**2021 LSRS Medtronic Research Grant Award Project**

**Title:** Randomized Controlled Trial of Erector Spinae Block for Peri-Operative Pain Reduction in Lumbar Spine Fusion

**Principal Investigator:**
Nicholas Spina, MD
University of Utah

**Introduction:** In light of the opioid crisis in America, the reduction of peri-operative opioid use through multi-modal analgesia is of paramount importance. Postoperative opioid use is a risk factor for chronic opioid use disorder. The erector spinae block (ESB) is a non-opioid pain modality consisting of bupivacaine and dexamethasone that can be administered immediately prior to lumbar surgery. It has been used in various specialties, including cardiothoracic, general, and oncologic surgery. We hypothesize that an ESB placed at the level of lumbar fusion will reduce perioperative pain and opioid use and improve patient-reported outcomes and physical function.

**Methods:** Patients undergoing primary lumbar fusion of 1-2 levels with degenerative spine diseases were randomized (1:1) to receive an ESB injection (study group) or no injection (control group). Patients remained blinded to group enrollment. Preoperative Oswestery Disability Index (ODI), PROMIS Pain Intensity Short Form (PISF-3), Numerical Pain Rating Scale (NRS), opioid usage as Milligrams of Morphine Equivalent (MME), PROMIS Physical Function CAT (PFCAT), and PROMIS Pain Intensity CAT (PICAT) were recorded. PISF-3, NRS, MME, and ambulation distance were collected while in-patient. MME, NRS, PICAT, and PISF-3 were collected at postoperative weeks 1, 2, 4, 6, and postoperative months 3 and 6. ODI and PFCAT were also collected at POW6 and POM3 and 6. Intergroup means for each endpoint were compared with students T-Test.

**Results:** Enrollment is partially complete with 55 participants. Enrollment goal is 100 patients. Groups are not significantly different in age, gender, surgical indication, or preoperative PRO scores or MME. No significant differences have been observed in MME, ambulation distance, or pain scores. Improvement in ODI scores at postoperative week 6 was different between groups (study: 16.0, control: 6.9, p=.037), as was PFCAT (study: 5.9, control:.36 p=.0180).

**Discussion:** As enrollment and data collection are incomplete, we are limited in our analyses. We have observed an increased divergence in ODI and PFCAT scores between the groups at...
later post-operative timepoints, perhaps indicative of faster recovery and faster improvement from surgery with ESB use. We expect to complete enrollment by the end of next year to better understand whether the current findings are real or spurious.
2022 LSRS Zimmer Biomet Research Grant Award Project
Title: Do Cannabinoids Affect Spinal Fusion Rates in an Animal Model
Principal Investigator:
Harold A. Fogel, MD
Harvard University

Co-Investigators: Caleb Young, MD, Ara Nazarian, PhD, Diana Yeritsyan, BS, Kaveh Momenzadeh, MD, Mohammadreza Abbasian, MD, Mitchel Harris, MD, Christopher M Bono, MD

Background/Introduction: The opioid epidemic causes significant health and economic effects. Medical marijuana is a potential non-opioid analgesic but its effects on bone healing are not understood, affecting its use for post-orthopaedic surgical care. This study aims to determine the effect of cannabis derivatives, D9-tetrahydrocannabinol (THC) and cannabidiol (CBD), on bone healing. We hypothesized that THC and CBD will not decrease bone healing in a rat model for spinal fusion.

Materials/Methods: L4-L5 posterolateral fusion was performed on 28 adult Sprague-Dawley rats. Animals were divided into 4 groups of 6, each receiving 0.1ml intraperitoneal injections weekly as follows: placebo (Saline), 5mg/kg THC, 5mg/kg CBD, and combination of 5mg/kg THC and 5mg/kg CBD (combo). Animals were euthanized and fusions assessed 8 weeks post-surgery. Manual palpation assessed the strength of arthrodesis on all rats. Twelve underwent three-dimensional micro-computed tomography (μCT) and histological analysis. The remaining half underwent quantitative polymerase chain reaction (qPCR) analyses (currently pending). μCT bone analysis consisted of quantifying ratio of bone volume (BV) to total volume (TV) within each volume of interest (VOI), as well as bone mineral density (BMD) and tissue mineral density (TMD) for the corresponding VOI. One animal from the saline and one from the combination group were lost due to wound dehiscence.

Results: The combination treatment group had the highest fusion rates (66.7% full fusion; 33.3% partial fusion) followed by the THC group (60% full fusion; 20% partial fusion; 20% no fusion). Fusion rates were lower in CBD and saline groups. Fusion rates were not significantly different between treatment groups based on manual palpation scoring (Figure 1A). Callus formation was more extensive in THC and combo treatments on μCT 3D reconstruction (Figure 1B) and bone volume fraction was significantly higher for CBD and THC treatment groups compared to the saline group (P<0.05). BMD and TMD values were higher for all cannabis treatment groups compared to the saline group, though not statistically significant (Figure 1C).

Discussion/Conclusion: This study preliminarily demonstrates that CBD and THC have no adverse effects on bone regeneration and rate of spinal fusion in rats. Cannabinoids may possess osteoinductive properties which require further investigation.
Paper 01

Personalized Opioid Prescription Protocol to Combat the Opioid Pandemic in 612 Patients Undergoing Lumbar Spine Surgery

Agarwal Nitin, MD¹, Langnas Erica, MD², Letchuman Vijay, BA³, Shabani Saman, MD⁴, Chan Andrew, MD¹, Schumacher Mark, MD¹, Abrecht Christopher, MD¹, Miller Catherine, MD¹, Sankaran Sujatha, MD¹, Berven Sigurd, MD⁵, Chou Dean, MD⁶, Guan Zhonghui, MD¹, Mummaneni Praveen, MD⁶

¹ University of California, San Francisco, San Francisco, California, United States, ² University of California, San Francisco - San Francisco General Hospital, San Francisco, California, United States, ³ University of California, San Francisco General Hospital, San Francisco, California, United States, ⁴ Academic Medical Center, UCSF, San Francisco, California, United States, ⁵ Department of Orthopedic surgery, San Francisco, California, United States, ⁶ Department of Neurological Surgery, UCSF Medical Center, San Francisco, California, United States

Background/Introduction: Given the increasing prevalence of lumbar spine surgery, a novel method of reducing acute postoperative opioid dosages by matching the discharge daily opioid dose with 24-hour pre-discharge opioid dosage is proposed.

Materials/Methods: A retrospective, observational study of 612 opioid-naïve adult patients undergoing a lumbar spinal surgery from June 2012 to December 2019 was performed at a large, quaternary care institute. In 2018, the use of a novel opioid equivalent calculation tool was implemented to reduce opioid prescriptions. All opioids consumed in the 24 hours prior to hospital discharge were converted to standardized oral morphine equivalents (OMEs) and physicians were made aware of each patient’s unique personalized opioid needs. Opioid discharge prescriptions were then matched to inpatient use. The impact of this personalized protocol was assessed with regard to opioid refills.

Results: Of the 612 included in the study cohort, 538 (88%) received opioid medications during their inpatient stay and 472 (77%) were discharged with an opioid prescription. After the implementation of the hospital’s opioid calculation tool in 2018, there was a significant decrease in outpatient daily opioid prescription doses from 2012 to 2019 (p=0.0098). Despite an observed reduction in opioid discharge prescriptions, opioid refill rates did not increase.

Discussion/Conclusion: This study proposes a simple, effective opioid calculation tool that matches daily discharge opioid prescription dose with a patient’s personalized inpatient opioid requirement. Increased physician awareness regarding individual opioid requirements in the postoperative period following lumbar spinal surgery may help curb the opioid epidemic by decreasing discharge prescription doses.
In Opioid Naive Patients, Smoking Increases Risk of Opioid Use Disorder Following Thoracolumbar Spinal Fusion

Chilakapati Sai, MS1, Adogwa Owoicho, MD2, Khalid Syed, MD3, Eldridge Cody, BS1
1 University of Texas Southwestern Medical Center, Dallas, Texas, United States, 2 University of Cincinnati College of Medicine, Cincinnati, Ohio, United States, 3 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Opioids are commonly used for management of pain following thoracolumbar spinal fusions. Numerous studies have identified patient and surgical risk factors for opioid dependence including preoperative opioid use, affective disorders, and invasiveness of surgery. However, the association of smoking and opioid use disorder, specifically in preoperative opioid naïve patients, has not been well characterized in spine literature. The aim of this study is to characterize the risk for opioid use disorder (DSM V) after thoracolumbar spinal fusions among active smokers who were opioid naïve prior to surgery.

Materials/Methods: This was a retrospective analysis using the Mariner-53 database (administrative database containing 53 million participants) of patients (age > 18 years) who were opioid naïve preoperatively and underwent thoracolumbar fusions with and without a history of smoking, based on ICD-9 and ICD-10 diagnostic codes. A total of 30,856 patients were identified, and exact 1:1 matching based on baseline patient demographics, procedure type (single vs. multi-level fusion), affective disorders (depression, anxiety), social determinants of health, and comorbidities were used to create two groups with identical covariates: smoking group (n=2960), non-smoking group (n=2960). Opioid utilization and rates of opioid use disorder were compared between both groups.

Results: Baseline characteristics were similar between both groups. Postoperatively, opioid utilization at 6 months were similar between both groups (56.8% vs. 57.4%, p=0.65). However, opioid naïve patients who were active smokers had higher odds of developing opioid use disorder postoperatively compared to nonsmokers (OR 4.18, 95% CI: 3.20 – 5.46).

Discussion/Conclusion: This study suggests that active smokers who are opioid naïve prior to thoracolumbar spinal fusion have 4-fold higher odds of developing opioid use disorder postoperatively compared to non-smokers. Further multi-institutional prospective studies are needed to corroborate our findings.
Paper 03

Pain Plan Implementation Decreases Post-Operative Opioid Use, Hospital Length of Stay, and Clinic Resource Utilization for Patients Undergoing Elective Spine Surgery

Williams Seth, MD1, Uppal Harjot, BS2, Bice Miranda, MD1, Hetzel Scott, MS3, Ludwig Trisha, Doctor of Pharmacy4, Hesselbach Kristin, Pharmacy Student4, Rozenfeld Sydney, BA2
1 University Of Wisconsin-Madison, Department of Orthopedics and Rehabilitation, Madison, Wisconsin, United States, 2 University of Wisconsin Madison School of Medicine and Public Health, Madison, Wisconsin, United States, 3 University of Wisconsin - Madison, Madison, Wisconsin, United States, 4 University of Wisconsin Madison, Madison, Wisconsin, United States

Background/Introduction: The Pain Plan was developed and implemented for patients undergoing elective spine surgery, to provide appropriate postoperative pain management while minimizing opioid use. The plan was built collaboratively with patients preoperatively, based on patient opioid experience.

Materials/Methods: This is a retrospective cohort study. The Pain Plan was implemented on 5/1/19; the experimental group comprised patients over the subsequent 1-year period with a Pain Plan (n=319), and the control group comprised patients from the prior year without a Pain Plan (n=385). Surgical invasiveness (SI) indexes were calculated, and patients were stratified into small (1-4), medium (5-8), or large (≥9) magnitude surgeries. Inpatient opioid consumption and outpatient opioid prescription quantities were calculated and converted to morphine milliequivalents (MME). Demographics were analyzed. Primary outcome measures were inpatient opioid consumption, outpatient opioid prescription quantities, hospital length of stay (LOS), and outpatient spine clinic communication encounter number and complexity. Secondary outcome measures were patient-reported pain scores and the influence of SI on primary outcome measures.

