.05) and 1 year follow-up (Mann-Whitney; p=0.025) compared to PCF. There were no differences in the complication rates between the surgical approaches (Chi-Square test; p>0.05).

Conclusions

Both ACDF and PCF are successful surgical options in treating cervical radiculopathy, showing equal improvements in pain scores; however, ACDF has better patient satisfaction within 1 year of the post-operative period. Larger sample size is needed to confirm these results.
“Reverse Roussouly:” Ratios of Cervical to Thoracic Shape Curvature in an Adult Cervical Deformity Population

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Objectives

Explore baseline normative curvature ratios of the cervico-thoracic spine and establish radiographic thresholds for severe myelopathy and disability within the context of shape.

Method

CD patients (C2-C7 Cobb>10°, CK>10°, cSVA>4cm, or CBVA>25°) with baseline (BL) radiographic data were included. Cervical lordosis (CL) was measured using C2-C7 Cobb angle and thoracic kyphosis (TK) using T2-12, with negative values indicating kyphotic angles. A mathematical ratio was calculated for CL:TK ranging from -1 to +1, and correlated to cSVA(>or<40mm), SVA(>or<40mm), and mJOA scores at BL(>or<14, severe) using Pearson bivariate r. Univariate analyses including independent samples t-tests analyzed differences in presence of severe myelopathy (mJOA>14) or NDI>40 across CL:TK curve ratio groups.

Results

63 pts (55.2yrs, 56%F) met inclusion criteria. All patients had a kyphotic thoracic curvature at BL. CL:TK ratio, 37 had a negative ratio (more lordotic c-spine/kyphotic t-spine), and 26 had a positive ratio (more kyphotic c-spine/kyphotic t-spine). Positive CL:TK significantly correlated to greater SVA (r=0.382, p=0.013, R²=0.146), but not cSVA. BL mJOA scores correlated to increasing CL:TK (r=0.530, p=0.001), and positive CL:TK pts had a higher rate of Severe Myelopathy than negative CL:TK (48% vs 13.2%, p=0.004). CL:TK did not correlate to NDI scores, but positive CL:TK trended higher neck disability (NDI>40) than negative CL:TK (52% vs 26.3%, p=0.061). Conditional Tree Analysis analyzed all CL:TK curvatures to establish predictive cSVA and TS-CL thresholds. Conditional forward regression controlling for CL:TK ratio revealed: cSVA>27mm increased odds of severe myelopathy by 5.99x and cSVA>30mm of significant neck disability by 7x. TSCL>29° increased odds of neck disability by 4.1x, but TS-CL cutoffs for severe mJOA were not found (p>0.05).

Conclusions

Patients with an increased CL:TK ratio, indicating cervical and thoracic kyphotic curves, had higher rates of baseline severe myelopathy and NDI. Specific thresholds for cSVA(>27mm or >30mm) and TS-CL(>29°) predicted severe myelopathy or NDI regardless of shape curvature.
Treatment of Acute Traumatic Central Cord Syndrome: A Study of North American Trauma Centers

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Objectives

The optimal management of central cord syndrome (CCS) remains unclear. We sought to evaluate variability in non-operative versus operative treatment for CCS between trauma centers participating in the American College of Surgeons (ACS) Trauma Quality Improvement Program (TQIP); identify patient- and hospital-level factors associated with treatment; and determine the association of treatment with outcomes.

Method

Adults with CCS were identified from the ACS TQIP database for 2014-2016. Mixed-effects modeling with a random intercept for trauma center was used to examine the adjusted association of patient- and hospital-level variables with non-operative treatment. The random-effects output of the model was used to assess the risk-adjusted variability in non-operative treatment across trauma centers. Outlier hospitals were identified and the median odds ratio (MOR) calculated. The adjusted effect of non-operative treatment on mortality, morbidity, and hospital length of stay (LOS) was examined at the patient and hospital level by mixed-effects regression.

Results

In total, 3,928 patients admitted to 255 TQIP centers were eligible; of these, 1,523 (38.8%) were treated non-operatively. Older age, non-commercial insurance (OR 1.26), absence of fracture (OR 0.58), severe head injury (OR 1.41), and comatose presentation (1.82) were associated with non-operative treatment. Twenty-eight hospitals were outliers (significantly more or less likely to treat non-operatively), and the MOR was 2.02. Patients receiving non-operative treatment had shorter LOS (MD -4.65 days). Non-operative treatment was associated with lesser in-hospital morbidity (OR 0.49) at the patient, but not hospital, level. There was no difference in mortality.

Conclusions

There is substantial variability between trauma centers in non-operative versus operative treatment of CCS that is not explained by differences in case mix. Non-operative treatment may be associated with shorter hospital LOS and lesser inpatient morbidity, but no difference in mortality. This needs to be counterbalanced against the expected efficacy of decompressive surgery in improving neurological outcomes.
Comparing Minimally Invasive Versus Traditional Open Lumbar Decompression and Fusion Surgery: a Canadian Spine Outcomes Research Network (CSORN) study

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Objectives

Minimally invasive spine surgery (MISS) techniques continue to evolve and are increasingly being adapted across Canada. However, multicenter comparison against conventional open techniques in real world settings are limited. This study aims to evaluate acute and 1 year clinical and patient reported outcomes measures in patients after undergoing MISS versus open lumbar decompression and fusion with and without interbody construct.

Method

We conducted a multicenter review of prospectively collected data on consecutive spine surgery patients enrolled by CSORN from 2015 through 2019 who underwent 1 or 2-level instrumented lumbar fusions regardless of technique for principle degenerative pathology. Patient demographics, functional outcome scores, and perioperative course were assessed preoperatively, at 3 months and 1 year postoperatively. Descriptive, univariate as well as adjusted analysis using multivariate logistical regression was utilized to determine between group differences.

Results

A total of 407 MISS fusion and 922 open fusion patients were collected, of which 318 MISS patients and 603 open patients received an interbody fusion respectively. Adjusted analysis between interbody-fusion cohorts indicated no significant baseline population differences in age, BMI, comorbidities, numerical back or leg pain, ODI, EQ5D, SF-12, and PHQ9 (p>0.05). Significant perioperative differences were found with OR time (MISS–180min, Open–195min, p<0.05), EBL (MISS–182cc, Open–440cc, p<0.001), intra-operative AEs (MISS-5.7%, Open-10.3%, p<0.05), and length of stay (MISS–3.4days, Open–4.6days, p<0.001). Patient reported outcomes at 3 and 12 month follow-up demonstrated non-significant differences across all outcome measures with the exception of only EQ5D at 3 month demonstrating a 3.2 times odds ratios of improvement favoring the MISS interbody cohort (p<0.05).

Conclusions

Our pragmatic national results confirm findings from published international literature on MISS procedures, with favorable perioperative clinical outcomes including a shorter OR time for interbody fusions. Overall 1-year patient-reported outcome measures between MISS and open techniques for 1-2 level degenerative pathology are comparable. System-wide assessment of the cost-utility of MISS is required.
Time To Return To Work After Lumbar Spine Surgery

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Objectives

Return to work (RTW) after lumbar elective spine surgery is largely arbitrary and recommendations for RTW do not rely on evidence-based medicine. The primary objective was to describe time to RTW after elective lumbar spine surgery. Secondary objectives were to determine predictors of early return to work (< 90 days) as well as predictors of not returning to work.

Method

This is a retrospective study of a prospectively multicentric followed cohort of patients enrolled in the Canadian Spine Outcomes and Research Network (CSORN) between January 2015 and December 2018. Inclusion criteria were employed patients (currently working or not working) undergoing one/two level discectomies, laminectomies or fusion procedures. Patient demographic and surgical data were extracted and analyzed for time to RTW and factors predictive of early RTW. Multivariable logistic regression analysis was completed including predictors variables of greatest theoretical importance.

Results

1691 patients met the inclusion criteria (710 discectomies, 253 laminectomies and 728 fusions). In the overall cohort, median RTW was 61 days and 70.9% of the cohort returned to work after surgery. The median RTW to work after a discectomy, a laminectomy and a fusion was 51, 46 and 90 days, respectively. Predictive factors for early RTW (< 90 days) included patient factors (male gender, higher education level, preoperative working status, higher baseline MCS-12), surgical factors (blood loss, non-fusion procedure) and surgical treatment in a Western Canadian province.

Conclusions

This study provides useful clinical information about RTW. Most non fusion procedure patients will RTW within 2 months, whereas fusion procedure patients are generally back to work at 3 months. The second part of this study will be to survey Canadian spine surgeons to understand how they set up patient’s expectation about RTW. Combining this information, we will formulate realistic time frame recommendations for RTW after lumbar spine surgery.
Patient reported outcomes following surgery for lumbar spinal stenosis: Comparison of a universal and multitier health care system

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Objectives

Canada has a universal health care system that is funded by the government and access to spinal surgeons requires a referral by general practitioners. In contrast, the United States utilizes a combined public and private payer system where patients may directly access specialists. The purpose of this study is to investigate whether there are differences in clinical outcomes between those surgically treated for spinal stenosis in Canada as compared to the United States.

Method

Surgical lumbar spinal stenosis patients treated in Canada that were enrolled in the Canadian Spine Outcome Research Network (CSORN) prospective multicenter registry. The Canadian Cohort was compared with the surgical cohort enrolled in the Spine Patients Outcome Research Trial (SPORT) study. Baseline demographics, and spine-related patient reported outcomes were compared at 3 months and 1 year post-operatively.

Results

The CSORN cohort consisted of 432 patients and the SPORT cohort was made up of 278 patients. The rate of females in each cohort was similar (35.9% vs. 38.12%, p=0.78), however, patients in the CSORN cohort were older (66.8 ± 10.9 vs. 64.3 ± 12.5, p=0.017), had a higher rate of smoking (16.7% vs. 8.9%, p=0.0035), and were less likely to be employed (29.7% vs. 34.2%, p=0.043). The SPORT cohort had a slightly lower physical component score of the SF36 at baseline (33.2± 8.4 vs. 28.6± 7.5, p<0.01). The CSORN cohort had a higher proportion of patients with a symptom duration greater than 6 months (92.3% vs. 58.3%, p<0.0001). The CSORN cohort demonstrated significantly greater rates of satisfaction after surgery at 3 months (89.2% vs. 60.4%, p=0.003) and 1 year (86.8% vs. 62.6%, p<0.001).

Conclusions

Patients undergoing surgical treatment for lumbar spinal stenosis in Canada (CSORN cohort) reported higher rates of satisfaction at 3 months and 1 year post-operatively compared to the United States cohort (SPORT) despite having longer durations of symptoms prior to surgery.
Outcomes of Surgery in Older Adults with Lumbar Spinal Stenosis

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Objectives

Advanced age is seen as a barrier to surgery for lumbar stenosis as improvements in patient reported outcomes (PROs) may be less favourable than younger adults and risk of complications high. The purpose of this study was to evaluate whether patient age influences the improvements seen in PROs or complication rates after surgery for lumbar stenosis.

Method

An ambispective cohort study of patients in the Canadian Spine Outcomes and Research Network was conducted. Patients were divided into age group by decade, <50, 51 – 60, 61 – 70, 71 – 80, and >80 years old. Demographic, surgical and outcome data was compared between age groups using summary statistics. A multivariate analysis was performed to determine which factors influenced achievement of the minimally clinically important difference (MCID) for the Oswestry Disability index (ODI).