Results: There was a statistically significant decrease in hospital LOS (p=0.028), inpatient opioid use (p=0.001), average number of steps per communication encounter (p=0.010), and a trend towards decreased outpatient opioid prescription quantities (p=0.052) in Pain Plan patients. SI subgroup analysis (Table 1) showed a decrease in inpatient opioid use of 50% and LOS of 20.5 hours for large magnitude surgeries, and a decrease in inpatient opioid use of 49% and LOS of 17 hours for medium magnitude surgeries. Differences in inpatient opioid consumption and LOS for small magnitude surgeries was not statistically significant, but outpatient opioid prescription quantities decreased by 33%. No significant differences were found in demographic variables between experimental and control groups, validating them as equivalent for comparison. Patient-reported pain scores were not statistically significant between groups.

Discussion/Conclusion: The Pain Plan was implemented to collaboratively address pain management with patients, resulting in decreased opioid use, hospital LOS and clinic resource utilization. There was a 50% decrease in inpatient opioid use, and LOS decreased by almost a full day, for patients undergoing larger magnitude surgeries. Patient-reported pain scores did not change, indicating that even with decreased opioid use, pain management was not compromised.
Paper 04

Single-Level MIS TLIF vs ALIF for Surgical Treatment of Isthmic Spondylolisthesis

Jacob Kevin, BS¹, Patel Madhav, BS¹, Prabhu Michael, BS¹, Pawlowski Hanna, BS¹, Vanjani Nisheka, BS¹, Singh Kern, MD¹
¹ Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Limited studies have compared minimally invasive transforaminal lumbar interbody fusion (MIS TLIF) with anterior lumbar interbody fusion (ALIF) for the treatment of isthmic spondylolisthesis. This study aims to compare perioperative variables, patient-reported outcome measures (PROMs), and minimal clinically important difference (MCID) achievement rates between these surgical approaches.

Materials/Methods: Isthmic spondylolisthesis patients undergoing primary, single-level MIS TLIF or ALIF were identified in a surgical database. Patients were divided into MIS TLIF and ALIF cohorts. Demographics and perioperative characteristics were collected and compared between groups using chi-squared or Student’s t-test. PROMs including Patient-Reported Outcomes Measurement Information System Physical Function (PROMIS PF), SF-12 Physical Composite Score (PCS), VAS back, VAS leg, and Oswestry Disability Index (ODI) were collected at preoperative, 6-week, 12-week, 6-month, 1-year, and 2-year timepoints. Mean PROMs were compared using Student’s t-test for independent samples. MCID attainment was determined using established values in literature; achievement rates by grouping were compared using chi-squared analysis.

Results: A total of 171 patients were included (121 patients undergoing MIS TLIF; 50 patients undergoing ALIF). Mean operative time was 139.7 min and 165.5 min for MIS TLIF and ALIF cohorts, respectively. Mean estimated blood loss was 63.8 mL and 73.7 mL for the MIS TLIF and ALIF cohort, respectively. Mean postoperative length of stay was 43.9 hours for the MIS TLIF cohort and 42.5 hours for the ALIF cohort. Operative time was significantly higher among the ALIF cohort (p<0.001). No other differences were observed among perioperative variables. Mean PROMs did not significantly differ among groups at any timepoint. MCID attainment was significantly higher among MIS TLIF patients for ODI at 6-weeks (p=0.046) and 12-weeks (p=0.007), and VAS leg at 6-weeks (p=0.031) and 12-weeks (p=0.045). No other significant differences were observed among MCID achievement by grouping (Table 1).

Discussion/Conclusion: While single-level ALIF demonstrated significantly higher operative times, other perioperative characteristics and PROMs were comparable among ALIF and MIS TLIF patients. Although inferior MCID attainment rates for overall leg pain may be observed among patients receiving single-level ALIF, intermediate and long-term achievement remains comparable among both procedures.
Paper 05

ALIF versus TLIF for L5-S1 Isthmic Spondylolisthesis: ALIF Demonstrates Superior Segmental and Regional Radiographic Outcomes and Clinical Improvements Across More PROMs Domains

Lightsey Harry, MD1, Pisano Alfred, MD2, Striano Brendan, MD1, Crawford Alexander, MD1, Xiong Grace, MD1, Hershman Stuart, MD3, Schoenfeld Andrew, MD4, Simpson Andrew, MD5

1 Harvard Combined Orthopaedic Residency Program, Massachusetts General Hospital, Boston, Massachusetts, United States, 2 Walter Reed Army Medical Center, Bethesda, Maryland, United States, 3 Massachusetts General Hospital, Harvard Medical School, Boston, Massachusetts, United States, 4 Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, 5 Brigham and Women's Hospital, Boston, Massachusetts, United States

Background/Introduction: Isthmic spondylolistheses are frequently treated with interbody fusion via ALIF or TLIF approaches. Robust comparisons of radiographic and clinical outcomes are lacking. The purpose of this study was to compare segmental and regional radiographic parameters between anterior interbody fusion (ALIF) and posterior interbody fusion (TLIF) for treatment of L5-S1 isthmic spondylolisthesis, and to assess for changes in these parameters over time. Secondarily, we sought to compare clinical outcomes via patient-reported outcome measures (PROMs) between techniques and within groups over time.

Materials/Methods: We reviewed pre- and postoperative radiographs as well as Patient-Reported Outcomes Measurement Information System (PROMIS) elements for patients who received L5-S1 interbody fusions for isthmic spondylolisthesis in the Mass General Brigham (MGB) health system (2016-2020). Intraclass correlation testing was used for reliability assessments; Mann-Whitney U tests and Sign tests were employed for intercohort and intracohort comparative analyses, respectively.

Results: ALIFs generated greater segmental and L4-S1 lordosis than TLIF, both at first postoperative visit (Mean 26 days [SE = 4]; 11.3° vs 1.3°, p < 0.001; 6.2° vs. 0.3°, p = 0.005) and at final follow up (Mean 410 days [SE = 45]; 9.6° vs 0.2°, p < 0.001; 7.9° vs. 2.1°, p =0.005). ALIF also demonstrated greater increase in disc height than TLIF at first (9.6 vs 5.5mm, p < 0.001) and final follow up (8.7 vs 3.6mm, p < 0.001). Disc height was maintained in the ALIF group but decreased over time in the TLIF cohort (ALIF 9.6 vs 8.7mm, p = 0.1; TLIF 5.5 vs 3.6mm, p < 0.001). Both groups demonstrated improvements in Pain Intensity and Pain Interference scores; ALIF patients also improved in Physical Function and Global Health - Physical domains.

Discussion/Conclusion: ALIF generates greater segmental lordosis, regional lordosis, and restoration of disc height compared to TLIF for treatment of isthmic spondylolisthesis. Additionally, ALIF patients demonstrate significant improvements across more PROMs domains relative to TLIF patients.
Paper 06

Response to pre-operative steroid injections predicts surgical outcomes in patients undergoing fusion for isthmic spondylolisthesis

Turtle Joel, MD1, Randell Zane, BS2, Spiker W. Ryan, MD2, Brodke Darrel, MD3, Spina Nicholas, MD4
1 University of Utah, Salt Lake City, Utah, United States, 2 University of Utah Orthopaedic Center, Salt Lake City, Utah, United States, 3 University of Utah, Salt Lake City, Salt Lake City, Utah, United States, 4 University of Utah - Department of Orthopaedics, Salt Lake City, Utah, United States

Background/Introduction: The decision to pursue operative intervention for patients with isthmic spondylolisthesis is complex. While steroid injections are a well-accepted therapeutic modality that may delay or obviate surgery, little is known regarding their ability to predict surgical outcomes. Here we examine whether response to pre-operative steroid injections can accurately predict an individual patient’s response to surgical intervention.

Materials/Methods: A retrospective cohort analysis was performed on adult patients undergoing primary posterolateral lumbar spine fusions for isthmic spondylolisthesis. Data were stratified into a control (no pre-operative injection) group and an injection group (received a pre-operative diagnostic and therapeutic injection). We collected demographic data, peri-injection VAS pain scores, PROMIS pain interference (PI) and physical function (PF) scores, ODI, and VAS pain (back and leg). Student t test was utilized to compare baseline group characteristics. Linear regression was performed comparing changes in peri-injection VAS pain scores and post-operative measures.

Results: 73 patients were identified that did not receive a pre-operative injection and were included in the control group. 59 patients were included in the injection group. Of patients who received an injection, 73% had greater than 50% relief of their pre-injection VAS pain score. Linear regression revealed an interaction between the injection efficacy and post-operative pain relief as measured by VAS leg scores (p<0.05). There was also an association between injection efficacy and back pain relief, though this did not achieve statistical significance (p=0.068).

Discussion/Conclusion: Steroid injections are often utilized in the conservative therapeutic management of patients with lumbar spine disease. Here, we demonstrate the diagnostic value of steroid injections in predicting the response of patients with isthmic spondylolisthesis to lumbar fusion.
Paper 07

A Prospective Study of Lumbar Facet Arthroplasty in the Treatment of Degenerative Spondylolisthesis and Stenosis: Results from the Total Posterior Spine System (TOPS) IDE Study

Pinter Zachariah, MD\(^1\), Freedman Brett, MD\(^1\), Nassr Ahmad, MD\(^1\), Sebastian Arjun, MD\(^1\), Coric Domagoj, MD\(^2\), Steinmetz Michael, MD\(^3\), Robbins Stephen, MD\(^4\), Smorgick Yossi, MD\(^5\), Anekstein Yoram, MD\(^5\)

\(^1\) Mayo Clinic Rochester, Rochester, Minnesota, United States, \(^2\) Carolina Neurosurgery and Spine Associates, Charlotte, North Carolina, United States, \(^3\) Center for Spine Health, Cleveland Clinic Foundation, Cleveland, Ohio, United States, \(^4\) Wisconsin Bone & Joint, Milwaukee, Wisconsin, United States, \(^5\) Shamir (Assaf Harofeh) Medical Center, Zerifin, Israel, affiliated to the Sackler Faculty of Medicine, Tel-Aviv University, Tel-Aviv, Israel, Beer Yaakov, Israel

Background/Introduction: The purpose of the present study is to report the 1-year clinical and radiographic outcomes as well as safety profile of patients who underwent lumbar facet arthroplasty via implantation of the TOPS device as part of a prospective Investigational Device Exemption (IDE) trial.

Materials/Methods: We reviewed the prospectively collected clinical and radiographic outcomes of patients who underwent facet arthroplasty via implantation of the TOPS device in the investigational arm of a multicenter, prospective, randomized, controlled FDA IDE trial. Standard demographic information was collected for each patient, including surgical variables. Radiographic parameters and patient reported outcome measures (PROMs) including ODI, VAS back and leg, and ZCQ were assessed preoperatively and at 6 weeks, 3 months, 6 months, and 12 months postoperatively. Adverse event, complication, and reoperation data were also collected for each patient.

Results: At the time of this study, 153 patients had undergone implantation of the TOPS device as part of this ongoing clinical trial and were included in this study. The mean surgical time was 187.8 minutes and mean estimated blood loss was 205.7cc. The mean length of hospital stay was 3.0 days. Mean ODI, VAS leg and back, and ZCQ scores improved significantly at all postoperative time points (P>0.001). Greater than 79% of patients achieved MCID in all patient reported outcome measures at all postoperative time points. There were no clinically significant changes in radiographic parameters, and all operative segments remained mobile at 1-year follow-up without evidence of worsening sagittal translation. Postoperative complications occurred in 11 patients out of the 153 patients (7.2%) who underwent implantation of the TOPS device, including two new neurological deficits, two dural tears, two retained drains, one misplaced pedicle screw, one screw loosening, one infection, one seroma, and one hematoma. Nine patients (5.9%) underwent a total of 13 reoperations, eight for surgical complications (5.3%) and one (0.6%) of which was for device-related failure due to bilateral L4 pedicle screw loosening.