Results

In total, 1445 patients had a diagnosis of lumbar stenosis with 728 having complete 12-month follow-up. Mean age was 66.1 (SD 10.7) and 60.3% were female. Patients were more likely to have decompression without fusion over the age of 70 (p<0.05). Intraoperative and postoperative complications were similar between all decades (p>0.05). All age categories demonstrated significant improvement in VAS Leg and Back pain scores, ODI, EQ-5D and the SF-12 Mental (MCS) and Physical (PCS) component scores. The overall proportion of patients who met MCID for back, leg pain, and ODI was 68.2%, 71.4% and 55.2% respectively. Age had no influence on meeting MCID for pain improvement. Patients over 80 were less likely to meet the MCID for ODI, EQ-5D, SF-12 MCS and SF-12 PCS than those in younger decades (p<0.001). On multivariate analysis, independent risk factors for not meeting the MCID for ODI were age over 80 and female gender.

Conclusions

Patients can expect similar postoperative improvements in back and leg pain regardless of age. Advancing age was not associated with an increased risk of adverse events however, improvement in outcome metrics may be less favourable.
**Functional objective assessment using the TUG-test is a useful tool to evaluate outcome in lumbar spinal stenosis**

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**Objectives**

Patient-reported outcome measures (PROMs) are typically used to assess perceived limitation in ambulation that is associated with lumbar spinal stenosis (LSS). Objective testing of ambulatory capacity is also recommended; however, this is difficult to implement in clinical settings. The timed-up-and-Go (TUG) is the simplest objective mobility measure, however, its utility in LSS patients is unclear. Our primary objective was to evaluate the change in pre-operative TUG test at 3, 6 and 12 months postoperatively in LSS patients.

**Method**

We performed a retrospective analysis of prospectively collected data from 287 surgical LSS patients. The time taken to stand up from a chair, walk three meters, turn around, walk back and sit back down was measured. We compared change in TUG-times as well as correlation (Spearman Rank) with that of self-reported walking using question 4 of the Oswestry Disability Index (ODI-4).

**Results**

Mean age at surgery was 66.8 with 46.7% female patients. Decompression with and without fusion was performed in 141 and 146 patients respectively. Mean baseline TUG-time was 14.5±5.7s with 46.3% of patients presented categorized as moderate to severe impairment in TUG. TUG-time significantly improved at 3 months (12.7±5.4s) (p<0.001) and 6 months (12.1±4.7s) (p<0.001) and improved to 11.7±3.9 at 1 year post-operatively (p=0.3, 6 vs 12 months). Also, ODI4 improved from baseline (2.5±1.2) to 3 months (p<0.001) (1.6±1.4), 6 months (1.5±1.4) (p<0.001) and 1-year respectively (1.4±1.3) (p=0.2). Significant correlation (p<0.001) was found between TUG-time and ODI4 at baseline (r=0.41), 3 months (r=0.54), 6 months (r=0.5) and 1-year (r=0.6).

**Conclusions**

Significant postoperative functional improvement in the TUG-test occurred and was moderately correlated to self-reported walking improvement over the course of 1-year postoperatively. The simple TUG-test is a potentially useful tool to objectively determine LSS walking impairment in the clinic setting. Further studies are necessary to validate the TUG test in the surgical LSS population.
A Canadian Spine Outcomes Research Network (CSORN) Matched-Cohort Study Comparing Lumbar Fusion and Disk Arthroplasty

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Objectives

There is a paucity of published Canadian literature comparing lumbar total disc arthroplasty (LDA) to fusion on patient outcomes in degenerative spondylosis. The purpose of this study is to quantify and compare the long-term patient reported outcomes following LDA and matched-fusion procedures.

Method

We conducted a matched-cohort study comparing consecutive patients enrolled by CSORN who underwent standalone primary LDA or hybrid techniques for degenerative disk disease between 2015-2019. Fusion patients were included by a primary diagnosis of degenerative disk disease, chief complaint of back pain, who received a primary fusion irrespective of technique. Fusion patients were matched by number of involved levels of surgery to LDA counterparts. Outcome scores and patient satisfaction were assessed preoperatively and 2-years postoperatively.

Results

97 patients (39-female, 58-male) underwent LDA or hybrid construct up to 4 levels. 94 patients (52-female, 42-male) underwent a lumbar fusion were selected based on inclusion criteria. 36 LDA and 57 Fusion patients underwent a 1-level surgery. 39 LDA and 25 Fusion patients underwent 2-level surgery. 18 LDA and 7 Fusion patients underwent 3-level surgery. 4 LDA and 5 Fusion patients underwent a 4-level procedure. Slight differences in average cohort age were found (LDA-43.4yrs, Fusion-49.8yrs, p<0.01). Cohort preoperative-BMI (LDA-27.0kg/m², Fusion-27.9kg/m², p=0.29) and total comorbidities (LDA-2.6, Fusion-2.1, p=0.05) demonstrated no clinically significant differences. At 2 year follow-up, no differences were found in ODI improvement (LDA-20.32pts, Fusion-17.02pts, p=0.36), numerical back-pain improvement (LDA-3.5pts, Fusion-3.06pts, p=0.40), numerical leg-pain improvement (LDA-1.67pts, Fusion-1.87pts, p=0.76), and Health Scale improvement (LDA-17.12, Fusion-10.73, p=0.20) between cohorts. Similar positive findings were found in subgroups stratified by number of surgical levels. Satisfaction rate at 2 years was 86.7% and 82.4% for LDA and Fusion patients respectively.

Conclusions

There didn't appear to be significant differences in outcomes or satisfaction through 2 years comparing patients who underwent LDA (whether used in isolation or as part of a hybrid construct) for debilitating degenerative disk disease and isolated spinal fusion for back dominant pain.
Development of clinical practice guidelines for the management of traumatic spinal column and cord injuries in British Columbia: an approach to standardizing care of spine trauma patients

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Objectives

Clinical practice guidelines (CPGs) for the management of spinal column and spinal cord injuries have been developed across jurisdictions by synthesizing knowledge in the literature. CPGs ensure that clinicians have access to the information required to provide appropriate care to patients, reducing variations of care across populations. However, CPGs need adaptation to individual health care jurisdictions to ensure that they are aligned with the availability of resources. In Canada, CPGs for spinal column and cord injuries have not been developed. We aimed to develop CPGs for managing spinal column and spinal cord injuries in adults (>16 years of age) in British Columbia.

Method

A guideline development group composed of spine surgeons, trauma physicians, emergency physicians, radiologists, intensivists, and Trauma Services BC administrators was formed. A systematic review of the literature was conducted to synthesize knowledge on the best practices for managing suspected or confirmed spinal column and cord injuries. Thereafter, a Modified Delphi approach was used to synthesize the knowledge into CPGs appropriate for the health care context of British Columbia.

Results

Five published society guidelines in jurisdictions outside of Canada, in addition to the clinical expertise of the guideline development group, were used to develop the CPGs. Algorithms for suspected and confirmed injuries were developed, and included recommendations on 1) the initial management, 2) diagnostic imaging requirements, 3) criteria for transferring patients to higher levels of care, 4) pre-transfer care, and 5) local management of stable spinal fractures. These CPGs will be rolled out over 2020.

Conclusions

These CPGs represent the first Canadian recommendations for the management of spinal column/cord injuries. They can serve as a model for other jurisdictions aiming to develop similar CPGs. Further efforts are necessary to assess clinicians’ adherence to the guidelines and to assess the impact that the guidelines have on quality of care.
Notes from a small island: stemming the tide of a spinal deluge. The use of encrypted software applications to ensure accountability, quality control and surgical consensus in a national acute adult spinal surgery centre.

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Objectives

Since 1991, our hospital provides the only 24-hour acute spinal centre in Ireland, a catchment of 4 million. Initially referrals constituted major spinal trauma, critical metastases and infection. Recently referrals include minor end plate fractures, chronic sciatica and age-indeterminate osteoporotic fractures. With ≥30 acute referrals/week made by fax and phone call, this became a major resource problem and safety concern for continuity of care, patient data collation, follow-up and communication back to the referral centre.

Method

To devise a secure referral pathway that guaranteed accountability, transparency and consistency from the referrer, and a live, centralised, visible “air-traffic control” system for our receiving unit.

Results

A fully encrypted web-based acute spine portal with a unique hospital and physician identifier login and predetermined access and visibility level. The referral cannot be submitted without a signed declaration by the referrer, including to take the patient back once deemed appropriate by our unit. Equally our residents are not allowed to take an outside referral before the online portal has been submitted. The portal has an external view and internal view, depending on the physician and hospital access level. Since July 2019 all files are uploaded to Siilo such that our unit surgeons can view each referral in real-time on smartphone, tablet or laptop. In January 2020 a major new HL7 compatible iteration will launch and will be linked to the national integrated medical imaging system and the national critical care transfer system.

Conclusions

CONCLUSION

Cases are traffic-lighted live according to clinical priority and bed availability. Equally cases are reviewed and updated for transfer, further investigation, out-patient follow-up, discussion at our twice weekly MDT, or local follow-up. Every case since launch in August 2016 remains hosted in the portal database including a comprehensive clinical information file which is about to undergo major audit.
Presentation 093

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Traumatic Spinal Cord Injuries among Aboriginal and Non-Aboriginal Populations in Canada: An Ambispective Outcomes Study

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Objectives

People of Aboriginal (Indigenous) ancestry are more likely to suffer traumatic spinal cord injury (TSCI) compared to other populations in Canada, however, outcome studies are limited. This study aims to compare Aboriginal and non-Aboriginal populations in Canada with acute TSCI with respect to pre-injury baseline, injury severity, treatment, outcomes, and length-of-stay characteristics.

Method

We completed a retrospective analysis of 3478 participants with TSCI enrolled in the prospective Rick Hansen Spinal Cord Injury Registry (RHSCIR) from 31 facilities across Canada between 2004 and 2018. Demographic, injury, and clinical management data were assessed to identify differences between the populations.

Results

Of the participants, 166 (4.8%) identified as Aboriginal, and 3312 as non-Aboriginal. The Aboriginal cohort was significantly younger (38.0 vs 46.9 years, p=0.0031) and less likely to be male (68.1 vs 78.1%, p=0.0025) than the non-Aboriginal group. Mechanism of injury was also significantly different between groups with the Aboriginal population more likely to be injured from assault (12.2 vs 3.4%, p<0.0001). There were no significant differences in neurological severity and level of injury, comorbidity, rate/timing of surgical management, and neurological or functional recovery. Aboriginal individuals had a 21% longer stay in acute care(p=0.0377), and were more likely to be injured in (48.1 vs 28.4%, p<0.0001) and discharged to (50.5 vs 26.4%, p<0.0001) a rural area.

Conclusions

This study reveals differences in the epidemiology and outcomes of Aboriginal people with TSCI in Canada. Given the significant rural disease burden in this population, better allocation of resources for transition to the community for Aboriginal peoples with TSCI should be a priority. This work fills a critical knowledge gap and opens the opportunity for unique interventions in prevention and management.
Traumatic spinal cord injury in New Zealand and Canada: a comparative analysis

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Objectives

Traumatic spinal cord injury (TSCI) is a devastating injury causing a significant burden on society and individuals. New Zealand (NZ) has partnered with the Canadian-wide Rick Hansen SCI Registry (RHSCIR) to collect equivalent demographic and clinical data from patients sustaining a new TSCI. Our objective was to examine similarities and differences between these registry populations to guide further collaborative research.

Method

Data from 2007-2018 was obtained from two SCI observational registries from Canada (RHSCIR) and NZ (New Zealand Spinal Cord Injury Registry, NZSCIR). Variables of interest include demographics (e.g. age, sex), injury characteristics (e.g. neurological level/severity) and care management practices (e.g. time-to-hospital) were compared.