Discussion/Conclusion: Lumbar facet arthroplasty with the TOPS device demonstrated a statistically significant improvement in all PROMs and the ability to maintain motion at the index level while limiting sagittal translation with a low complication rate.
Paper 08

Comparison of Postoperative Clinical Outcomes Between Primary MIS TLIF and MIS TLIF with Revision Decompression for Degenerative Spondylolisthesis

Jacob Kevin, BS1, Patel Madhav, BS1, Parsons Alexander, MS1, Chavez Frank, BS1, Ribot Max, BA1, Vanjani Nisheka, BS1, Prabhu Michael, BS1, Pawlowski Hanna, BS1, Singh Kern, MD1
1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Minimally Invasive Transforaminal Lumbar Interbody Fusion (MIS-TLIF) and Lumbar Decompression (LD) are suitable procedures for lumbar degenerative disease. Patients who have undergone primary LD with recurrent symptomatology are often treated with subsequent fusion.

Materials/Methods: Inclusion criteria was set as (1) patients undergoing single-level MIS-TLIF with LD as a primary procedure (MIS TLIF) for degenerative spondylolisthesis and (2) patients undergoing a primary single-level MIS-TLIF as a revision to a primary microdiscectomy and/or laminectomy (MIS-TLIF revision LD) for degenerative spondylolisthesis. PROMs (Patient-Reported Outcomes Measurement Information System Physical Function (PROMIS-PF), Visual Analogue Scale (VAS) back/leg pain, Oswestry Disability Index (ODI), 12-Item Short-Form Physical Composite Score/Mental Composite score (SF-12 PCS/SF-12 MCS)) were administered pre-/post-operatively. Patients were grouped: Primary MIS-TLIF or MIS-TLIF with Revision Decompression. Differences in patient demographic and perioperative characteristics between procedure groups were compared using Pearson chi-squared analysis and Student t-test for categorical and continuous variables, respectively. Paired t-test compared improvements in PROMs between primary and revision cohorts. Pearson chi-squared analysis compared rates of minimum clinically important difference (MCID) achievement between cohorts. Student t-test compared rates of postoperative complications. Statistical significance was set at P<0.05.

Results: 259 patients were included. Postoperative inpatient VAS pain score on day 0 and postoperative narcotic consumption on days 0/1 were significantly higher in MIS-TLIF revision LD cohort. Significant differences in postoperative mean PROMs between cohorts were: VAS back 6-weeks favoring Primary TLIF cohort (p<0.027). Both cohorts demonstrated significant postoperative improvement from baseline for PROMIS-PF, SF-12 PCS, ODI, VAS back, and VAS leg collected at 1-year. MIS-TLIF and MIS-TLIF revision LD patients demonstrated similar rates of MCID achievement for all PROMs measured (Table 1).

Discussion/Conclusion: Patients undergoing primary MIS-TLIF with revision LD for degenerative spondylolisthesis can expect to have similar long term postoperative improvement in physical function, disability, back/leg pain when compared to primary MIS-TLIF patients. In the short term, however, Primary MIS-TLIF patients may demonstrate improved back pain scores. Findings suggest that primary decompression does not compromise long term clinical outcomes in patients undergoing subsequent MIS-TLIF and further that a history of primary LD should not preclude patients from undergoing MIS-TLIF if necessary.
Paper 09

Patient-Reported and Clinical Outcomes after Lumbar Laminectomy and Fusion Versus Laminectomy Alone in Patients with Lumbar Spondylolisthesis and Harmonious Sagittal Spinopelvic Alignment

Mohanty Sarthak, BS¹, Barchick Stephen, MD², Kadiyala Manasa, BS¹, Lad Meeki, BS¹, Rouhi Armaun, BA⁴, Saifi Comron, MD⁵, Khalsa Amrit, MD², Casper David, MD²
¹ University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, United States, ² University of Pennsylvania, Philadelphia, Pennsylvania, United States, ³ Rutgers New Jersey Medical School, Newark, New Jersey, United States, ⁴ Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, United States, ⁵ Houston Methodist Orthopedics & Sports Medicine, Houston, Texas, United States

Background/Introduction: Controversy still exists about whether degenerative spondylolisthesis can be treated with decompression in isolation; however, it is well known that all degenerative spondylolistheses are not created equally. In order to better assess treatment options, one must compare equivalent pathology. We hypothesized that decompression alone is comparable to decompression and fusion after adjusting for confounding variables, including sagittal spinal alignment.

Materials/Methods: Cohorts were matched based on degree of lumbar spondylolisthesis, flexion-extension listhesis, and intervertebral disc height. This sub-group analysis of a non-randomized, prospective cohort study assessed two-year clinical outcomes following laminectomy plus fusion versus laminectomy alone for management of grade I degenerative spondylolisthesis and comorbid spinal canal stenosis among patients with sagittal spinopelvic alignment (pelvic incidence – lumbar lordosis <10 degrees). Outcome measures comprised estimated blood loss, operative time, length of hospital stay, discharge to skilled nursing facility, prospective patient-reported outcomes (PROs), and reoperation. Two alternative matching methods were employed to minimize treatment selection bias when estimating treatment effects: (1) propensity score matching (PSM) and (2) coarsened exact matching (CEM). Binary outcomes between cohorts were evaluated using McNemar test; continuous outcomes used the Wilcoxon rank-sum test.

Results: 327 (48.1%) study patients had low PILL mismatches (<10º), indicating good sagittal spinopelvic alignment. After PSM and CEM matching to control treatment choice bias, patients undergoing fusion experienced greater operative blood loss (203 vs 125 mL, p=0.0006), operative time (216 vs 128 min, p=0.0006), and length of stay (3.50 vs 2.83 days, p<0.0001) than patients receiving decompression alone; in turn, these patients were more likely to be discharged to rehabilitation facilities (6.86% vs 0.98%, p=0.0412) and receive longer durations of physical therapy post-op (2.47 vs 1.34 months, p<0.0001). Finally, fusion-treated patients had a greater likelihood of reoperation at 2 years (25.49% vs 14.71%, p=0.0152)(Table 1). CEM matching generally did not alter the pattern, significance, or direction of findings.

Discussion/Conclusion: The study demonstrates lumbar laminectomy was superior to fusion in health–related quality of life and reoperation rate at 2-years postoperatively for patients without...
PILL mismatch. Patients with low-grade spondylolisthesis, spinal stenosis, and spinopelvic harmony may benefit from less invasive decompression alone based on PROs and clinical outcomes.
Comparison of Harmonious versus Localized Correction in Adult Spinal Deformity Surgery

Passias Peter, MD1, Williamson Tyler, MS2, Joujon-Roche Rachel, BS3, Imbo Bailey, BA3, Krol Oscar, BA1, Schoenfeld Andrew, MD4, Tretiakov Peter, BS2, Vira Shaleen, MD5, Diebo Bassel, MD6, Smith Justin, MD7, Lafage Renaud, MS8, Lafage Virginie, PhD8
1 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 New York University School of Medicine, NYU School of Medicine, New York, New York, United States, 4 Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, 5 Department of Orthopedic Surgery, UT Southwestern Medical Center, Dallas, Texas, United States, 6 Department of Orthopedic Surgery at SUNY Downstate Medical Center, Brooklyn, New York, United States, 7 University of Virginia, University of Virginia School of Medicine, Charlottesville, Virginia, United States, 8 Hospital for Special Surgery, New York, New York, United States

Background/Introduction: Recent debate has arisen between whether to use a three-column osteotomy or multiple low-grade osteotomies to treat more rigid deformities in adult spinal deformity (ASD) surgery. Therefore, we examined the performance of three-column (3CO) versus multi-level low-grade (MLG) osteotomies in ASD patients undergoing corrective surgery.

Materials/Methods: Included: ASD patients with full baseline (BL) and 1-year radiographic and HRQL data. Patients were included if undergoing a 3CO or greater than 3 lower-grade osteotomies (i.e. Smith-Peterson osteotomy, corpectomy, etc.), and a BL PI-LL deemed severely deformed (greater than 20°). Patients were grouped by undergoing 3CO or MLG. Baseline factors were compared between the osteotomy groups. Best clinical outcome defined by Smith et al. as 1Y SRS > 4.5 and ODI < 15. Multivariate analysis evaluated the complication rates, radiographic and patient-reported outcomes between groups.

Results: 126 ASD patients included. 45 patients (35.7%) underwent an MLG and 81 (64.3%) underwent a 3CO. Tables 1 and 2 outline baseline comparisons between the two osteotomy groups. Notably the groups did not significantly vary in age, frailty, CCI, deformity, or HRQLs at baseline. MLG underwent significantly less revisions than 3COs (34% vs. 86%, p<.001). MLG patients had significantly less blood loss. Groups did not differ in any 1Y patient-reported outcome. MLG were more often age-adjusted aligned in PI-LL by one year. The MLG group had lower rates of any complications (p=.067), pulmonary (p=.161), operative complications (p=.014), and reoperations (p=.062). Multivariate analysis via ANCOVA, controlling for BL CCI, PI-LL, and revision status, revealed operative complications (0.041) and matching in PI-LL at one year (p=.028) remained significant, with reoperations (p=.029) becoming significant as well.

Discussion/Conclusion: For patients with a higher degree of deformity, multi-level low-grade osteotomies show improved utility for deformity correction, while minimizing operative complication and reoperation rates by one year. While there are certainly unique indications for a
three-column osteotomy, these findings offer the spine deformity surgeon a safer alternative when addressing severe deformity in ASD corrective surgery.
Lumbar Lordosis Correction with Transforaminal Lumbar Interbody Fusion in Adult Spinal Deformity Patients with Minimum Two Year Follow Up

Mikula Anthony, MD, Lakomkin Nikita, MD, Pennington Zach, MD, Elder Benjamin, MD, PhD, Fogelson Jeremy, MD

1 Mayo Clinic Rochester, Rochester, Minnesota, United States

Background/Introduction: Positive sagittal balance in adult spinal deformity patients is a severely debilitating disease. Three column osteotomy (3CO) and anterior lumbar interbody fusion (ALIF) are powerful surgical techniques that have the capability to generate significant lordosis correction but the role of transforaminal lumbar interbody fusion (TLIF) in correcting severe positive sagittal imbalance remains unknown. The purpose of this study was to determine the degree of segmental lumbar lordosis correction possible via TLIF in patients with severe positive sagittal balance.

Materials/Methods: A retrospective chart review identified patients at least 18 years of age with severe positive sagittal balance defined by the Schwab classification of pelvic incidence (PI) to LL mismatch >20°, sagittal vertical axis (SVA) >9.5cm, and/or pelvic tilt (PT) >30°. All patients had surgery between 2013 to 2018 with a TLIF at L4-L5 and/or L5-S1 by the senior author (JLF) utilizing open aggressive deformity techniques in combination with a posterior column osteotomy. Patients had a minimum of two year follow up. Patients with a 3CO, ALIF, tumor, and infection at the index case (eg: osteomyelitis) were excluded. Perioperative variables collected included basic demographics, pre-operative risk factors (eg: bone mineral density), operative details, spinopelvic parameters, and complications.