Results

8596 registry participants were included; 1277 from NZ and 7319 Canada. In both registries the male-to-female ratio is 3:1. In NZ, TSCI patients are on average younger (45 vs 50 yrs, p<0.01) and more likely to sustain a higher cervical cord injury (38% vs 33%, p=0.02). Falls represent the most common injury mechanism in both registries, but a higher proportion occur in Canada (47% vs 33%) while sports are a more common injury mechanism in NZ (22% vs 13%).

In Canada, patients were more likely to arrive direct to a registry site (59 vs 41%, p<0.01) and more rapidly (6 vs 9 hrs, p<0.01). Surgical intervention was higher in Canada (86 vs 78%, p<0.01) with length of stay in both acute and rehabilitation facilities significantly longer. In-hospital mortality was higher in Canada (5.9 vs 1.4%, p<0.01).

Ethnic differences exist. In Canada 82% of TSCI patients identified as ‘White’, compared with 73% in the general population. ‘NZ European/Pakeha’ comprised 55% of the NZ registry population compared with 74% in the general population, reflecting a higher propensity of TSCI in Maori and Pacific peoples of NZ.

Conclusions

There are notable differences in the demographics, injury and care management practices between the two countries. Understanding the similarities and variances between populations will inform future research. Further analysis will be conducted to identify opportunities to impact patient and system outcomes by changing processes of care.
Exploring the reasons for readmission following traumatic spinal cord injury

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Objectives

Most studies report on unplanned hospital readmissions following traumatic spinal cord injury (tSCI) for only one time period but do not report the patterns over time. The objectives of this study were to determine common reasons for unplanned readmissions related to secondary complications of tSCI and examine whether these reasons change over time post-injury to inform long-term care.

Method

A cohort of 4625 individuals admitted to hospital in British Columbia with acute tSCI over 23 years (1995-2017) was created from the hospital Discharge Abstract Database (DAD) using ICD-9/10 codes. Ethical and other regulatory approvals were obtained prior to data access. Administrative data from DAD between April 1995-December 2017 was used to determine causes of readmissions. The time periods examined were: within one-year, 1-5 years, and 5-10 years post-tSCI. ICD diagnosis codes for most responsible diagnosis were used to document reason for readmission. Descriptive analysis was performed. Future work includes modelling of how patient characteristics and reasons for readmissions impact the health system (i.e. patterns of readmission and costs).

Results

Within the cohort of 4625, there were 2337 unplanned readmissions within one-year, 4612 between 1-5 years, and 3040 between 5-10 years. The most common reasons for readmission within one-year were genitourinary (e.g. urinary tract infections) (21.3%), procedural adverse events/injuries (17.9%), musculoskeletal (10.6%), and respiratory (e.g. pneumonia) (8.3%). In addition to the complications seen within one-year, digestive-related causes and mental/behavioural disorders (7.5%) occurred between 1-5 years. Between 5-10 years, readmissions related to skin and subcutaneous tissue conditions (e.g. pressure injuries) (9%) were reported.

Conclusions

Common reasons for readmission within one-year following tSCI include procedural adverse events/injuries, and genitourinary, musculoskeletal and respiratory conditions. As the post-tSCI time progresses, the onset of digestive system diseases, mental/behavioural disorders, and skin/subcutaneous tissue diseases occurs. These results highlight the importance of regular follow-ups and understanding the effect of tSCI over time to tailor effective tSCI care programs to prevent readmissions.
Exploring the Epidemiology and Impact of Spinal Cord Injury in the Elderly: A 15-Year Canadian Population-Based Cohort Study

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Objectives

Although experience suggests a shift in the epidemiology of spinal cord injury (SCI) toward an older demographic, population studies are lacking. Our objectives were to investigate: 1) how the epidemiology and age profile of SCI have changed over time, and; 2) how increased age impacts health outcomes.

Method

A population-based cohort study was performed using Ontario administrative data. Adults diagnosed with traumatic SCI between 2002-2017 formed the primary cohort; older and younger SCI cohorts were created based on an age cut-off of 65 years. An older cohort of non-injured persons was matched to the older SCI cohort based on age, gender and co-morbidity status. Changes in crude incidence rates were reported as average annual percentage change (AAPC). Survival, hospital readmissions and costs were compared between the older and younger SCI cohorts as well as the older SCI and older non-injured cohorts.

Results

The incidence of SCI increased among females (AAPC:2.2;95%CI:0.1,4.3) during the study period, driven by a marked rise (4%/year) among elderly females (AAPC:4.3;95%CI:0.1,4.3). While no change in incidence was detected for males, there was a trend towards increased incidence among older males (AAPC:1.2;95%CI:-1.3,3.8). There were a higher proportion of cervical, incomplete and fall-related injuries in the older vs. younger SCI cohort. Age over 65 was associated with a 6-fold increased risk of death (HR:5.75;95%CI:4.72,7.00). In comparison to the older non-injured cohort, the older SCI cohort had double the risk of death (HR:2.23;95%CI:2.00,2.50). Older persons with SCI had higher odds of hospital readmission at 1- and 5-years and accumulated higher costs as compared to younger persons with SCI and older non-injured persons.

Conclusions

The incidence of SCI among the elderly is increasing, particularly among women. Older SCI patients are at higher risk of death, hospital readmission and accumulate greater health care costs as compared to younger persons with SCI and older non-injured persons. Prevention through fall reduction and education to improve outcomes are needed.
Incidence and Management of Spinal Metastasis in Ontario: A Population-Based Study

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Objectives

Metastatic Spinal Cord Compression (MSCC) is one of the most debilitating complications of cancer. To our knowledge, the incidence, management and outcome of MSCC at a population level have not been investigated since 2003.

Method

Patients with a diagnosis of cancer admitted at least once with a concurrent diagnosis of MSCC in Ontario, Canada (2005-2015), and the associated management of MSCC, were identified by linking unique patient identifier from the Ontario Cancer Registry to the Same Day Surgery Database, Cancer Activity Level Reporting and National Ambulatory Care Reporting System.

Results

Overall, the number of patients with cancer admitted at least once with a concomitant diagnosis of MSCC is decreasing (n=3619 in 2005 vs. n=677 in 2015). The median survival after the first admission with a diagnosis of MSCC was 79 days (95% CI: 74-84), i.e. 2.6 months; patients alive at 3, 12 and 24 months were 37.81%, 13.67% and 9.64%, respectively. There was no record of receiving either radiotherapy or surgery for 36.2% of patients with MSCC while 42.9%, 16.7% and 4.2% were treated with surgery only, radiotherapy only and both surgery and radiotherapy, respectively. The proportion of patient admitted with a diagnosis of MSCC was relatively stable between 5, 2 and 1 year preceding death (1.41%, 1.47% and 1.49%, respectively), and varied widely according to the type of primary tumor (leukaemia: 0.18% vs. multiply myeloma: 5.50%, at 5 years before death). In the last year of life, the length of stay was longer for patients with cancer and MSCC (17.1±19.34, median: 11 vs. 11.1±14.24, median: 7; p < 0.001).

Conclusions

Overall, the number of admission of patients with cancer and MSCC is decreasing. Approximately 1% of patients admitted with a diagnosis of cancer have a concurrent diagnosis of MSCC. There is nearly a 30-fold variation in the proportion of patients admitted with MSCC between different types of primary tumor. Over 40% of patients admitted with MSCC are treated with surgery.
A general population utility valuation study for the Spine Oncology Study Group Outcomes Questionnaire – 8D

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Objectives

Treatment decision making for metastatic spine disease is challenging since multiple patient and treatment related factors including patient performance status, survival prognosis and risk of adverse events must be considered. QALY analysis could help patients and clinicians jointly assess the trade-offs between survival, health-related quality-of-life (HRQoL) benefits, recovery, and potential complications to reach an optimal treatment decision. QALYs are also required in economic analysis because economic decisions are based on the incremental cost-effectiveness ratio, which is the cost per QALY gained. QALYs are calculated using utilities, or HRQoL weights.

The AOSpine Knowledge Forum Tumor (former Spine Oncology Study Group, SOSG) developed an eight-item spine oncology-specific outcome questionnaire (SOSGOQ-8D) which is suitable for developing a utility mapping.

Method

We recruited a sample of 3821 adults from a market research company. Quota sampling was used to ensure that the participants were representative of the United States population in terms of age, gender, and state of residence. Participants were asked to rate 10 of 100 S-optimal SOSGOQ-8D health states in a discrete choice experiment. Utility mapping was developed using a random-effects conditional logit regression model.

Results

Of 3821 individuals recruited, 749 (20%) met all quality criteria. Response quality was not related to perceived difficulty of the DCE task. Regression parameter estimates were monotonic for each domain which indicated sensible and valid results. Self-care and social function items were the greatest determinants of health state utility.

Conclusions

We have provided utility estimates for the SOSGOQ-8D. The utility values derived from this study can be used to help inform population-level healthcare decision making, such as allocation of limited resources for specific treatments. The ability to calculate QALYs for metastatic spine disease will enhance treatment decision making and facilitate economic analysis. When offering treatment, clinicians should be mindful that extremity neurologic function is not the greatest determinant of utility, and thus HRQoL.
Metastatic Vertebrae Segmentation by Augmented 3D Convolutional Neural Network

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Objectives

Metastasis of tumours to the bony spine are common complications of primary cancers that alter bone architecture potentially leading to vertebral fracture and neurological compromise. Quantitative radiologic measures of vertebral stability may complement existing clinical scoring for assessing fracture risk and vertebral stability. Existing quantitative methods used to generate measures are slow and require manual intervention, limiting their utility. The broader goal of this work is to develop tools for the assessment of mechanical stability that will be useful within the context of typical care and imaging for patients.

Method

This investigation proposes a deep learning method, specifically a 3D U-Net Convolutional Neural Network (CNN) to accurately segment individual trabecular centrum from metastatically compromised vertebrae of interest in CT imaging. Within this investigation we were focused on making the algorithm robust to changes seen typically, specifically changes in image resolution and to changes to vertebrae position. To do this, multiple augmentation techniques were investigated that target changes in medical image resolution and position of the vertebrae within the volume of interest. The networks were trained with data from 30 patients with sequential imaging taken at 4-month scan intervals, yielding approximately 530 vertebral segmentations used for training and 130 for validation.

Results

The 3D CNN using all augmentation techniques achieved the best performance (DSC=90.4±5.6%) with the segmentation model remaining accurate with simulated lower image quality, and translation of the vertebrae within the image volume of interest, especially compared to training the network without augmentation. (DSC=77.4%±18.8%).

Conclusions

Use of augmentation techniques during training of machine learning algorithms to specially address real-world concerns (changes in image resolution and vertebral position) improved the ability of the trained networks to account for these situations and created a more robust and useful algorithm. Integration of this method into a clinical tool will allow accurate and robust quantitative assessment of mechanical stability from CT imaging, aiding clinical decision making to improve patient care.
Risk factors for failure of radiation therapy for spinal metastases

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Objectives

The spinal instability in neoplasia score (SINS) was developed as a referral tool for medical providers in patients with concern for instability in metastatic spine disease. There is limited research studying how SINS correlates with rates of failure after radiation therapy. The goal of this study was to evaluate a cohort for risk factors for failure of radiation therapy. We hypothesized that a higher SINS, particularly the domains of mechanical pain and deformity would correlate with failure of radiation therapy.

Method

We performed an IRB approved retrospective cohort study at a tertiary academic center. All patients with spinal metastasis being treated with radiation between September 2014 and October 2018 were identified. Pediatric patients and patients with myeloma, leukemia, lymphoma, sarcoma, cord compression, history of prior radiation or surgery, or inadequate follow up were excluded. Baseline demographics were recorded and the SINS was calculated. Other variables analyzed were primary tumor, Karnofsky and ECOG scores, time to treatment, dosage, and type of radiation. The outcome was radiation therapy failure as defined by persistent pain, need for re-irradiation, or surgical intervention. Chi squared and fisher exact test was used for analysis of the categorical. Continuous variables were analyzed with the student t-test. Univariate analysis was performed and is being used to build a multivariate regression model.

Results

583 patients were identified, of those 170 met the inclusion criteria. Median follow up was 218 days. 43 patients failed radiation therapy, 10 required repeat radiation, and 7 underwent surgery. 36 reported no pain relief, including some that required re-irradiation and surgery. Significant risk factors were SINS grouping (<6, 7-12, >12) (p = 0.038), percent vertebral involvement (p = 0.002), biologically effective dose (BED) <43 (0.047), categorical Karnofsky (<50, 50-70, >80) (p = 0.003), continuous Karnofsky (p = 0.001), and ECOG (0-2, 3-4) (p = 0.025).

Conclusions

Lower performance scores, lower BED, higher SINS and vertebral involvement were associated with radiation failure on univariate analysis.
Significance of Extracanalicular Cement Extravasation in Thoracolumbar Kyphoplasty

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Objectives

Kyphoplasty is a procedure performed for pain relief in patients with vertebral insufficiency fractures. The procedure involves augmentation of one or more vertebral bodies using bone cement. During cement insertion, cement extravasation may occur into the spinal canal as well as into extracanalicular regions such as paravertebral soft tissues, intervertebral disc spaces, and along anterior vascular structures. The rationale of this study is to determine if adverse functional outcomes occur due to such cement leakage during thoracolumbar kyphoplasty.

Method

This study is a retrospective analysis of a case series of data collected prospectively. A series of 152 thoracolumbar kyphoplasty cases in 132 patients was reviewed over a 14-year span. The primary surgical indication was back pain secondary to osteoporotic or pathologic vertebral fractures refractory to conservative management. Intra-and post-operative imaging was assessed for cement extravasation outside of the spinal canal. Length of hospital admission, re-operation rates and re-admission rates were assessed and correlated with extracanalicular cement leakage.

Results

Between 2004-2018 a total of 282 levels were augmented. Extracanalicular cement extravasation occurred in 62/282 (22%) levels augmented. Of these, 26/62 (42%) leaks were intradiscal, 20/62 (32%) occurred lateral to the vertebral body, 12/62 (19%) occurred along vasculature anteriorly, and 4/62 (6%) involved multiple locations. There was one case of cement extravasation into the spinal canal, however, it did not result in any adverse clinical outcomes. There were no re-operations for cement-related complications. There was no correlation between number of levels augmented and re-admission to hospital within 30 days post-operatively.

Conclusions

Extracanalicular cement extravasation during thoracolumbar kyphoplasty for vertebral insufficiency fractures does not appear to result in adverse clinical sequelae. Cement leakage did not correlate with re-admission to hospital or re-operation on the same spinal level. This study helps to demonstrate that symptoms post-operatively may be related to factors such as pre-existing degenerative disc disease or inorganic etiologies rather than being due to cement leakage when it occurs outside the spinal canal.
Modeling fracture in osteoblastic vertebrae

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Objectives

The negative consequences of fracture in the metastatic spine motivates improved understanding of bone quality and fracture risk. Computational models can evaluate effects of changes in structural and material properties due to the presence of pathology or intervention. This work aimed to develop and validate voxel-based micro-finite element (µFE) models of vertebrae with osteoblastic involvement that can predict fracture initiation and propagation.

Method

A preclinical of osteoblastic metastatic lesions in the spine was created via intracardiac injection of ZR-75-1 breast cancer cells into athymic rats. Motion segments, T13-L1 and L1-L3, were excised 4-months post inoculation. Displacement-controlled axial and bending loads were applied to the metastatically involved motion segments with sequential µCT imaging (34 µm) to capture progression of failure.

Specimen specific µFE models (n=2) were created from unloaded µCT images using an in-house voxel-based meshing algorithm. Displacement boundary conditions were created using surface-based registration. Damage mechanics were incorporated using cohesive elements to model damage within predefined regions of interest. Healthy and metastatic bone material property assignment was implemented via spine specific thresholding and manual segmentation of osteoblastic tissue.

Results

Failed elements were seen at anatomical sites consistent with experimental observation, with one model predicting failure in the pedicle and the second at the endplate. However, the µFE models predicted less displacement at the fracture sires than seen experimentally. Changes in crack propagation direction at the growth-plate was not captured, as the growth plate was not specifically included in the µFE models.

Conclusions

The specimen specific voxel-based µFE models including cohesive zone-based damage mechanics were able to accurately predict the location of damage in preclinical vertebrae with osteoblastic lesions. The assumed damage mechanics parameters and material property definitions of the osteoblastic tissue and the absence of growth-plate specific material properties may have limited the ability to predict the extent of the damage propagation and displacement. Identifying fracture initiation and propagation in osteoblastic vertebrae with µFE modeling may ultimately be useful in guiding therapeutic interventions.
The Development of novel 2-in-1 patient specific, 3D-printed laminar osteotomy guides with integrated pedicle screw guides

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**Objectives**

Laminectomy is the mainstay of treatment for spinal conditions that require decompression of neural element. Despite being a very common procedure, spinal decompression has several risks, including dural tear, damage to neural elements and spinal instability due to iatrogenic spondylolisthesis. This study examines the novel design of 2-in-1 3d-printed patient-specific laminar osteotomy guides, with integrated pedicle screw drill guides.

**Method**

Three human cadaveric lumbar spines were meticulously cleaned after boiling. Vertebral digital models and patient-specific templates were created using 3D Slicer version 4.10.2. Longitudinal laminar osteotomy guides were placed in the appropriate position to preserve the facet joints and pars interarticularis. The guides were 2.5mm wide to accommodate the standard sized matchstick burr. The contour of the laminar osteotomy guides were created to match the deep surface of the lamina, set at a depth of 14mm, so that if the burr is offset 14mm from the tip of the handle it should safely travel along the dorsal aspect of the ligamentum flavum and dura. Pedicle screw drill guides were designed to fit into the lamina osteotomy guides. The templates were 3d printed and tested. The under-surface of the lamina was filmed using a high-definition digital camera, to determine the burr tip position compared to the inner table of the lamina. CT scans were obtained to analyse screw and laminectomy positions.

**Results**

There was no difference between the pre-operative and post-operative laminectomy positions. The burr tip did not pass deep to the inner table of the lamina in any specimen. There were no pedicle screw breaches, and mean axial and sagittal screw error was 2.5 degrees (SD 1.7) and 0.6 degrees (SD 1.2) respectively. Average surgical time was 4 minutes 46 seconds per level.

**Conclusions**

Our novel 2-in-1 3d-printed laminar osteotomy guides are an accurate and efficient way of performing spinal decompression and instrumentation.
Effect of Pelvic Retroversion on Pelvic Geometry and Muscle Morphometry From Upright MRI

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Objectives

With adult spinal deformity positive sagittal imbalance, pelvic retroversion is typically the first compensatory step. Consequently, there is interest to better understand the underlying mechanisms in such compensatory changes. First however, a better understanding of dynamic changes in pelvic musculature/geometry with asymptomatic retroversion is needed. This would help identify key muscles and could influence future treatment planning. This study aimed to assess the effect of pelvic retroversion on pelvic musculature/geometry in asymptomatic adults using upright magnetic resonance imaging (MRI).

Method

Six healthy volunteers were imaged in a 0.5T upright MRI (MROpen, Paramed) using T1-weighted Spin Echo sequences in 4 postures (standing, standing pelvic retroversion, standing 30° flexion, supine). Pelvic tilt (PT), pelvic incidence (PI), sacral slope (SS), and L3-S1 lumbar lordosis (LL), as well as muscle cross-sectional area (CSA), circularity, radius, and angle for the gluteus (maximus, medius, minimus combined) and iliopsoas were measured. Effects of posture, correlations, and repeatability were evaluated by ANOVA\((p<0.05)\), Pearson’s\((p<0.05)\), and intraclass\((ICC(3,1))\) respectively.

Results

Posture and level had a significant effect and interaction on the gluteus (CSA, circularity, radius, angle). Generally, CSA/ circularity decreased supine to standing and CSA/ circularity increased standing/standing flexion to retroversion (up to 22%). Posture and level also significantly affected the iliopsoas (angle), with some significant interactions (circularity, radius). Additionally, posture affected PT, SS, and LL, but not PI. On average PT increased 6° supine to standing and 7° standing to retroversion. Muscle CSA/circularity also had significant correlation with PT (positive), SS (negative) and LL (negative) at specific levels. Repeatability (ICC(3,1)) was 0.86-0.99 for posture and 0.76-0.99 for intra-rater. Across postures, PI repeatability was 0.85-0.92.

Conclusions

The effects, interactions, and correlations of posture and level with pelvic muscles/geometry notably between supine to standing and standing to retroversion confirms some expected trends such as muscle narrowing with elongation. Promising repeatability supports imaging feasibility, with inter-rater repeatability evaluation planned before scanning patients.
Anatomical relationship between the accessory process of the lumbar spine and the pedicle screw entry point

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Objectives

Pedicle screws are a common medical device being used for treatment of several spine disorders. The precision of screw entry point is crucial, with several free-hand placement techniques being described. The majority of techniques are based on anatomical landmarks using the midpoint of the transverse process and the facet joints. However, in degenerative diseases, the facet becomes hypertrophied and normal bony anatomy is distorted. The vertebra accessory process (or tubercle) of the lumbar spine is an understated anatomic landmark which lies below the mammillary process at the base of the transverse process. No studies compare its relation to the pedicle isthmus and entry point. We proposed to evaluate the relationship between the accessory process and the projected pedicle axis.

Method

CT scan DICOM files of 6 lumbar cadaveric spines were imported into 3D Slicer, version 4.10.2, and 3D mesh models were created. The largest axial diameter of the pedicle was measured in order to template screw size. A cylinder model with the equivalent width of the planned screw was positioned in the center of the pedicle in the ideal trajectory, avoiding breach of the facet joint. The distance between the tip of the accessory process and center of the cylinder (the entry point of the pedicle screw) was measured. The angle between this axis and the midline was measured. Interrater reliability was assessed intraclass correlation coefficient for two raters. Statistical analysis of the results was performed using SPSS.

Results

The mean distance between the tip of accessory process and pedicle screw entry point was 6.5mm (SD 2.05), and the mean angle between this axis and the midline was 29.4 degrees medial (SD 10.08). The calculated mean distance between the tip of the accessory process and pedicle screw entry point was 3.2mm (SD ±1.3) and 5.7mm (SD±1.9) medial and cranial respectively.

Conclusions

The accessory process is a reliable and consistent landmark to guide pedicle screw entry point. To our knowledge, this is the first study in the published literature to assess this relationship.
Novel chair to measure lumbar spine extensors strength in adults.

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Objectives

In this study, we examined the use of a static dynamometer chair to measure lumbar spine extensors strength in a sample of 79 healthy adults.

Method

A total of 79 subjects, 25-63 years of age were included. Subjects were placed in a seated position on the novel chair, secured tightly with a lap belt. The vertical rail, positioned upright against the backside of the chair, was used to manipulate the height of the force transducer, allowing it to be at the level of the apex of the thoracic curve. The height of the force transducer on the rail was recorded and used for subsequent measurements. The unit used to measure the extensor strength is pounds (LBS). The subjects were asked to extend their back against the force transducer at maximum capacity, maintaining the extension for 5 seconds. The maximal force delivered over that period was recorded. Subjects had a practice trial followed by 3 forceful extensions with pausing intervals of 30 seconds. The average force of all 3 attempts were recorded. A follow up test was carried out 1-14 days later in 60 of the 79 subjects.