Results: Sixty-one patients with 85 TLIFs were included with an average age of 66 years and average follow up of 50 months. Lumbar lordosis (L1-S1) improved from an average of 27° preop to 48° postop and 45° at two year follow up (p-value <0.001). Segmental lordosis at L4-L5 TLIF sites improved from 3° preop to 13° postop and remained 13° at two year follow up (p-value <0.001). Segmental lordosis at L5-S1 TLIF sites improved from 7° preop to 21° postop and 20° at two year follow up (p-value <0.001). Seventeen of the TLIFs (20%) had >20° of segmental lordosis improvement at long term follow up. The rate of revision surgery for pseudoarthrosis at the TLIF level was 5%.

Discussion/Conclusion: Significant lordosis correction can be achieved through an open TLIF in patients with severe positive sagittal balance when utilizing aggressive deformity correction techniques.
Paper 12

Vacuum Discs in Lumbar Spinal Deformity: Relationships with Pain and Patient Factors

Kleimeyer John, MD¹, Sambare Tanmay, MD¹, Cabell Akaila, MD², Follett Matthew, MD³, Koltsov Jayme, PhD², Shen Huaishuang, PhD¹, Alamin Todd, MD³, Wood Kirkham, MD³, Hu Serena, MD²

¹ Department of Orthopaedic Surgery, Stanford University School of Medicine, Stanford, California, United States, ² Stanford University, Department of Orthopaedic Surgery, Palo Alto, California, United States, ³ Stanford University Orthopaedic Surgery, Palo Alto, California, United States

Background/Introduction: The goals of this study are to identify the prevalence of vacuum discs in patients with lumbar spinal deformities and determine whether this phenomenon is associated with low back or leg pain severity.

Materials/Methods: Patients aged≥18 years from a single institution (2013-2019) were included if they had a CT and a diagnosis of scoliosis, kyphosis, or flat back. Prior thoracolumbar fusion, spinal malignancy, and inflammatory arthritis were excluded. CTs were evaluated for the presence and size of vacuum discs from T12-S1. Patient reported outcomes included back and leg numeric pain rating scales (NPRS) and the Oswestry Disability Index (ODI). Relationships between patient factors and vacuum discs were first assessed with univariate analyses. Repeated measures Generalized Estimating Equations were constructed to examine relationships with the NPRS and ODI and whether these depended on the level the vacuum discs presented.

Results: The final cohort included 130 patients [62.3% female, age (median(IQR))=71.8 years (65.5, 76.6)]. 95.4% of patients had a vacuum in ≥1 disc, and 61.6% had a vacuum in ≥4 levels. The most common level was L3-L4 (72.9% of patients). Vacuum discs were more prevalent with older age at every disc level (p<0.037 for each). Older patients had greater numbers of vacuum discs (p<0.001) and increased vacuum size (p<0.001). Males had more levels with vacuum discs [median(IQR) males=5 (3, 5), females=4 (3, 5); p=0.031] and trended towards larger vacuums (p=0.089). Considering all levels together, vacuum discs at L4-L5 were associated with higher NPRS back pain [+1.5 (0.2, 2.7), p=0.023]. Vacuum discs at L5-S1 were associated with greater leg pain [+2.1 (0.4, 3.9), p=0.016]. There was a trend towards higher ODI (greater disability) with a vacuum at L5-S1 [+5.9, (-0.6, 12.4) p=0.071]. The number of vacuum levels and vacuum size were not associated with pain or ODI.

Discussion/Conclusion: The presence, number, and severity of vacuum discs increased with age, and males had more vacuum discs than females. Vacuum discs were associated with increased pain and potentially increased disability at L4-L5 and L5-S1. These findings are pertinent to surgical planning in spinal deformity, as vacuum discs at these levels may be associated with more severe symptoms.
Paper 13

Determining the Utility of 3-Column Osteotomies in Revisions Compared to Primary Surgeries

Passias Peter, MD1, Williamson Tyler, MS2, Imbo Bailey, BA3, Tretiakov Peter, BS2, Joujon-Roche Rachel, BS2, Krol Oscar, BA1, Vira Shaleen, MD4, Schoenfeld Andrew, MD5, Diebo Bassel, MD6, Smith Justin, MD7, Lafage Renaud, MS8, Lafage Virginie, PhD8

1 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 New York University School of Medicine, NYU School of Medicine, New York, New York, United States, 4 Department of Orthopedic Surgery, UT Southwestern Medical Center, Dallas, Texas, United States, 5 Brigham and Women’s Hospital, Harvard Medical School, Boston, Massachusetts, United States, 6 Department of Orthopedic Surgery at SUNY Downstate Medical Center, Brooklyn, New York, United States, 7 University of Virginia, University of Virginia School of Medicine, Charlottesville, Virginia, United States, 8 Hospital for Special Surgery, New York, New York, United States

Background/Introduction: Three column osteotomies (3CO) obtain great correction in high mismatch in rigid lumbar spines. However, it would helpful to identify the presence and performance of the three column osteotomy (3CO) in ASD patients undergoing either revision or primary corrective surgery, given the proper indication.

Materials/Methods: Included: ASD patients with BL and 2Y data undergoing an osteotomy. Patients were grouped by undergoing three column osteotomy [3CO]. BL factors were compared between the osteotomy groups. A favorable outcome was defined as follows: 1) no PJF or mechanical failure with reoperation and 2) Smith et al. best clinical outcome for 2Y SRS or ODI. Patients were stratified into groups based upon the surgery being primary (P3) or revision (R3) of a previous thoracolumbar fusion. Multivariate analysis evaluated the complication rates, radiographic and patient-reported outcomes between groups.

Results: Included: 315 patients. 88 patients (27.9%) had 3CO and 227 (72.1%) underwent lower grade osteotomies. 195 were undergoing a primary, 120 revision. A 3CO was performed in 27 (16.1%) primaries (P3), and 61 (50.8%) revisions (R3). P3 had greater improvement in each parameter by 2Y compared to other primary osteotomies. R3 had greater improvement in HRQLs and radiographic parameters by 2Y compared to other revision osteotomies. When comparing P3 and R3, the groups differed in all four BL radiographic parameters and GAP Score. However, R3 had similar 2Y radiographics and HRQL scores with P3, while showing greater improvement in SVA (p=.014). P3 trended towards greater two-year improvement (-20.3 vs. -11.9, p=.061), with similar rates of meeting BCO. P3 had more neurological complications (11.1% vs. 4.9%, p=.032), while R3 was trending towards higher implant failures (21.3% vs. 11.1%, p=.258).

Discussion/Conclusion: Primary and revision surgeries incorporating a three-column osteotomy showed greater improvement in realignment by two year compared to the use of other
osteotomies. Primaries with a three-column osteotomy demonstrated similar improvement in patient-reported outcomes and radiographic realignment compared to a revision with three-column osteotomy. Specifically for patients with a higher degree of mismatch deformity and a suitable indication, a three-column osteotomy offers superior utility for achieving realignment across primary and revision surgeries for ASD correction.
Paper 14

Telemedicine Visits Can Generate Highly Accurate Diagnoses and Surgical Plans for Spine Patients

Bovonratwet Patawut, MD1, Song Junho, BS1, Kim Ashley Yeo Eun, BS2, Shinn Daniel, BS1, Morse Kyle, MD1, Huang Russel, MD3, Albert Todd, MD3, Sandhu Harvinder, MD3, Qureshi Sheeraz, MD3, Iyer Sravisht, MD1
1 Hospital for Special Surgery, New York, New York, United States, 2 Weill Cornell Medical College, New York, New York, United States, 3 Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States

Background/Introduction: Despite the recent increase in utilization of telemedicine, data regarding its capability to deliver high quality preoperative assessment without a traditional in-person interaction and physical exam is lacking. The aim of this study was to (1) assess whether diagnoses and surgical plans established during a new patient telemedicine visit changed following an in-person evaluation and (2) determine any differences in perioperative characteristics between patients who only had a telemedicine visit prior to surgery versus those who had a telemedicine visit followed by an in-person evaluation prior to surgery.

Materials/Methods: Records of patients who had a new telemedicine visit and indicated for surgery with documented specific diagnosis and surgical plan from a spine department at an urban tertiary center were reviewed. For patients that had follow-up in-person evaluation prior to surgery, these diagnoses and plans were compared. Perioperative characteristics were compared between patients who only had a telemedicine visit prior to surgery versus those who had a telemedicine visit followed by in-person evaluation prior to surgery.

Results: The study included a total of 166 patients. Of these, 101 patients (61%) only had a new patient telemedicine visit prior to surgery while 65 (39%) had a telemedicine visit followed by an in-person evaluation. There were no differences in demographics and rate of case cancellations prior to surgery between these two groups (p>0.05). Of the 65 patients who had both a telemedicine followed by an in-person visit, the diagnosis did not change for 61 patients (94%) and the surgical plan did not change for 52 patients (80%). Of 13 patients (20%), whose diagnosis or surgical plan changed, the main reasons were due to updated findings on new imaging, 10 patients, (77%) and new findings during in-person exam, 2 patients (15%).

Discussion/Conclusion: The current study suggests that telemedicine evaluations can provide an effective means of preoperative assessment for spine patients. Diagnoses and surgical plans rarely change after an in-person follow-up visit. Further, since the main reason for modifications was due to updated imaging, the rate of change is most likely even lower if these imaging studies had been available at the initial telemedicine visit.
Paper 15

Understanding the Influence of Prior Positive COVID-19 Infection on 90-day Outcomes following Elective Lumbar Spine Surgery

Malik Azeem, MBBS¹, Roebke Austin, MD², Curatolo Christian, MD¹, Drain Joey, MD¹, Jones Jeremy, MD³, Jurenovich Kathryn, MD⁴, Karnes Jonathan, MD³, Khan Safdar, MD¹
¹ Ohio State University Wexner Medical Center, Columbus, Ohio, United States, ² Wexner Medical Center, The Ohio State University, Columbus, Ohio, United States, ³ Ohio State University, Columbus, Ohio, United States, ⁴ Ohio State University Medical Wexner Center, Columbus, Ohio, United States

Background/Introduction: The COVID-19 pandemic has radically impacted and transformed the practice of the surgical world over the past couple of years. While a significant proportion of research has rightfully focused on prevention and/or treatment of acutely infected COVID-19 patients, little is known about how a prior history of a positive COVID-19 infection (i.e. recovered patients) influences outcomes following major elective surgeries. The purpose of the current study was to study whether previous positive COVID-19 infection has an impact on 90-day medical and surgical complication rates following elective lumbar spine surgeries.

Materials/Methods: The 2019 to 2021 PearlDiver Mariner Database, an all-payer claims database, was used to identify patients undergoing elective 1-to-2 level primary posterior/anterior/combined fusions or 1-to-2 level laminectomies for degenerative lumbar spine pathologies and 1-to-2 level primary microdiscectomies for herniated discs. Patients undergoing fusion for fracture, malignancy, infection and/or those undergoing revision procedures were excluded from the study. The study group was divided into two cohorts – those who had a prior history of a COVID-19 infection within the 6 months before surgery and those who were not infected by the virus. Patients who had a positive coded COVID-19 status on the day of surgery were excluded from the analysis. Multi-variate logistic regression analyses were used to assess the impact of prior COVID-19 infection on 90-day medical and surgical complication rates, while controlling for baseline demographics (age, gender, payor type/insurance) and clinical characteristics (charlson comorbidity index, type of surgery, and prior ventilator dependence).