Results

Initial test mean noted was 69.474 LBS (67.047 and 71.901). Intraclass Correlation Coefficient for single measure was 0.853 (0.765 and 0.908 with 95% CI) and for average measures, 0.921 (0.867 to 0.952 with CI 95%).

Follow up test mean noted was 71.661 LBS (71.615 and 71.706). Intraclass Correlation Coefficient for single measure was 0.798 (is 0.683 and 0.874 with 95% CI) and for average measures, 0.888 (0.812 and 0.933 with CI 95%)

Relationship (average measure) between first set and follow up set of measurements (r=0.80; p<0.001; R²=0.62).

Conclusions

Based on the data collected from 79 patients, the measurement of the novel chair is reliable and consistent. It is a non-invasive, cost-effective test that facilitates the assessment of lumbar spine extensors strength in adult patients.
Error measurement between human spine, 3D scans, CT-based models, and 3D-printed models

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Objectives

There is a paucity of evidence validating the accuracy of 3D models, when compared to the organ that has been scanned and to digital models from which they are created. This study will examine the differences between human lumbar vertebrae, CT-based 3D models, and 3D-printed models.

Method

Five cadaveric lumbar spines were meticulously cleaned after boiling, in order to not inadvertently damage or distort boney details. The individual bones were 3D scanned using NextEngine 3D Scanner Ultra UH. 3D mesh models were created by importing CT scan DICOM files into 3D Slicer version 4.10.2. The models were aligned using at least 3 fiducial points. Hausdorff distances and Dice coefficients were calculated to determine the digital similarities of the CT models and 3D scans of the vertebral bones. For each vertebra, 3D digital model, and 3D-printed model, 15 different anatomical measurements were recorded with a digital caliper. Statistical analysis was performed with SPSS, using one-way ANOVA and interclass correlation coefficient. T-tests for each of the groups (bone vs 3d scan and CT vs 3D print) were performed to validate the other statistical methods.

Results

There was no statistically significant difference between the human vertebral bone, 3D scanned model, 3D digital model and 3d-printed model for each of the 15 measurements, except for vertebral width and spinal canal width. The mean Hausdorff distance was 0.99 mm (SD 0.55mm) when comparing the 3D scanned model to CT model, signifying the CT model was larger by 0.99mm. The mean Dice coefficient was 0.9 (SD 0.07), indicating excellent geometric overlap.

Conclusions

There is no difference between the difference in manual measurements between human lumbar vertebrae, CT-based 3D models and 3D-printed models. However when digital comparisons are made, CT models are approximately 1mm larger than the corresponding vertebra. This is the first study to compare human spine bones to CT-based 3d models and 3d printed models. This is clinically important when utilising CT scans to make 3D-printed bio-models, and patient specific templates.
The diagnostic precision of computed tomography for traumatic cervical spine injury: an in vitro investigation

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Objectives

We recently performed the biomechanical tests applying dynamic axial compression and lateral bending to in vitro cervical spine specimens, simulating high energy traumatic loads. The purpose of this study is to evaluate how CT is precise and could be gold standard to diagnose cervical spine fractures by comparing to detailed dissection of the injured spine specimens.

Method

35 three-vertebra human cervical spine specimens were applied dynamic axial compression with three lateral eccentricities and two end condition. Two clinicians diagnosed vertebral fractures based on the high-resolution CT images, using OsiriX software. Each vertebra was divided into 34 anatomical structures. The CT diagnosis was compared detailed dissection.

Results

The interobserver agreement was moderate (0.523) by Cohen's statistic. The average sensitivity of CT was highest for fractures of the facet joint (59\%) and lowest for fractures of the pedicle (13\%) and lateral mass (23\%). The precision was highest for fractures of the spinous process (83\%) and lowest for the fractures of pedicle (21\%). The specificity was above 90\% for all components.

Conclusions

In this axial compression lateral bending cervical spine fracture mode common to rollover accidents, and perhaps other loading modes, care should be taken in diagnosing lateral mass and pedicle fractures through CT, particularly if subsequent surgery will utilize this anatomy for implant stabilization.
Epidural abscess causing spinal cord infarction

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Objectives

The risk of spinal cord infarction related to spinal epidural abscess (SEA) is not clearly understood. The pathophysiology may involve arterial or venous compromise. We reviewed our hospital experience with spinal cord infarction associated with epidural abscess to better define risk factors, pattern of neurological impairment, and prognosis.

Method

A retrospective analysis was performed at Banner University Medical Centre, Tucson. Relevant cases between February 2012 and July 2019 were identified in the neurosurgical database. Magnetic Resonance Imaging data and electronic records were reviewed. Patient details were documented pertaining to: age, gender, neurological examinations, known SEA risk factors, abscess location, number of spinal levels affected, surgical intervention, and culprit pathogen.

Results

119 cases of SEA were identified. Eight patients experienced a precipitous decline in their neurological condition during their admission. Seven of these patients underwent emergency decompressive surgery. All patients were male. Mean age was 53.1 years. The mean number of spinal segments affected was 6.0. Five of the eight cases involved the cervical spine, and six cases involved the thoracic spine. Staphylococcus aureus was the culprit organism in seven cases. Decline in neurological condition was evident over the course of several hours or days in all cases. Past history of alcohol or intravenous drug abuse, diabetes, and immunosuppression were frequent. Of the four cases of infarct, T2 cord signal hyperintensity was present in all. Epidural abscess location was anterior in two cases and circumferential in two. Two patients suffered American Spinal Injury Association (ASIA) A impairment and two patients ASIA B. Two patients recovered to non-functional antigravity motor strength.

Conclusions

Our findings suggest 6% of SEA patients may go on to develop spinal cord infarction irrespective of the degree of spinal cord compression or institution of antibiotic therapy. The pattern of variable neurological impairment and variable spinal cord signal change on MRI suggests venous rather than arterial infarction. Prognosis for meaningful return of function is poor even with emergent decompression.
The nerve root sedimentation sign on MRI is not only correlated with neurogenic claudication: Association with all types of leg dominant mechanical pain

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Objectives

Many studies have found a correlation between the nerve root sedimentation sign on MRI (SedSign) and neurogenic claudication; however, they have failed to account for patients with constant leg dominant pain (i.e., sciatica). The objective of this study was to analyze the clinical utility of SedSign to diagnose leg dominant pain that is intermittent (neurogenic claudication) or constant (sciatica) by comparison with a validated classification for low back and leg pain (Saskatchewan Spine Pathway classification; SSPc).

Method

Prospectively collected data was retrospectively reviewed for 367 consecutive patients with back and/or leg pain presenting between January 1, 2012 and May 31, 2018. Baseline clinical characteristics included SSPc, Oswestry disability index (ODI), visual analogue pain scores for back and leg (VAS), and EuroQol Group 5-Dimension Self-Report (EQ5D). 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%) patients. On univariate analysis, a positive SedSign was correlated with age, male sex, several ODI components, EQ5D mobility, cross-sectional area (CSA) of stenosis, antero-posterior diameter of stenosis, neurogenic claudication and leg dominant pain; negative SedSign was correlated with back dominant pain and sciatica. On multivariate analysis, SedSign was associated with age, male sex, CSA stenosis and ODI walking distance. The sensitivity and specificity of SedSign for detecting leg dominant pain was 37.4 and 81.8, respectively (positive and negative predictive value, 77.5 and 43.8).

Conclusions

The SedSign has high specificity for neurogenic claudication, sciatica or leg dominant pain, but the sensitivity is poor. The strength of correlation between SedSign and either neurogenic claudication or sciatica is similar, but both are lost on multivariate analysis.
Accuracy of robot-assisted compared to freehand pedicle screw placement in spine surgery: a meta-analysis of randomized controlled trials

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Objectives
To investigate the differences in accuracy between robotic-assisted and freehand technique for pedicle screw insertion.

Method
Two investigators independently searched for articles on randomized controlled trials (RCTs) from 2012 to 2019 in Pubmed, Web of science and Cochrane Library. The final meta-analysis included 7 RCTs. Statistical analysis was performed by using the Review Manager 5.3. We compared accuracy of pedicle screws placement between robot-assisted and conventional freehand groups.

Results
7 RCTs included 540 patients and 2476 screws were included. The combined results showed that Gerztein–Robbins Classification Grade A (OR = 1.68, 95% CI:0.82, 3.44; P = 0.16) and Grade A+B (OR = 1.67, 95% CI:0.44, 6.31; P = 0.45) accuracy rate showed no significant difference. Subgroup analysis showed TiRobot (TINA VI Medical Technologies) significantly improve pedicle screw accuracy in both Grade A (OR = 3.22, 95% CI:2.07, 5.01; P < 0.00001) and Grade A+B (OR = 5.10, 95% CI:2.31, 11.23; P < 0.0001) classification. Robot-assisted by SpineAssist (Mazor Robotics Ltd.) showed inferior pedicle screw accuracy rate, in both Grade A (OR = 0.63, 95% CI:0.39, 1.00; P =0.05) and Grade A+B (OR = 0.40, 95% CI:0.19, 0.84; P = 0.02) classification. Surgery assisted by Renaissance (Mazor Robotics Ltd.) showed no difference between two groups in both Grade A (OR = 1.58, 95% CI:0.85, 2.96; P = 0.15) and Grade A+B (OR = 2.20, 95% CI:0.39, 12.43; P = 0.37) classification

Conclusions
The accuracy rate differed among different robot systems. Surgery assisted by TiRobot (TINA VI Medical Technologies) is superior to conventional method in terms of accuracy of pedicle screw insertion. However, SpineAssist (Mazor Robotics Ltd.) reduces pedicle screw accuracy compared to conventional freehand technique, and Renaissance (Mazor Robotics Ltd.) shows no difference between two groups.
A positive nerve root sedimentation sign on MRI is associated with improved surgical outcomes in patients with back dominant pain

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Objectives

Our group has previously shown that a positive nerve root sedimentation sign on MRI (SedSign) had no prognostic value for lumbar laminectomy outcomes, although other have found a weak association. We also found that SedSign correlates equally well with neurogenic claudication and other types of leg dominant pain (i.e., sciatica). In addition, there is a negative correlation between SedSign and back-dominant pain. The objective of this study was to compare the outcomes of all types of lumbar surgery (decompression with or without instrumented fusion) with respect to SedSign utilizing a validated classification for low back and leg pain (Saskatchewan Spine Pathway Classification; SSPc).

Method

Prospectively collected data was retrospectively reviewed for 243 consecutive patients receiving elective surgery for back and/or leg pain due to degenerative conditions presenting between January 1, 2012 and May 30, 2019. Baseline clinicoradiologic characteristics included SSPc, dural sac cross sectional area (CSA) and anteroposterior diameter (AP) at maximal stenosis. Outcome measures included Oswestry disability index (ODI), visual analogue pain scores for back and leg (VAS), and EuroQol Group 5-Dimension Self-Report (EQ5D).

Results

SedSign was associated with older age and more severe radiologic stenosis. For SSPc 1 (back dominant pain, worse in flexion), a positive SedSign was associated with a statistically significant decrease in both VAS leg pain ($p = 0.024$) and ODI pain intensity ($p = 0.023$).

Conclusions

This is the largest analysis of SedSign with respect to surgery outcomes, and the only study to analyze for any correlation between SedSign and outcomes for back dominant pain. Although the indications for lumbar spine surgery in patients with back dominant pain are hotly debated, this study demonstrates that a positive SedSign on MRI is associated with better pain relief outcomes.
Thoracolumbar Burst Fracture: McCormack load-sharing classification - Systematic Review and single arm meta-analysis.

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Objectives

Study design: A systematic review and single arm meta-analysis of randomized clinical trials.

Objective: To evaluate if Load-sharing Classification (LSC) is reliable to predict the best surgical approach for thoracolumbar burst fracture (TBF).

Summary of Background Data: There is no previous review evaluating the efficacy of LSC as a guide for surgical treatment in burst fractures.

Method

Methods: On April 19th, 2019, a broad search of was performed in the following databases: EMBASE, PubMed, Cochrane Library, SCOPUS, Web of Science, LILACS and grey literature. The protocol of this study was registered on the International Prospective Register of Systematic Reviews - PROSPERO under number CRD42019126382. We included clinical trials that had patients with TBF undergoing isolated posterior surgical treatment, classified by load-sharing score and that could be analysed the outcomes: loss of segmental kyphosis and implant failure. We performed random or fixed effects model meta-analyses depending on data homogeneity. Heterogeneity between studies was estimated by $I^2$ and $\tau^2$ statistic.

Results

Results: The initial search identified 189 references, of which 9 studies were eligible for this review. All papers with LSC up to 6 proved to be reliable in indicating that only posterior instrumentation is necessary, without screw failures or loss of kyphosis correction. For cases with LSC greater than 6, only 2.5% of the individuals presented implant failure with isolated posterior approach ($I^2=7\%$, $\tau^2<0.0001$, $p=0.37$). For loss of kyphosis correction, only 5% of patients had this outcomes if LSC >6 ($I^2=76\%$, $\tau^2<0.0011$, $p<0.01$). For both outcomes, we had 6% of postoperative problems ($I^2=77\%$, $\tau^2<0.0015$, $p<0.01$).

Conclusions

Conclusion: Load-sharing score up to 6 is 100% reliable and only posterior intrumentation is sufficient for stabilization. For Scores greater than 6, the incident of implant breakage and loss of kyphosis correction in isolated posterior fixation is low. So others factors should be taken into account to define the best surgical approach.
Morphological features of thoracolumbar burst fractures associated with neurological recovery after thoracolumbar traumatic spinal cord injury

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Objectives

To identify specific morphological characteristics in thoracolumbar burst fractures associated with neurological outcome after severe traumatic spinal cord injury (TSCI).

Method

We retrospectively analyzed the clinical and radiological (CT-Scan morphological characteristics specific to burst fractures) data of 25 consecutive patients admitted for TSCI secondary to a burst fracture at levels from T11 to L2 between 2010 and 2017 at single level-1 trauma center. We included severe TSCI, defined as American Spinal Injury Association Impairment Scale (AIS) grade A, B or C. Seven morphological parameters were assessed: mean canal compromise, comminution of vertebral body fragment retrospulsed into the spinal canal, magnitude of translation of postero-inferior vertebral body corner, lamina fracture, vertebral body kyphosis, segmental kyphosis, and vertebral body comminution. The association between neurological recovery (improvement by at least 1 AIS grade) and morphological and clinical parameters were assessed from logistic regression analyses.

Results

Among the 25 patients with severe TSCI, 14 were AIS A, 5 were AIS B and 6 were AIS C upon initial preoperative neurological evaluation. The AIS grade and the burden of associated injuries (ISS) were the only clinical factors significantly associated with poor neurological recovery. The trauma level of energy was not associated with neurological outcome. Several morphological parameters were independently related to neurological recovery: postero-inferior corner translation, presence of retropulsed fragment comminution and complete lamina fracture. Neurological recovery was more strongly associated with these 3 morphological parameters than with the initial AIS grade. The magnitude of sagittal kyphosis angle, vertebral kyphosis index and vertebral body comminution were not associated with the neurological outcome.

Conclusions

Morphological features of the bony structures involving the spinal canal in thoracolumbar burst fractures with severe TSCI are associated to the neurological outcome, and could provide additional insight other than the AIS clinical grading. The fracture pattern may better reflect the actual level of energy transferred to the spinal cord than distinguishing between low- and high-energy trauma.
Radiographic Parameters of Listhesis and Instability are Not Associated with Health Status or Clinical Outcomes in Grade 1 Degenerative Spondylolisthesis

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Objectives

Slip magnitude and presence of motion are utilized in surgical planning for degenerative spondylolisthesis. Fusion is considered in patients with higher slip magnitude or instability. The purpose of this study is to identify if slip magnitude and mobility correlate with symptomatology pre-op or post-op.

Method

From the Quality Outcomes Database, patients who had fusion for grade 1 degenerative spondylolisthesis with complete pre-op and one-year post-op Patient Reported Outcomes (PROs) were identified. The magnitude of slip and presence of motion were measured on flexion and extension x-rays. Pre-op and one-year post-op PROs including Back Pain (BP, 0-10), Leg Pain (LP, 0-10), Oswestry Disability Index (ODI) and EQ-5D were analyzed.

Results

Seventy-nine patients from multiple centers were identified. Mean age was 60.7 years and there were 46 females (58%). Patients were categorized based on upright slip into 3 groups: ≤5mm, >5mm to <7mm, and ≥7mm slip. Motion was defined as >3mm slip difference between flexion and extension films. No significant differences were identified in PROs at baseline or at one-year post-op follow-up between the groups (p>0.05).

Conclusions

While slip magnitude and presence of motion are useful for surgical planning, they are not associated with pre-op health status or post-op outcome in grade 1 degenerative spondylolisthesis.
Predictive Socioeconomic Factors Following Lumbar Disk Arthroplasty: A Canadian Spine Outcomes Research Network (CSORN) Study

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Objectives

There is a paucity of published Canadian literature investigating patient reported outcomes following lumbar total disc arthroplasty (LDA). The study purpose was to compare socioeconomic factors against 2 year reported functional outcomes and satisfaction following LDA.

Method

We conducted a multicenter review of prospectively collected data on consecutive spine surgery patients enrolled by CSORN who underwent isolated primary LDA or hybrid constructs (LDA with adjacent fusion) for symptomatic degenerative disk disease (2015-2019). Patient socioeconomic factors, functional outcome scores, and satisfaction were assessed preoperatively, and at 1 and 2 years postoperatively. Descriptive and inferential statistics were performed, with multivariate logistical regression analysis to investigate predictive factors on outcome.

Results

97 patients (39 female:58 male) underwent LDA or a hybrid construct up to 4 levels with 1 or 2 year follow-up (1-level:36 patients, 2-level:39 patients, 3-level:18 patients, 4-level:4 patients). From this cohort, 52 patients (22 female:30 male) underwent single/multilevel LDA (1-level:36 patients, 2-level:15 patients, 3-level:1 patient). Within the total cohort, patients who reported an impact in preoperative work-status as a result of their spinal condition (change to modified duties/hours or short/long term disability) were found to consistently report lower satisfaction (1 year: r = -0.469, p<0.001, 2 year: r = -0.523, p<0.001), lower ODI improvement (1 year: r = -0.321, p<0.01, 2 year: r = -0.280, p<0.05), and lower improvements in numeric back and leg pain scale. Daily narcotic/antidepressant use were other significant but inconsistent predictors. Non-significant patient factors include gender, age, BMI, marital/education status, living arrangement, smoking, exercise, and number of comorbidities. Similar findings were found in the isolated LDA cohort regarding work status and patient satisfaction.

Conclusions

Spinal symptoms that result in impact to employment status (i.e. modified duties/hours or short/long term disability) is predictive of poorer satisfaction and functional outcomes in patients undergoing isolated or hybrid LDA for degenerative spondylosis.
Effect of In-situ Fusion in Lumbar Spondylolisthesis on clinical outcomes and Spino-pelvic sagittal balancing

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**Objectives**

To study the effect on sagittal balancing in spine and pelvis radiographically and also, to study the clinical outcomes after surgical In-situ fusion of Lumbar Spondylolisthesis.

**Method**

This is a prospective study of a hundred and thirty eight patients from June 2015 to November 2016 which includes patients from age group of 20 to 80 years, excluding traumatic, pathological and cases which were treated conservatively. Clinically VAS, SF-36 and ODI scores were measured and for radiographical evaluation Lumbosacral spine AP, lateral and Flexion-extension views were taken including the femoral head, pre-operatively and then at 6 and 12 months. The radiological parameters included Pelvic incidence, Pelvic tilt and sacral slope. Posterior midline approach was taken and pedicle screws for fixation and TLIF was done in most of the cases.

**Results**

The mean Pelvic tilt changed from a mean of 23.85 degrees to 18.25 degrees post op whereas Pelvic incidence changed from 61.58 degrees to 56.34, both of which were statistically significant. VAS score improved from a median of 8 pre operatively to 2 at 12 months post-operatively, ODI score improved from a mean of 39.07 to 7.92 and SF-36 scores showed a statistically significant improvement as well. 23 of our patients had Pseudarthrosis, 4 patients had neurological deficit, which recovered in a year, whereas 4 patients had superficial infection which were treated with intra-venous antibiotics.

**Conclusions**

Posterior instrumented stabilisation with pedicle screws and Trans-foraminal Lumbar interbody fusion in-situ, in cases of lumbar spondylolisthesis can provide significantly better clinical outcome with minimal complications and can be attributed to improved spino-pelvic sagittal balancing as evidenced on measurements of Pelvic tilt and pelvic incidence. This also suggests that the need for reduction to achieve near normal anatomical alignment, can be avoided.
Gender differences in the surgical management of lumbar degenerative disease: a systematic review

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Objectives

The objective of this study was to systematically map and synthesize the adult surgical literature regarding gender differences in pre- and post-operative patient-reported clinical assessment scores for patients with a diagnosis of lumbar degenerative disease (disc degeneration, disc herniation, spondylolisthesis, spinal canal stenosis).

Method

A systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) guidelines. MEDLINE, EMBASE, and Cochrane Registry of Controlled Trials were searched from inception to September 2018. Study characteristics including patient demographics, diagnoses, procedures, pre-operative and post-operative clinical assessment scores (pain, disability, and health-related quality of life (HRQoL)) were collected. Levels of Evidence were scored using the Oxford Centre for Evidence-Based Medicine grading system.

Results

Thirty articles were identified, accounting for 32,951 patients. Six studies accounted for 84% of patients; five of the six studies were published by European groups. The most common lumbar degenerative conditions were disc herniation (59.0%), disc degeneration (20.3%) and spinal canal stenosis (15.9%). The majority of studies reported worse pre-operative pain (93.3%), disability (81.3%), and HRQoL (75%) among females. The remainder reported equivalent pre-operative scores between males and females. The majority of studies (63.3%) did not report pre-operative duration of symptoms. Eighty percent of studies found females had worse absolute post-operative scores in at least one outcome category (pain, disability, or HRQoL). The remainder reported equivalent absolute post-operative scores between males and females. Seventy-three percent of studies reported either an equivalent or greater interval change for females. The majority of studies provide Level IV evidence.

Conclusions

Female patients undergoing surgery for lumbar degenerative disease (disc degeneration, disc herniation, spondylolisthesis, spinal canal stenosis) have worse absolute pre-operative pain, disability and HRQoL. Following surgery, females have worse absolute pain, disability, and HRQoL, but demonstrate an equal or greater interval change compared to males.
Two Year Results of Lumbar Disk Arthroplasty: a Canadian Spine Outcomes Research Network (CSORN) study

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Objectives

There is a paucity of published Canadian literature on patient outcomes following lumbar disc arthroplasty (LDA). We quantified 1 and 2 year patient-reported outcomes following LDA, comparing results to international experience.