Results: A total of 49,639 patients undergoing elective lumbar spine surgery between 2019 and 2021 were included in the study, out of which 150 patients (0.3%) had had a positive COVID-19 status and/or infection in the 6 months prior to the surgery. After adjusting for baseline demographics and clinical characteristics, patients with a prior history of COVID-19 infection were more likely to experience cardiac complications (3.3% vs. 1.1%, OR 2.75; p=0.021), thromboembolic complications (6.0% vs. 2.3%, OR 2.35; p=0.014) and sepsis (5.3% vs. 2.0%, OR 2.31; p=0.024) within 90 days of the index surgery.

Discussion/Conclusion: Based on a national retrospective review of patients undergoing elective lumbar spine surgery, it appears that having harbored a positive COVID-19 infection in the 6 months prior to surgery is associated with higher risks of experience thromboembolic events, sepsis and acute myocardial infarctions or acute congestive heart failure. The findings of the study support the need of careful post-operative care monitoring and/or risk-stratification of prior COVID-19 patients.
Paper 16

Patient Satisfaction with Spine Surgery Telemedicine Visits

Plantz Mark, MD¹, Arpey Nicholas, MD², Goedderz Cody, BS², Gerlach Erik, MD², Weiner Joseph, MD², Swiatek Peter, MD², Divi Srikanth, MD², Patel Alpesh, MD, MBA¹, Hsu Wellington, MD¹

¹ Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States, ² Northwestern University Department of Orthopaedic Surgery, Chicago, IL, United States

Background/Introduction: Telemedicine is rapidly growing as a means of delivering health care. Telehealth visits can theoretically improve access to care, minimize costs, and increase the efficiency of healthcare delivery. How patients perceive these visits is relatively unknown though. The purpose of this study is to assess patient satisfaction with spine surgery telemedicine visits.

Materials/Methods: Patients who underwent a telemedicine visit secondary to the COVID-19 pandemic from July 2020 to Jan 2021 were identified and emailed a standardized satisfaction survey within 24 hours of their visit. Patients were instructed to assign an integer score from 0-10 (0 being worst and 10 being best) for seven different categories: 1) likelihood to recommend institution, 2) likelihood to recommend provider, 3) understanding of care plan, 4) spent enough time, 5) care needs met, 6) prefer a telehealth visit, and 7) easiness to connect with telehealth visit. One-way ANOVA was used to compare: a) differences in mean scores between different categories, b) differences in survey scores between subspecialties, and c) differences in scores between advanced practitioner and physician-led encounters. Statistical significance was defined as p<0.05.

Results: A total of 241 patients completed surveys after telehealth visits across a variety of orthopaedic surgery subspecialties including 71 spine patients. Six of the seven metrics for spine surgery telehealth visits had mean scores > 9.0. Only one metric – “prefer a telehealth visit” – had a mean score of 7.7 ± 2.4. When compared to other orthopaedic subspecialties, spine visits resulted in a greater “understanding of care plan” and “spent enough time” score relative to other visits though not statistically significant. “Understanding of care plan” and “prefer a telehealth visit” metrics were higher for physician-led visits.

Discussion/Conclusion: Patients exhibit a high satisfaction with spine surgery telemedicine visits though when given the option, many still prefer a regular in-person clinic visit. These trends were similar across different orthopaedic subspecialties. Patients were more likely to express a greater understanding of their treatment plan and a preference for telehealth visits when a physician rather than an advanced practitioner led the telemedicine encounter.
Paper 17

Similar Accuracy of Surgical Plans after Initial In-Person and Telemedicine Evaluation of Spine Patients

Ye Ivan, BS1, Thomson Alexandra, MD1, Donahue Jack, BS1, Miseo Vincent, MD1, Jauregui Julio, MD1, Cavanaugh Daniel, MD1, Koh Eugene, MD, PhD1, Ludwig Steven, MD1, Gelb Daniel, MD1

1 University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore, Maryland, United States

Background/Introduction: It remains unclear how the use of telemedicine, with the limited opportunity to perform a detailed physical examination, affects the ability to formulate a surgical plan for spine patients. The objective of this study was to compare the accuracy of surgical plans generated from in-person and telemedicine evaluations.

Materials/Methods: Consecutive new patients who were evaluated by the orthopaedic spine division between 2019 and 2020 were identified. Patients were included if they were indicated for elective spine surgery at their first appointment, had documented definitive surgical plans, and received surgery within 3 months. Patients were divided into two cohorts based on initial appointment type: telemedicine (N=39) and in-person appointment (N=92). The primary outcome was change in surgical plan from the initial appointment to the actual performed procedure, defined as either a change in number of operated levels (e.g., adding additional level), change in the surgical approach (e.g., change from anterior to posterior cervical fusion), change in the performed procedures (e.g., adding fusion to decompression), or change in region of surgery (e.g., change from lumbar to cervical surgery). Statistical analysis included Student’s T-test or Wilcoxon’s rank-sum test for continuous variables and Chi-square analysis for categorical variables. Secondary analysis compared the length of stay, hospital complication rate, and readmission/reoperation rate between patients who had changes to the surgical plan and those who didn’t.

Results: There was no significant difference in the accuracy of initial surgical plans between the telemedicine and in-person cohorts (79.5% versus 82.6%, p=0.673). The most common modification in the surgical plan (79%) was change in the number of operated levels, of which all but one of the 19 patients received one more operated level. Less common reasons were change in approach (13%) and change in procedure (8%). Patients with changes to their surgical plan experienced longer length of stay (3.1 versus 2.0 days, p=0.027) than patients with consistent surgical plans.

Discussion/Conclusion: Telemedicine and in-person evaluations generated similarly accurate surgical plans. Initial surgical plans most often change for adding operated levels. Our findings show that telemedicine visits are an acceptable option for preoperative assessment to generate surgical plans, however further research is needed.
Lower Hounsfield Units are Significantly Associated with Proximal Junctional Kyphosis and Failure at the Upper Thoracic Spine

Mikula Anthony, MD1, Lakomkin Nikita, MD1, Pennington Zach, MD1, Pinter Zachariah, MD1, Nassr Ahmad, MD1, Freedman Brett, MD1, Abode-Iyamah Kingsley, MD2, Bydon Mohamad, MD1, Fogelson Jeremy, MD1, Elder Benjamin, MD, PhD1
1 Mayo Clinic Rochester, Rochester, Minnesota, United States, 2 Mayo Clinic in Florida, Jacksonville, Florida, United States

Background/Introduction: Numerous risk factors have been identified for proximal junctional kyphosis (PJK) and failure (PJF), including low bone mineral density (BMD) on dual-energy x-ray absorptiometry (DXA). However, DXA only measures BMD within the lumbar spine, hip or femur, and prior spinal instrumentation and degenerative changes can preclude accurate measurements. Hounsfield units (HU) represent an alternative method to estimate BMD via targeted measurements at the intended operative levels. HU have been shown to be predictive of PJK and PJF for spine fusion constructs with an upper instrumented vertebra (UIV) near the thoracolumbar junction, but their utility in the upper thoracic spine is unknown. The objective of this study was to determine if patients with lower HU at the UIV and vertebral body superior to the UIV (UIV+1) are at greater risk for PJK and PJF.

Materials/Methods: A retrospective chart review identified patients at least 50 years of age who underwent instrumented fusion extending from the pelvis to a UIV from T1 to T6, a preoperative CT, pre and postop x-rays, and a minimum follow up of 12 months. HU were measured in the UIV, UIV+1, L3, and L4 vertebral bodies. Numerous perioperative variables were collected, including basic demographics, smoking and steroid use, preoperative osteoporosis treatment, multiple frailty indices, proximal junctional tether, UIV soft landing, preoperative DXA, spinopelvic parameters, UIV screw tip distance to the superior endplate, UIV pedicle screw to pedicle diameter ratio, lumbar lordosis distribution, and post-operative spinopelvic parameters compared to age adjusted normal values.

Results: Eighty-one patients were included with an average age of 66 years and average follow up of 38 months. Multivariable logistic regression analysis (AUC =0.804) demonstrated HU at the UIV/UIV+1 to be the only independent predictor of PJK and PJF with an odds ratio of 0.93 (p-value =0.012). Patients with HU at the UIV/UIV+1 of <145 (n=27), 145-195 (n=27), and >195 (n=27) had a PJK/PJF rate of 56%, 37%, and 7%, respectively (p-value <0.001).

Discussion/Conclusion: Patients with lower HU at the UIV and UIV+1 were significantly associated with PJK and PJF in the upper thoracic spine, with an optimal cutoff of 164 HU that maximizes sensitivity and specificity.
Does measurement technique impact the strength of CT-based diagnosis of osteoporosis or osteopenia? A comparison of axial and sagittal measures of Hounsfield units

Parry Matthew, BS\textsuperscript{1}, Aynaszyan Stephan, BS\textsuperscript{1}, Devia Luis, MS, BS\textsuperscript{1}, Badve Siddharth, MD\textsuperscript{2}, DelSole Edward, MD\textsuperscript{2}

\textsuperscript{1}Geisinger Commonwealth School of Medicine, Scranton, Pennsylvania, United States, \textsuperscript{2}Geisinger Musculoskeletal Institute, Danville, Pennsylvania, United States

**Background/Introduction:** CT Hounsfield Units (HU) are an alternative to the gold standard of Dual-energy x-ray absorptiometry (DEXA) in assessing bone quality, however the best method of measurement is not defined. The purpose of this study is to compare the predictive ability of HU measured from axial and sagittal CT images for diagnosing osteopenia and osteoporosis.

**Materials/Methods:** The population consisted of 50 patients who had received CT of the lumbar spine and a DEXA scan within a two year time period. HU measurements were made by two independent researchers who were blinded to DEXA values and averaged for a final value. HU measurements were recorded at the mid-axial or mid-sagittal planes of the L1-S1 vertebral bodies using a circular region of interest. HU values were then correlated with DEXA results. Receiver operating Characteristic (ROC) curves accompanied by logistic regression models were constructed and the Area Under the Curve (AUC) was utilized to compare diagnostic ability of the Average Lumbar HU Axial and Sagittal Scores for Osteopenia and/or Osteoporosis.

**Results:** Linear regression revealed strong positive correlation between both axial/sagittal HU measures and T Scores. The ability to distinguish between osteoporosis and normal bone quality was similar when using the Average Lumbar HU Axial (AUC: 0.659; OR: 0.99, 95% CI: [0.97, 1.00]; p=0.09; Figure 1a) and Average Lumbar HU Sagittal (AUC: 0.627; OR: 0.99, 95% CI: [0.98, 1.00]; p=0.17; Figure 1b) scores. These trended toward but did not achieve significance. On ROC analysis, Average Lumbar HU Axial Score was effective in distinguishing between osteopenia and osteoporosis and healthy bone (AUC: 0.8115; OR: 0.97, 95% CI: [0.95, 0.99]; p=0.001; Figure 2). The Average Lumbar HU Sagittal Score was not significantly effective to this end.