Method

We conducted a multicenter review of prospectively collected data on consecutive spine surgery patients enrolled by CSORN who underwent isolated primary LDA or hybrid constructs (LDA with adjacent fusion) for symptomatic degenerative disk disease (2015-2019). Functional outcome scores, complications, and patient satisfaction were assessed preoperatively, and at 1 and 2 years postoperatively. Descriptive and inferential statistics were performed with the results compared to international experience.

Results

A total of 97 patients (39 females:58 males) were analyzed (average age=43 years). 36 patients underwent single level arthroplasty, 39 underwent 2-level surgery (15 LDA, 24 hybrids), 18 underwent 3-level surgery (1 LDA, 17 hybrids), and 4 underwent 4-level surgery (4 hybrids). Mean surgical time and estimated blood loss was 118 minutes and 172cc (1 level), 131 minutes and 250cc (2 level), 131 minutes and 386cc (3 level), and 179 minutes and 775cc (4 level), respectively. No device-related complications were observed. By 2 years (76% follow-up) the total average numerical back pain scale improved from 7.21 to 3.25 and average Oswestry Disability Index (ODI) improved from 45.7 to 23.9 at 2 years (p<0.0001), with statistical significance found in all subgroups. Similar findings were found with SF-12 and Health State questionnaires. 83.0% and 86.7% of patients were satisfied or extremely satisfied at one and two year follow-up, respectively.

Conclusions

Lumbar disk arthroplasty whether used in isolation or as part of a hybrid construct is an effective treatment option in clinically appropriate patients with debilitating degenerative disk disease. Significant improvements exceeding minimum clinically important differences were seen in patient reported functional outcome scores and were maintained through 2 year follow-up, alongside high patient satisfaction rates. Our CSORN-based outcomes confirm positive and comparable results to published international literature.
Does disc morphology affect the success of non-operative treatment of chronic sciatica from a lumbar disc herniation?

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Objectives

This study aimed to determine whether disc morphology and the success of standardized non-operative treatment for chronic lumbar disc herniation are related. A secondary objective was to evaluate the association between disc morphology, pelvic parameters, and patient-reported outcomes (PROMs).

Method

Retrospective analysis was performed on patients enrolled in a previous RCT that examined surgery vs. non-operative treatment for sciatica lasting ≥ 4-12 months from a posterolateral lumbar disc herniation. During the trial 24 patients failed ≥6 months of non-operative treatment and crossed over to surgery. In the present study, a comparison was made between the cross-over group and those that received non-operative care only. Two independent, blinded observers evaluated herniation type, Michigan State University (MSU) grade, canal occupancy, size, pelvic incidence, pelvic tilt and sacral slope. For secondary analysis, disc morphology and radiographic parameters were compared between patients that achieved good PROMs vs. those that achieved poor PROMs. A good outcome was 30% improvement in Oswestry Disability Index (ODI) score, or a score of 0-3 numerical rating scale (NRS) for leg and back, or improvement of ≥ 4.9 SF36-physical component summary score (PCS) at 6 months after enrollment.

Results

Data was available for 24 patients in the cross-over group and 35 patients in the non-operative group. Demographics, herniation level/location/type, MSU grade, disc height ratio, sagittal area of herniation, and sacral slope were not different between the 2 groups. The cross-over group had smaller herniation width ratios (p=0.01), smaller herniation area ratios (p=0.02) and smaller pelvic incidences (p=0.02). Patients with a poor ODI outcome had smaller pelvic incidence and pelvic tilt (P=0.008 and P=0.001 respectively), and those with a poor SF36 PCS outcome tended to have smaller width disc/canal ratio (P=0.05).

Conclusions

Disc morphology is not associated with the success of conservative management. However, non-operative management of herniated discs is associated with poor outcome if the patients have smaller width disc/canal ratios and pelvic incidence.
Opioid Prescribing Patterns: Preliminary Investigation

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Objectives

To provide a preliminary investigation into the opioid prescribing patterns of spine surgeons in Canada.

Method

An anonymous online survey (SurveyMonkey) was distributed by email to the Canadian Spine Society membership, a total of 179 Orthopaedic, Neurosurgeons and affiliates. The survey included 10 questions: 2 demographic questions regarding region of practice and department affiliation. Four questions were posed regarding prescribing practices for patients who undergo spinal fusion surgery, and 4 in regards to decompression surgery.

Descriptive statistics were used to get an initial look at overall trends in prescribing practices and to look if trends differ based on region of practice, or departmental affiliation.

Results

To date, 20.30% of the total population has responded to the survey. Of those who responded 20% are practicing in Atlantic Canada, 32.5% in Central Canada and 47.5% in Western Canada. Orthopaedic surgeons accounted for 65% of respondents and Neurosurgeons for 35%.

Of surgeons surveyed 12.5% reported providing pain medication prior to fusion surgery and the majority (95%) reported prescribing opioids following spine fusion surgery. Hydromorphone (52.5%), oxycodone/Percocet (15%) and codeine/Tylenol 3 (12.5%) were the opioids surgeons reported as standard for their practice. Duration of opioid prescription ranged with the majority prescribing opioids for 8-30 days (57.5%), or for 7 days or less (40%). For decompression surgery 92.5% prescribe opioids following surgery. Prior to surgery 5% gave pain medication. Hydromorphone (37.5%) and Codeine/Tylenol 3 (25%) are the opioids most frequently reported as standard of practice. 35% of respondents prescribed opioids for 8-30 days. Hydromorphone and Percocet prescriptions were more likely to be prescribed for 8-30 days. 12.5% of respondents provided opioid refills following decompression surgery. For both surgery types there are emerging trends based on region and departmental affiliation.

Conclusions

There is variability in opioid choice and duration of opioid prescriptions between spine surgeons in Canada. There would be value to increasing respondents and in discussion/implementation of standardized opioid prescription guidelines based on surgical procedures.
Frailty is a better predictor of complications than age alone after surgical treatment of Degenerative Cervical Myelopathy: An ambispective study of 5,107 elderly patients from the National Surgical Quality Improvement Program Database

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Objectives

To compare whether age or frailty assessment is a better predictor of peri-operative complications for surgery in Degenerative Cervical Myelopathy (DCM).

Method

Patients who underwent surgery for DCM listed in the NSQIP database were included. The 5-point modified Frailty Index (mFI) was applied to each, with descriptive statistics calculated for continuous and categorical variables of demographic and complication metrics. The independent effect of age and frailty on outcomes was evaluated by multivariable regression. For each outcome, a logistic or linear regression model was constructed that included both variables and adjusted for sex, type of fusion, and number of levels as covariates. Effect sizes were summarized by odds ratio (OR) (dichotomous outcomes) or mean difference (MD) (continuous outcomes) and associated 95% confidence intervals (CIs). In addition, to weigh the relative importance of age versus frailty in predicting each outcome, standardized regression coefficients were calculated and their magnitudes directly compared.

Results

5107 patients (2248 females) were extracted for analysis (mean 71.7 years), with 3298 (64.6%) undergoing anterior surgery, 1649 (32.3%) posterior surgery, and 160 (3.1%) combined. The mean mFI was 0.23 (SD 0.16). In the regression analyses, age and mFI were found to be statistically significant predictors for 30-day mortality, unplanned readmission, unplanned reoperation, major complication, hospital LOS and discharge home. However, mFI was found to have a greater effect size than age, as measured by the standardized Beta coefficient, for mortality, unplanned reoperation, major complication and discharge home.

Conclusions

Frailty, as measured by the mFI, is a better predictor than age for mortality, unplanned reoperation, major complication and discharge home in the first 30 days after surgical treatment for DCM. We recommend this index should be used in preference over age when considering the risks of surgical management in DCM.
Pathway Analysis in Spine Surgery: A Model for Evaluating Length of Stay

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Objectives

To identify pre-, intra-, and post-operative factors associated with length of stay (LOS) in patients undergoing spine surgery at a Canadian quaternary academic teaching hospital.

Method

This retrospective cohort study included all patients who underwent spine surgery by two orthopedic spine surgeons between October 2014-2016. Chart data were extracted on 16 factors by two reviewers. Factors collected included age, sex, BMI, ASA class, insurance claim, transfusion, pre-op medication use, surgical procedure, Charlson Comorbidity Index, pre-op hemoglobin, surgical time, initial versus revision surgery, and intra-op analgesics. Postoperative LOS was the outcome, calculated from date of surgery to date of discharge. Multiple quasi-poisson regression was used to identify factors associated with LOS.

Results

A total of 763 patients were identified. Average age of the cohort was 59 years (16.2 sd, range 16-97) and 49% were female. Prominent procedures were 1-level transforaminal lumbar interbody fusion (TLIF) (29%), 2-level TLIF (8%), discectomy (17%), and laminectomy (13%). The average LOS for the cohort was 6.7±12.4 days. There were 634 patients with full data included in the multivariable model. Compared to patients undergoing a laminectomy, those that had a discectomy stayed less than half as long (IRR=0.37, 95% CI:[0.21,0.64]). Posterior c-spine patients (IRR=5.93, 95% CI:[3.4,10.34]), major deformities (IRR=2.39, 95% CI: [1.53,3.72]), anterior cervical decompression and fusion (ACDF) and cervical vertebrectomies (IRR=2.58, 95% CI:[1.49,4.46]), 1-level TLIFs (IRR=1.65, 95% CI:[1.22,2.23]), 2-level TLIFs (IRR=1.62, 95% CI:[1.13,2.33]), and patients undergoing an incision and drainage, hardware removal, or hematoma evacuation (IRR=1.83, 95% CI:[1.16,2.87]), all had a significantly longer LOS. Patients undergoing a re-operation (IRR=1.32) and patients that received a blood transfusion also had a significantly longer LOS (IRR=2.56).

Conclusions

The LOS within this cohort was correlated with the procedure performed, presence of a blood transfusion and re-operation. Other medical comorbidities and surgical, clinical, and patient factors were not significantly associated with LOS. Future pathway improvement should focus on procedure-specific, post-operative rehabilitation protocols.
Patients with Adolescent Idiopathic Scoliosis (AIS) have different cervical lordosis than the normal population.

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Objectives

An often neglected component of sagittal balance in AIS is the cervical spine. The cervical spine can compensate for sagittal deformities by altering head position, but this may give rise to symptoms when the extremes of these mechanisms are reached. This paper seeks to define whether AIS patients have a different cervical profile when compared to normal adolescents.

Method

The literature was searched to define the normal sagittal cervical profile in adolescents. A retrospective analysis of 81 patients with AIS who had received corrective surgery was carried out, and pre- and post-operative cervical lordosis was independently measured using full length spine radiographs. This data was compared to the 95% confidence interval of cervical lordosis in controls to show if patients showed different cervical spine profile to normal patients before or after corrective surgery.

Results

Normal cervical spine sagittal profiles values are poorly described. One study (paper A) gives values of -16° (95%CI -12 - -20°) for male C2- C7 lordosis and -15° (95% CI -12.5- -17.5°) for female C2- C7 adolescents. Another reference (paper B) gives values of -8.4 (95%CI -6.7- -10.1°) for male and -1.9 (95%CI -0.5- -3.3°) for female adolescents for the same C2- C7 measurements. Our values for male patients for pre op C2- C7 lordosis was -1.2 (95%CI -8.5- -6.1°) and 9° (95%CI 2.9- 15.1°) for females. Post op values were 10.6° (95%CI 2.4-18.8°) for males and 8.3° (95%CI 4.8-11.8°) for females.