**Discussion/Conclusion:** The results of this study demonstrate that both sagittal and axial HU of the lumbar vertebral bodies are effective in assessing bone quality. Only the Average Lumber HU Axial score was effective at distinguishing between osteopenia and osteoporosis. Pre-operative measurement of BMD using the HU from an axial CT of the lumbar spine appears to be an effective alternative to a DXA derived T-Score.
Paper 20

MRI-based Score for Assessment of Bone Mineral Density in Operative Spine Patients

Kim Ashley Yeo Eun, BS1, Lyons Keith, MD2, Sarmiento J. Manuel, MD2, Qureshi Sheeraz, MD3, Lafage Virginie, PhD2, Iyer Sravisht, MD2

1 Weill Cornell Medical College, New York, New York, United States, 2 Hospital for Special Surgery, New York, New York, United States, 3 Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States

Background/Introduction: There have been numerous attempts at using MRIs for pre-operative assessment to eliminate the need for ionizing radiation. Based on osteopenic changes of bone marrow, many groups developed T1-weighted (T1W) MRI-based scoring systems for BMD that correlate with DEXA T-scores. Current study aimed to determine the ability of previously developed MRI-derived bone mineral density (BMD) scoring system in differentiating between healthy and osteoporotic bones and to validate this scoring system against QCT measurements.

Materials/Methods: QCT-derived BMD measurements vs MRI-derived VBQ scores in patients who underwent operative lumbar procedures at a single tertiary institution between 2016 and 2021 were retrospectively compared. 61 patients who underwent lumbar spine surgery for degenerative conditions were analyzed. Vertebral bone quality (VBQ) scores were measured using noncontrast T1W MRIs of the lumbar spine. Demographic data, comorbidities, VBQ scores, and QCT-derived BMD and T-scores of the lumbar spine were compared between the healthy (T-score > -1) and osteoporotic (T-score < -2.5) cohorts using Student’s t test. Linear regression and receiver operating characteristic (ROC) curve analyses were performed to assess the predictive value of VBQ scores.

Results: Out of 61 patients enrolled in this study, 19 were osteoporotic based on QCT. VBQ differed significantly between healthy and osteoporotic groups (p=0.01). ROC curve analysis revealed that a greater VBQ score was associated with presence of osteoporosis (AUC=0.754, p=0.006). The cutoff VBQ for osteoporosis was 2.6 (Youden index 0.484; sensitivity: 68%; specificity: 90%). VBQ scores correlated significantly with QCT-derived BMD (p=0.03) and T-scores (p=0.04).

Discussion/Conclusion: This is the first study that attempted to validate the previously described MRI-based VBQ scoring system by correlating with QCT-derived measurements. The VBQ scoring system was found to be a significant predictor of osteoporosis and could successfully differentiate between healthy and osteoporotic bone.
Lower Hounsfield Units at the Upper Instrumented Vertebra and Severe Multifidus Sarcopenia are Independent Predictors of Increased Risk for Proximal Junctional Kyphosis and Failure following Thoracolumbar Fusion

Pinter Zachariah, MD, Mikula Anthony, MD, Townsley Sarah, MD, Salmons Harold, MD, Lakomkin Nikita, MD, Michalopoulos Giorgos, MD, Nassr Ahmad, MD, Freedman Brett, MD, Sebastian Arjun, MD, Bydon Mohamad, MD, Fogelson Jeremy, MD, Elder Benjamin, MD, PhD

1 Mayo Clinic Rochester, Rochester, Minnesota, United States

Background/Introduction: The purpose of the present study was to determine demographic and radiographic variables that predict an increased risk of proximal junctional kyphosis (PJK) or proximal junctional failure (PJF) following thoracolumbar fusion.

Materials/Methods: We retrospectively reviewed a cohort of patients greater than 50 years of age who underwent posterior instrumented fusion with pelvic fixation and a construct that terminated proximally between T10 to L2 between the years 2013-2020. Patient demographic information was collected and the Modified Frailty Index (mFI) and Charlson Comorbidity Index (CCI) scores were calculated for each patient. Patients were subdivided into three groups: (1) no PJK or PJF, (2) PJK without PJF, and (3) PJF. These subgroups were then compared based upon demographics, preoperative and 1-year postoperative sagittal alignment parameters, bone mineral density (BMD), and paraspinal sarcopenia. We utilized student’s T-test and ANOVA to compare means within and between groups, respectively. Multivariable analyses were performed to determine risk factors for PJK and PJF. P values <0.05 were considered significant.

Results: We identified 150 patients for inclusion in this study with a mean age of 67.0 years and an average follow-up of 32 months. The subgroup of patients with no PJK/PJF demonstrated a significantly higher HU at the UIV (148.3±34.5) than patients who developed PJK (117.8 ±41.9) or PJF (118.8 ±41.8; P<0.001). There was a much higher rate of severe multifidus fatty infiltration observed in patients who developed PJF (78.9%) or PJK (76.0%) than in patients who did not develop PJK/PJF (34.0%; P<0.001). Furthermore, no patient that developed PJK or PJF had normal multifidus quality. Multivariate analysis identified both mean UIV HU (0.80, 95% CI 0.69-0.93; P<0.001) and moderate-severe multifidus sarcopenia (5.40, 95% CI 1.8-16.1; P<0.001) as independent predictors of increased risk of PJK and PJF.

Discussion/Conclusion: Patients with lower mean HU at the UIV and a higher degree of multifidus fatty infiltration are at increased risk of PJK and PJF following thoracolumbar fusions that terminate proximally between T10 and L2.
The Effect of Preoperative Ambulation Status on Postoperative Patient Reported Outcomes in Patients Undergoing Lumbar Spine Surgery

Koutsogiannis Petros, DO1, Katz Austen, MD2, Iturriaga Cesar, DO3, Song Junho, BS4, Seitz Mitchell, BA3, Strigenz Adam, BA3, Silber Jeff, MD3, Essig David, MD2

1 Northwell Health System, New Hyde Park, New York, United States, 2 North Shore LIJ Health System, Manhasset, New York, United States, 3 Northwell Health, New Hyde Park, New York, United States, 4 Hospital for Special Surgery, New York, New York, United States

Background/Introduction: Prior studies have demonstrated low preoperative ambulation distance may negatively impact postoperative outcome while rapid perioperative ambulation may improve them. The influence of low activity patients on postoperative patient reported outcomes (PROs) has not been previously evaluated. Therefore, our goal was to evaluate the differences in postoperative patient reported outcomes between low- and normal-activity patients undergoing lumbar spine surgery.

Materials/Methods: Patients at a single institution undergoing primary lumbar spinal decompressions with and without fusion procedures were enrolled in outcomes collections platforms (Force Therapeutics; New York, NY). The perioperative (Preoperative Day 7 to Postoperative Day 28) step counts were recorded, along with Patient-Reported Outcomes Measurement Information System (PROMIS) Mental and Physical scores, and Oswestry Disability Index (ODI) at Baseline, Week 6, Week 12, Month 6, and Year 1. Daily mean ambulation distances were evaluated. Patients who had preoperative ambulation distances less than 2,500 (threshold level for least active individuals) were compared to those above. Chi-square test and independent t-test were used to evaluate categorical and continuous variables, respectively.

Results: Of 47 patients included in the study, the mean age was 51.8±13.7 years, BMI was 29.85±5.00, and daily preoperative step count was 3453±2634. When compared to patients with low preoperative activity (N=21; 1354.6±638.6 steps), the normal activity group (N=26; 5147±2399 steps) had higher mean steps at POD8-14 (p=0.044) and POD1-28 (p=0.010). Of normal activity patients, 53.8% had returned to a mean step count of 2500 or more by week 2, compared to 14.3% of low activity patients (p=0.005). The activity groups did not differ statistically in preoperative pain, PROMIS Physical, PROMIS Mental, ODI scores. Postoperatively, the normal activity group had lower pain scores (4.8±2.1 vs 2.9±2.4, p=0.011) at week 6 and week 12 (4.0±2.5 vs 2.4±2.2, p=0.029), and improved ODI scores at week 12 (29.5±17.7 vs 17.4±14.7, p=0.018).

Discussion/Conclusion: Our results suggest that preoperative ambulation distance may be a useful predictor of postoperative walking ability, and correlates with pain reduction, and improvement in ODI. This highlights the necessity of additional studies to further elucidate the possible benefits of increasing preoperative activity on PROs following lumbar spine surgery.
Does Physical Therapy Improve Patient Reported Outcomes Following Lumbar Decompression?

D’Antonio Nicholas, BS1, Lambrechts Mark, MD2, Boere Payton, BS3, Canseco Jose, MD, PhD2, Hilibrand Alan, MD2, Kepler Chris, MD3, Vaccaro Alexander, MD, PhD, MBA2, Schroeder Gregory, MD2

1 Rothman Institute, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, United States, 2 Rothman Institute at Thomas Jefferson University, Philadelphia, Pennsylvania, United States, 3 Department of Orthopaedic Surgery, Rothman Institute, Thomas Jefferson University, Philadelphia, Pennsylvania, United States

Background/Introduction: Outpatient physical therapy (PT) is commonly prescribed after lumbar decompression surgery, especially for elderly patients, to improve physical function and reduce postoperative complications. This study evaluates the relative improvements in one-year patient-reported outcomes measures (PROMs) among patients based on their PT status.

Materials/Methods: All patients over 18 years of age who underwent primary single-level or multi-level lumbar decompression at a single academic institution within the past 7 years were retrospectively identified. Patients were then grouped based on PT status (attended outpatient PT, were not offered PT, or were offered a prescription for PT but did not attend). Patient demographics, surgical characteristics, clinical outcomes, and PROMs were collected and compared between the groups utilizing one-way ANOVA or Pearson’s chi-square tests. Multivariate linear regression models were developed to determine the independent associations of postoperative PT utilization on the change in PROM scores at the one-year postoperative point.

Results: A total of 1,199 patients were included (423 PT, 581 No PT, 195 Offered PT). Patients who attended PT were older (p<0.001), had more medical comorbidities (p=0.027), and had longer hospital length of stay (in days) after surgery (p<0.001). Patients who attended PT had significantly lower preoperative ODI (PT: 39.7, No PT: 47.1, Offered PT: 44.3, p=0.012) and preoperative VAS Leg (PT: 6.12, No PT: 7.06, Offered PT: 6.61, p=0.009) compared to patients who did not attend PT and patients who were offered PT, however PROM scores were not significantly different between each group at the one-year postoperative point (p>0.05). Linear regression analysis showed that attending PT and being offered PT were not independently associated with improvement in any PROM scores compared to not attending PT (p>0.05).

Discussion/Conclusion: Accounting for age, sex, BMI, medical comorbidities, smoking status, and total levels decompressed, both attending PT and being offered PT after lumbar decompression were not associated with improvements in any PROM score at one year compared to not attending PT.
Determining What Markers Increase the Odds of Successful Non-Operative Treatment of Lumbar Disc Herniation

Singh Devender, PhD, Truumees Eeric, MD, Duncan Ashley, RN, MBA, Mayer Eric, MD
1 Ascension Texas Spine and Scoliosis Center, Austin, Texas, United States

Background/Introduction: Treatment selection for acute lumbar disc herniation remains uncertain due to reports of similar outcomes with surgical and non-operative management over long-term follow-up. This study aims to identify factors predictive of successful non-operative treatment.

Materials/Methods: We reviewed 157 charts of patients for lumbar disc herniation. Independent variables collected consisted of age, smoker status, presence of comorbidities, antidepressant and opioid use, length of symptoms, treatment prescribed, baseline and three-month Oswestry Disability Index (ODI). A successful treatment was defined as a decrease (between baseline and three months) in ODI of at least 10 points. Treatment failure was defined as any increase in ODI or a decrease of less than 10. Multinomial logistic regression was conducted on the encoded data.