Conclusions

The values of cervical lordosis in our series show that patients with AIS have a significantly different cervical lordosis when compared to normal values both pre and post deformity correction (p < 0.05). A complete understanding of how the cervical spine is positioned prior to surgery is critical, as flattening the thoracic spine during corrective surgery could give rise to cervical pain and sagittal imbalance if the ability of the cervical spine to compensate for the new spinal position is exceeded.
Investigation of Thoracic Spinal Muscle Morphology with Upright MRI

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Objectives

MRI derived spinal-muscle morphology in weight-bearing postures is different from that in supine and thus has potential diagnostic, prognostic, and therapeutic applications in spinal health. However, the focus to date has been on cervical and lumbar regions. Recently, larger Cobb angles have been associated with smaller cross-sectional areas (CSA) and lower density of the thoracic spine muscles. Hence, we aim to quantitatively investigate the repeatability of measuring the thoracic muscle morphology (e.g. size/shape/structure) in different postures using upright open MRI.

Method

Four healthy volunteers (age 26±7 years) were imaged (0.5T MROpen, Paramed, Genoa, Italy) in three postures (supine, standing, and standing with 30° flexion). Due to dimensional limitations of the imaging area, two levels of the middle (T4-T5) and lower (T8-T9) thorax were scanned separately for each posture. A descriptive methodology for defining the regions of interest of erector spinae, transversospinalis, and trapezius in axial MR images was developed, and 3-D muscle volumes were generated from 2-D anatomical CSA segmentation. Segmentation repeatability was examined through Intraclass Correlation Coefficient (ICC) for 2-D CSA, and Dice Coefficient for the 3-D muscle volumes.

Results

The segmentation is based on the points of origin and insertion, probable size, shape, and the position of the muscle groups relative to other recognizable anatomical landmarks as seen from typical axial MR images. The intra-rater repeatability ranged from good to excellent (average ICC (3,1) along T4-T5 and T8-T9 respectively: erector spinae 0.83 and 0.94, transversospinalis 0.89 and 0.95, trapezius 0.98 and 0.98). The average Dice Coefficient was found to be good (erector-spinae 0.95 and 0.96, transversospinalis 0.92 and 0.94, trapezius 0.95 and 0.91, along T4-T5 and T8-T9 respectively).

Conclusions

The guidelines proposed are important for reliable MRI-based measurements and allow meaningful comparisons of muscle morphometry in the thoracic spine across different studies globally. Good segmentation repeatability suggests we can further investigate the effect of posture and spinal curvature on muscle morphology in the thorax.
post-operative complication prediction between spinal surgeons and a machine learning model: a comparative study

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Objectives

The purpose of this study is to determine the accuracy of surgeons when predicting complications in patients undergoing spinal surgery as compared to a predictive model developed using machine learning techniques.

Method

A single center NSQIP database of 893 patients undergoing spinal surgery was used to develop a prediction model, using gradient boosted decision tree (XBT) machine learning algorithm, to predict 30 day medical and surgical complications. Thirty clinical vignettes were selected from the database describing the patient’s age, gender, diagnosis, procedure, body mass index, comorbidities and procedural urgency. An online survey was developed and a request to participate was sent to spine staff and trainees at an academic hospital, including 6 staff surgeons, 8 residents, and 3 fellows. The participants were asked to read the vignette and predict the presence or absence of complications. The results were analyzed to determine the agreement between participants, the performance of the participants, the difficulty of the vignettes and the performance of the XBT model.

Results

The XBT model performance in predicting post-operative complications using 10-fold cross validation was 0.54 AUC. XBT model’s accuracy for the 30 clinical vignettes was 0.53 and this was the same as the most accurate staff surgeon. Only three residents and one fellow outperformed the model (accuracy range 0.57-0.63) while remaining 11 respondents predicted worse than the model (accuracy range 0.37-0.50). There was fair agreement between respondents’ predictions (Fleiss kappa 0.218). The average predictive accuracy of fellows was 0.50 while those of the staff surgeons’ were 0.47. There were three vignettes where only one respondent correctly predicted the presence or absence of complications.

Conclusions

This study demonstrates the difficulty in predicting complications for patients having spinal surgery. Although the XBT model demonstrated relatively poor accuracy in this set of 30 vignettes its performance was comparable to the respondents for these difficult predictions.
Is Using a Simplified Procedural Classification as Accurate as Using Current Procedural Terminology Codes to Predict Future Complications in Spinal Surgery?

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Objectives

Predicting surgical complications is valuable for surgeons and patients when considering surgical intervention. To this effect, several risk calculators have been developed. The American College of Surgeons National Quality Improvement Program (ACS-NSQIP) risk calculators already exist to predict the risk of different surgeries, its use can be challenging due to the use of Current Procedural Terminology codes (CPT codes) that is not intuitive and complex.

Method

We are proposing a model using a simplified procedural classification (SPC) as an alternative to evaluate the risk of spinal surgeries. Using spinal cases from the ACS-NSQIP database, we recreated the model used by the ACS-NSQIP to evaluate the accuracy at which the SPC could predict complications.

Results

It was found that the SPC assessment was as accurate as the ACS-NSQIP risk calculator in predicting complications following spinal surgeries.

Conclusions

The proposed SPC model is as valid as the ACS-NSQIP for predicting complications for patients undergoing spinal surgery.
Pre-operative patient performance status and frailty phenotype as predictive factors of outcome in surgically treated patients with metastatic spinal disease: a systematic literature review

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Objectives

Surgery for spinal metastatic disease (SMD) may be indicated for decompression of the neural elements, restoration of biomechanical stability, and relief of intractable pain. Scoring systems accounting for burden of malignancy have been developed to facilitate the surgical candidate selection process. Despite the inherent importance of physical reserve and ability to tolerate surgery, pre-operative patient-related “frailty” factors that may be used to prognosticate outcomes following surgery for SMD are not well described. The objective of this study was to systematically review and synthesize the adult literature regarding pre-operative patient-related factors that predict post-operative outcomes following surgery for SMD.

Method

A systematic review was performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. MEDLINE, Scopus, EMBASE, Cochrane Registry of Controlled Trials, CINAHL, and Web of Science were searched from 1990 to April 2018. Study and patient characteristics including demographics, diagnoses, tumor histology, interventions, and pre-operative surrogate markers of frailty were collected. Any post-operative outcomes were recorded. Quality of the evidence was scored using the Oxford Centre for Evidence Based Medicine Scoring System.

Results

Forty articles were identified, accounting for 8,364 patients. The overall quality of evidence was low; 39 of 40 studies constituted level IV evidence. Most studies were retrospective analyses of small heterogenous patient cohorts consisting of various tumor types. Aside from age, KPS and ECOG scores, few other patient-level surrogate markers of frailty influenced post-operative outcomes. The most commonly assessed outcome was overall survival, which appears to be highly influenced by the extension of systemic disease as opposed to surrogate markers of frailty.

Conclusions

The overall quality of evidence was low. Few pre-operative patient-related factors were found to predict outcomes following surgery for SMD. Larger homogenous prospective cohort studies should be conducted in order to examine patient-related factors that may be used to guide management decisions and prognosticate outcomes.
The measurements of frailty and their application to spine surgery

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Objectives

Frailty has demonstrated to significantly increase the risk of postoperative adverse-events (AEs) in the spine population. Clinical frailty measures containing modifiable and non-modifiable components have been developed based on different operational definitions. The primary aims of this study are to identify frailty measures currently reported throughout the surgical literature; to identify measures most appropriate as risk stratification tools in the surgical spine population; and to identify measures most sensitive to capturing the effect of spinal pathology and surgical intervention on frailty trajectory in the surgical spine population.

Method

This systematic review was registered with PROSPERO: CRD42019109045. Publications in English from January 1950 to October 2018 were identified by a comprehensive search strategy of PubMed, Ovid, Embase, and Cochrane, supplemented by manual screening. Included studies consisted of those reporting the use of clinical frailty measures in either the surgical spine or neurological population with a mobility-related disability. Clinical frailty measures were evaluated according to an appraisal score, which assessed objectivity, feasibility, and validity.

Results

A total of nineteen frailty measures were identified. Twelve measures with non-modifiable components and two measures with modifiable components were reported in the spine literature as risk stratification tools. Seven measures with modifiable components capturing frailty trajectory changes following targeted rehabilitation were reported in the neurological population. Ten complete frailty measures and 39 individual components qualified as objective, feasible, valid, and sensitive.

Conclusions

Several clinical frailty measures have been reported in the adult surgical spine literature. Measures containing non-modifiable accumulated deficits are most appropriate as risk stratification tools. Measures containing modifiable phenotypic components are most sensitive to capturing the effect of spinal pathology and surgical intervention on frailty trajectory. Items could be combined to create a unique spine frailty measure that is both a risk stratification tool and sensitive to capturing frailty trajectory changes. Further research is needed to determine the accuracy of these measures and the sensitivity of individual items for predicting postoperative AEs or capturing frailty trajectory changes.
The Effect of Prolonged Sitting on Muscle Reflexes of the Low Back

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Objectives

To determine if prolonged sitting, a sub-maximally flexed posture, will delay the ability of low back muscles to respond to a sudden perturbation.

Method

Forty healthy participants (17 men and 23 women) were recruited for a one time laboratory study. Participants were instrumented with accelerometers affixed to the skin overlying the spinous process of L1 and S2, and surface electrodes on six low back muscles. Muscle reflex times were obtained pre- and post-sitting. Biomechanical and neuromuscular parameters were also collected continuously during the 2-hour typing trial.

Results

The average onset time of the low back muscle reflexes was 60.00 ms (±27.77) before sitting and 72.89 ms (±38.72) after sitting. While not statistically different, the delay (approximately 12 ms) may have functional implications. No sex differences were observed.

Conclusions

Sitting for two hours does not appear to directly expose an individual to a perturbation-related back injury due to delayed muscle reflexes. Future work should investigate the functional ramifications of the delay observed and explore the response in a clinical population.
Implementing a Rapid Discharge Pathway for Adolescent Idiopathic Scoliosis in Canada

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Objectives

Rapid discharge pathways (RDP) have been implemented throughout most areas of orthopaedics. The goal of these pathways is to standardize the post-surgical hospital course for patients in order to decrease hospital length-of-stay (LOS). Surgical treatment of adolescent idiopathic scoliosis (AIS) remains one of the most invasive pediatric orthopaedic procedures and is routinely associated with a prolonged hospital stay. Therefore, the objective of this study was to determine if implementing a RDP at a single children’s hospital in Canada could decrease hospital LOS without increasing post-operative complications.

Method

A retrospective chart review was completed for all patients who underwent posterior spinal instrumentation and fusion (PSIF) between March 1st, 2010 and February 28th, 2019, with date of implementation being March 1st, 2015. Patient demographic information was collected from the charts along with the primary outcome variables: LOS, wound complication, 30-day return to the OR, 30-day emergency department admission, and 30-day hospital readmission. An interrupted time series analysis was utilized to assess for any differences in outcomes following implementation of the RDP. Ninety days before and after the implementation of the RDP was not included in this analysis due to variances in practice that were occurring at this time.

Results

A total of 244 participants were identified, with 113 patients in the conventional pathway and 131 patients in the RDP cohort. No significant differences in demographic features were found between the two groups. Hospital LOS was found to be significantly shorter in the RDP group, with the median LOS being 5.2 [95% IQR 4.3-6.1] days in the conventional group and 3.4 [95% IQR 3.3-3.5] days in the RDP group (p<0.05). There were no differences in post-operative complications between the two groups (p>0.05).

Conclusions

This study demonstrates that implementing a RDP following PSIF for AIS can successfully decrease hospital LOS without increasing post-operative complications. The decrease in LOS could correlate with lower costs for both the healthcare system and family.