Results: Mean age at appointment was 50.6 years. 81% were never smokers, while 13% were former smokers and 6% were current smokers. 89% had the presence of a comorbidity, and 16% were being treated with antidepressants for anxiety/depression and 15% were already taking opioids at the time of the first encounter. Mean duration of symptoms was 78.3 weeks ±26.8. 95% received a prescription, 69% had at least one epidural injection, 50% went to physical therapy and 16% received a prescription for opioids. Logistic analysis demonstrated only injection therapy and opioid treatment were significant predictors of treatment success with odds of 2.8 and 3.9, respectively. As expected, smoking and presence of comorbidities decreased the odds of successful non-operative treatment by 1.1% and 28.1%, respectively. Interestingly, the logistic analysis of this data showed that for each unit increase in age, the odds of successful outcome increased by 2.5%.

Discussion/Conclusion: Epidural injection and opioid therapy were the only variables that significantly impacted the odds of successful non-operative treatment at three months. The positive impact of opioid prescription was surprising, given the small number of occurrences in this population and the mechanism of action, with no known local or anti-inflammatory properties. Increased age was also positively correlated with treatment success, although non-significantly. The impact of opioid and age on treatment success in this analysis begs the question of what psychological factors impact the patients’ determination of a meaningful, successful outcome.
Influence of Preoperative SF-12 MCS on PROMs and Achievement of MCID in an Isthmic Spondylolisthesis Population undergoing MIS TLIF

Jacob Kevin, BS1, Patel Madhav, BS1, Chavez Frank, BS1, Prabhu Michael, BS1, Pawlowski Hanna, BS1, Vanjani Nisheka, BS1, Singh Kern, MD1
1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Our study evaluates the influence of preoperative Short Form 12 (SF-12) Mental Composite Score (MCS) on achieving minimally important clinical difference (MCID) for patient-reported outcome measures (PROMs) in patients with isthmic spondylolisthesis undergoing minimally invasive transforaminal lumbar interbody fusion (MIS TLIF).

Materials/Methods: Patients who underwent primary, single level TLIF for isthmic spondylolisthesis at L5/S1 were retrospectively identified. Patients were stratified into two groups based on preoperative mental health scores: SF-12 MCS <50 and preoperative SF-12 MCS ≥50. Visual Analog Scale (VAS) back/leg, Oswestry Disability Index (ODI), SF-12 Physical Composite Score (PCS), and Patient-Reported Outcome Measurement Information System physical function (PROMIS-PF) were collected preoperatively and postoperatively. Established MCID values (VAS Back = 2.1; VAS Leg = 2.8; ODI = 14.9, SF-12 = 2.5, PROMIS-PF = 4.5) were used to determine achievement rates. Differences in MCID achievement between cohorts were evaluated using Chi-square analysis.

Results: The SF-12 MCS<50 group had 35 patients and the SF-12 MCS≥50 group had 26 patients (61 patients total). Both cohorts demonstrated a 100.0% rate for 1-year arthrodesis. Cohorts differed in postoperative length of stay (p=0.032). Simple regression analysis of mean PROMs revealed a significant difference between the two groups at all timepoints for VAS back except at 6-weeks (p≤0.016, all), all timepoints for VAS leg except at 6-weeks and 1-year (p≤0.015, all), all timepoints of ODI (p≤0.030, all), SF-12 PCS at 6-months and 2-years (p≤0.049, both), and PROMIS-PF preoperatively and at 6-months (p≤0.003, both) (Table 1). MCID achievement for PROMs revealed significant differences among mental functioning groups only for ODI at 6-weeks (p=0.035) and PROMIS-PF at 12-weeks (p=0.034).

Discussion/Conclusion: Low preoperative mental functioning translated to significantly inferior back pain, leg pain, and disability scores throughout the entire postoperative period in isthmic spondylolisthesis patients undergoing MIS TLIF. Meanwhile, physical functioning remained relatively unchanged, especially at the longer timepoints irrespective of preoperative mental health score. MCID achievement largely did not differ by preoperative mental functioning score across any PROM studied, indicating clinically meaningful improvements are likely comparable regardless of preoperative mental health status among isthmic spondylolisthesis patients undergoing MIS TLIF.
Automated Prediction of the Thoracolumbar Injury Classification and Severity Score from Computed Tomography Using a Novel Deep Learning Algorithm

Doerr Sophia, BS, MSE1, Weber-Levine Carly, MS, BS1, Hersh Andrew, BS1, Awosika Tolulope, BS1, Judy Brendan, MD2, Jin Yike, MD2, Liu Ann, MD2, Lubelski Daniel, MD1, Raj Divyaansh, BS1, Jones Craig, PhD, BS3, Sair Haris, MD, BS1, Theodore Nicholas, MD1

1 Johns Hopkins University School of Medicine, Baltimore, Maryland, United States, 2 Department of Neurosurgery, The Johns Hopkins Hospital, Baltimore, Maryland, United States, 3 Johns Hopkins University, Baltimore, Maryland, United States

Background/Introduction: Damage to the thoracolumbar spine can confer significant morbidity and mortality. The Thoracolumbar Injury Classification and Severity Score (TLICS) is used to categorize injuries and determine patients at risk of spinal instability for whom surgical intervention is warranted. However, calculating this score can constitute a bottleneck in triaging and treating patients, as it relies on multiple imaging studies and a neurological exam. Therefore, we sought to develop and validate a deep learning model that can automatically categorize vertebral morphology and determine posterior ligamentous complex (PLC) integrity, two critical features of the TLICS score, using only Computed Tomography (CT) scans.

Materials/Methods: All patients between January 2018-December 2019 undergoing neurosurgical consultation for traumatic spine injury or degenerative pathology resulting in spine injury at a single tertiary center were retrospectively evaluated for inclusion. The morphology of injury and integrity of the PLC were categorized on CT scans. A state-of-the-art object detection architecture, Faster R-CNN, was leveraged to both predict vertebral locations and the corresponding TLICS. The network was trained with patient CTs, manually labeled vertebral bounding boxes, TLICS morphology, and PLC annotations. The model outputs the location of vertebrae, categorizes their morphology, and determines status of PLC integrity.

Results: A total of 111 patient cases were collected (average age 62 ± 20 years) with a total of 129 separate injury classifications. Vertebral localization and PLC integrity classification achieved Dice Scores of 0.92 and 0.88, respectively. Binary classification between non-injured and injured morphological scores demonstrated 95.1% accuracy. TLICS morphology accuracy, true positive rate, and positive injury mismatch classification rate were 86.3%, 76.2%, and 22.7%, respectively. Classification accuracy between no injury and suspected PLC injury was 86.8% while true positive, false negative, and false positive rates were 90.0%, 10.0%, and 21.8%, respectively.

Discussion/Conclusion: In this study, we demonstrate a novel deep learning method to automatically predict injury morphology and PLC disruption with high accuracy. This model may streamline and improve diagnostic decision support for patients with thoracolumbar spinal trauma.
Paper 27

Predicting Patient Success with Decompressive Spinal Surgery: Looking Into the Past to Predict the Future

Patel Arpan, MD¹, Coombs Jeffery, BS², Rabah Nicholas, BS¹, Sundar Swetha, MD³, Salas Sebastian, PhD², Steinmetz Michael, MD¹, Mroz Thomas, MD³, Habboub Ghaith, MD³
¹ Center for Spine Health, Cleveland Clinic Foundation, Cleveland, Ohio, United States, ² Case Western Reserve University, Cleveland, Ohio, United States, ³ Cleveland Clinic Foundation, Cleveland, Ohio, United States

Background/Introduction: Patient reported outcome measures (PROMs) are the new standard for evaluation of patients throughout the perioperative period surrounding spine surgery. Studies typically compare postoperative PROMs (i.e PROMIS, ODI, or SF-12) to the immediate preoperative “baseline”. This “baseline” however may not represent the patient’s true functional baseline prior to onset of spine pathology. This may fail to accurately contextualize a patient’s true outcome after spine surgery and their potential maximal response to surgery.

Materials/Methods: Retrospective review was performed of patients who underwent single-level lumbar laminectomy for central stenosis at our institution from 2010 to 2020. Patient-Reported Outcome Measurement Information Systems (PROMIS) scores were collected for all patients from services other than spine at least 1 year prior to their initial visit with a spine surgeon, which served as the baseline. PROMIS scores were also collected in the immediate preoperative period and at least 6 weeks postoperatively. T-test was used to compare postoperative PROMIS scores to both the patient’s baseline and immediate preoperative PROMIS scores.

Results: 120 patients were included in the study with a median age of 66 years. Mean baseline PROMIS scores at least 1 year prior to initial visit with spine surgeon was 40.96. The immediate preoperative and postoperative PROMIS scores were 38.20 and 41.56, respectively; median follow up time was 10 weeks. There was a significant reduction in mean PROMIS scores when comparing baseline scores with immediate preoperative scores (-2.66; p-value:<0.001). Patients had a significant increase in mean PROMIS scores when comparing immediate preoperative scores with postoperative scores (+3.37;p-value:<0.001). There was no difference between baseline and postoperative PROMIS scores (p-value:0.21).

Discussion/Conclusion: Patients had no significant difference between baseline PROMIS and postoperative PROMIS scores, suggesting that patients return at least, or possibly at most, to their functional baseline. This is a valuable tool for spine surgeons when setting realistic goals with patients preoperatively regarding expectations of outcomes.
Paper 28

Determining the Utility of the RAPSF Score as a Means of Predicting Post-Surgical Outcomes Following Elective Lumbar Fusions

Eisler Jesse, MD, PhD, MBA1, Solomito Matthew, PhD2
1 Connecticut Back Center, Storrs, Connecticut, United States, 2 Hartford Healthcare Bone and Joint Institute, Hartford, Connecticut, United States

Background/Introduction: Healthcare systems across the United States are focused on improving post-surgical outcomes specifically decreasing discharge rates to skilled nursing facilities (SNF), hospital length of stay, readmission rates, surgical site infections, and reoperations. Elective lumbar fusion surgeries are common surgical procedures in the United States, but these procedures are associated with a high incidence of poor post-surgical outcomes. The purpose of this study was to apply the Readmission after Posterior Spine Fusion (RAPSF) score to an elective lumbar fusion population regardless of surgical approach, and determine its associations with post-surgical outcomes (i.e. readmission, reoperation, surgical site infection, hospital length of stay, and discharge disposition) at a single tertiary orthopedic specialty center.

Materials/Methods: This was a retrospective study evaluating patients who underwent elective lumbar spine fusions between 2017 and 2020. Patient demographics, complications, and medical comorbidities were extracted from the medical record in order to calculate the RAPSF score. Patients were separated into two groups those that were treated with a posterior approach and those that were treated with a different surgical approach. Regression analyses were used to determine if the RAPSF score was associated with post-surgical outcomes in each group.

Results: A total of 867 patient charts (610 posterior approaches) were reviewed for this study (Table 1). The readmission rate for those undergoing a posterior approach was 6%, and 3.9% for patients undergoing another approach. Results indicated that the RAPSF score in the posterior fusion group was positively associated with 30-day readmissions (p=0.008), surgical site infections (p=0.048), extended length of stay (>3 days) (p=0.005), and negatively associated with discharge to home (p<0.001). Results indicated that when applying the RAPSF score to lumbar fusions performed with other approaches, the score was not associated with readmissions (p=0.456), but was positively associated with extended length of stay (p<0.001) and negatively associated with discharge to home (p<0.001).

Discussion/Conclusion: Although the RAPSF score was developed to predict readmissions following posterior fusions, the results of this study indicate that the RAPSF score may by a powerful preoperative screening tool to identify patients undergoing any elective spine fusion that are at risk for an extended length of stay or a non-standard discharge.
Paper 29

Data-Driven Phenotyping of Pre-Operative Functional Decline Patterns in Lumbar Decompression and Lumbar Fusion Patients Using Smartphone Accelerometry

Ahmad Hasan, BS1, Singh Shikha, BS1, Jiao Kenneth, 1, Basil Gregory, MD2, Wang Michael, MD2, Welch William, MD1, Yoon Jang, MD1
1 Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, United States, 2 University of Miami Miller School of Medicine, Miami, Florida, United States

Background/Introduction: The decision to operate on degenerative lumbar spine pathologies typically based on degree of pain and disability as assessed by patient-reported measures such as the Oswestry disability index (ODI). However, these qualitative surveys are subjective and can suffer from recall bias and limited data. In this analysis, we use smartphone-based accelerometry data to provide an objective, continuous measurement of physical activity that can aid in effective characterization of pre-operative functional decline in different lumbar spine surgical indications.

Materials/Methods: Up to 1 year of pre-operative activity data (steps taken per day) from 14 lumbar decompression (LD) and 15 endoscopic lumbar fusion (LF) patients was retrospectively extracted from patient smartphones. A data-driven algorithm was constructed based on unique 10,585 activity datapoints to identify and characterize patients’ functional decline preceding surgical intervention. Algorithmic estimation of functional decline onset was compared to reported symptom onset in clinical documentation across patients who presented acutely (≤ 5 months of symptoms) or chronically (> 5 months of symptoms).

Results: Our algorithm identified a statistically significant decrease in physical activity during measured periods of functional decline (p = .0020). To account for the distinct clinical presentation phenotypes of LD (71.4% acute, 28.6% chronic) and LF (6.7% acute, 93.3% chronic) patients, a variable threshold for detecting clinically significant reduced physical activity was implemented. Our algorithm characterized functional decline (i.e., acute or chronic presentation) in LD patients with 100% accuracy (sensitivity=100%, specificity=100%), while LF patient characterization was less effective (accuracy=26.7%, sensitivity=21.4%, specificity=100%). Adopting a less permissive detection threshold in LF patients to account for chronically decreased level of pre-operative activity increased functional decline classification accuracy of LF patients to 66.7% (sensitivity=64.3%, specificity=100%) (Figure 1).

Discussion/Conclusion: Smartphone-based accelerometer data successfully characterizes functional decline in patients with degenerative lumbar spine pathologies. Accuracy and sensitivity of functional decline detection was much lower when using non surgery-specific detection thresholds, indicating the effectiveness of smartphone-based mobility analysis in characterizing the unique physical activity fingerprints of different lumbar surgical indications. This study highlights the potential of using activity data to detect patients’ symptom onset and functional decline, enabling earlier diagnosis and improved prognostication.
Paper 30

Decision Making Factors Leading to Fusion vs. Decompression for One Level Degenerative Spondylolisthesis: Survey Results from Members of the Lumbar Spine Research Society and Society of Minimally Invasive Spine Surgery

Morse Kyle, MD\textsuperscript{1}, Steinhaus Michael, MD\textsuperscript{1}, Bovonratwet Patawut, MD\textsuperscript{1}, Kazarian Gregory, MD\textsuperscript{1}, Vaishnav Avani, MBBS\textsuperscript{1}, Song Junho, BS\textsuperscript{1}, Lafage Virginie, PhD\textsuperscript{1}, Lafage Renaud, MS\textsuperscript{1}, Iyer Sravisht, MD\textsuperscript{1}, Qureshi Sheeraz, MD\textsuperscript{2}
\par \textsuperscript{1}Hospital for Special Surgery, New York, New York, United States, \textsuperscript{2}Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States

Background/Introduction: Degenerative spondylolisthesis is one of the most common pathologies spine surgeons treat. While a number of potential factors have been identified, there is no current consensus on which variables most impact the decision to fuse vs. decompress alone in this population. The aim of this study was to identify radiographic and clinical factors leading to the decision to fuse segments for one level spondylolisthesis.

Materials/Methods: A survey consisting of questions pertaining to decision factors leading to fusion or decompression alone in the setting of degenerative lumbar spondylolisthesis was administered to the Lumbar Spine Research Society and Society of Minimally Invasive Spine Surgery. Radiographic parameters included grade of spondylolisthesis, instability, facet orientation > 60 degrees, facet diastasis, laterolisthesis or scoliosis, synovial cysts, vacuum disc, vertical disc space, preserved disc height, concomitant herniated nucleus pulposus, and symptomatic foraminal stenosis. Clinical factors included age > 70 years, activity level, patient sex, body mass index >35, osteoporosis, primary complaint of low back pain, primary complaint of neurogenic claudication, smoking, and anxiety/depression. The primary analysis was limited to completed surveys. Baseline characteristics were summarized. Clinical and radiographic parameters were ranked and compared. The most important, top three most important, and top five most important parameters were ordered given each parameter ranking.

Results: Of 561 surveys, 381 (67.9\%) were returned completed. Respondents mean years in practice was 17.8 $\pm$ 9.4 years and 77.7\% had undergone a formal spine fellowship. With regards to fusion vs. decompression, 19.9\% fuse all cases, 39.1\% fuse > 75\%, 17.8\% fuse 50-75\%, and 23.2\% fuse <25\%. Instability (93.2\%), spondylolisthesis grade (59.8\%), and laterolisthesis (37.3\%) were the most common radiographic factors impacting the decision to fuse (Table 1), whereas mechanical low back pain (83.2\%), activity level (58.3\%), and neurogenic claudication (42.8\%) were the top clinical parameters (Table 2).

Discussion/Conclusion: There is little consensus on the treatment of degenerative spondylolisthesis, with society members showing substantial variation in treatment patterns. The most common radiographic parameters impacting treatment are instability, spondylolisthesis grade, and laterolisthesis while mechanical low back pain, activity level, and neurogenic claudication are the most common clinical parameters.
The Effects of Static and Expandable Cages on Local and Global Lumbar Lordosis (LL) in Transforaminal Lumbar Interbody Fusion (TLIF) Patients: A Minimum One Year Follow Up

Yen Tzu Chuan, MD1, Burch Major, MD2, Crim Julia, MD1, Leary Emily, PhD1, Abolfotouh Sameh, MD3, Moore Don, MD, na4
1 University of Missouri-Columbia, Columbia, Missouri, United States, 2 Alpert Medical School of Brown University, Department of Orthopaedics, Providence, Rhode Island, United States, 3 Medcare Orthopaedics and Spine Hospital, Dubai, United Arab Emirates, 4 University of Missouri - Columbia, Columbia, Missouri, United States

Background/Introduction: Expandable cages theoretically offer better correction of lumbar lordosis than static cages. However, existing studies of expandable cages have not compared them to static cages, have not examined changes in lordosis, and have not included TLIF procedures. Therefore, the purpose of this study is to: determine if local lordosis and global lordosis is affected by the type of cage used, determine if one type of cage is better for one versus two or more level fusions, and to determine if one type of cage is better depending on the lumbar level fused (upper lumbar versus lower) in TLIF surgeries.

Materials/Methods: A total of 332 patients (40% male) were included from a retrospective institutional data review between 2014-2017. Patients had radiographs pre-operatively, immediately post-operatively, six weeks post-operatively, and at least 1 year post-operatively. Measurements were made by a board certified radiology attending with interobserver reliability evaluated by measurements of a subset of these patients by two orthopedic residents. Data analysis was performed with student’s T test and ANOVA, with statistical significance achieved when p <0.05.

Results: Overall, there was no statistically significant change at the final follow up visit in both local or global LL regardless of the type of cage use. There was a statistically significant decrease in global LL in the expandable cages group compared to the static cages group during the pre-operative and immediate post-operative period (p < 0.002 ) as well as the immediate post-operative and final follow up visit (p < 0.05), likely due to intra-operative correction and subsequent subsidence, respectively. In both the static and expandable cages groups, neither local nor global LL was statistically different when comparing one versus two or more level fusions or upper versus lower lumbar TLIF surgeries.

Discussion/Conclusion: Expandable cages do not significantly improve lumbar lordosis compared to static cages on radiographic evaluation and may not be the most cost-effective choice in TLIF surgeries.
Paper 32

Multicenter Evaluation of the Effect of Surgical Approach on Sagittal Plane Alignment in One- or Two- Level Fusions for Degenerative Pathology

Leveque Jean-Christophe, MD, Drolet Caroline, PhD, Nemani Venu, MD, PhD, Krause Katie, MD, PhD, Shen Jesse, MD, Sethi Rajiv, MD, Louie Philip, MD

Neuroscience Institute, Virginia Mason Medical Center, Seattle, Washington, United States

Background/Introduction: Interbody fusion implants have played a growing role in degenerative lumbar fusion procedures due to the increased fusion surface area as well as the potential ability to restore and maintain sagittal alignment. Understanding how these various interbody grafts affect lumbar lordosis both segmentally and globally is relevant to achieving radiographic goals. Given evidence that TLIF grafts do not achieve the same increases in lumbar lordosis as ALIF grafts, and that lordosis change from TLIF grafts is highly variable compared to LLIF grafts, we hypothesize the following. The use of ALIF/LLIF grafts will have a higher likelihood of correcting or preserving spinopelvic mismatch, while the use of posteriorly-placed TLIF or PLIF grafts would have a greater chance of leading to an under-corrected or worsened postoperative spinopelvic match.

Materials/Methods: This retrospective study included 474 patients from 18 centers across the United States. Patients were included in the study if they underwent a one- or two-level primary lumbar fusion for degenerative pathology, and obtained a standing neutral lumbar spine plain radiograph within one month prior to surgery and 6 months following surgery. Exclusion criteria included previous lumbar fusion, if fusion included more than two levels, and non-degenerative pathology. Measurements of the pre-operative and 6-month post-operative lumbar AP and lateral lumbar plain radiographs included: pelvic incidence, pelvic tilt, lumbar lordosis from L1-S1, as well as segmental lordosis of each segment between L1-S1.

Results: ALIF/LLIF resulted in significantly more segmental lordosis compared to TLIF/PLIF grafts (p < .001). Overall, ALIF/LLIF resulted in significantly more global lumbar lordotic alignment change compared to TLIF/PLIF (p = .01). Whether patients' alignment was preserved versus worsened was not significantly predicted by type of graft. Similarly, whether patients’ alignment was restored versus not corrected was not significantly predicted by type of graft.

Discussion/Conclusion: In this large-scale multicenter study of lumbar fusion patients presenting with degenerative lumbar pathology, we report that ALIF/LLIF grafts led to greater improvements in alignment compared to TLIF and PLIF grafts. Posteriorly-placed TLIF or PLIF grafts tended to worsen lordosis both segmentally and globally, yet even the anterior grafts only modestly improved those two measurements.
Modified Frailty Index Independently Predicts Morbidity in Patients Undergoing 3-Column Osteotomy

Katz Austen, MD¹, Seitz Mitchell, BA², Strigenz Adam, BA², Song Junho, BS³, Silber Jeff, MD², Verma Rohit, MD², Virk Sohrab, MD⁴, Essig David, MD¹

¹ North Shore LIJ Health System, Manhasset, New York, United States, ² Northwell Health, New Hyde Park, New York, United States, ³ Hospital for Special Surgery, New York, New York, United States, ⁴ North Shore University/Long Island Jewish Medical Center, Great Neck, United States

Background/Introduction: Three-column-osteotomy (3CO) involves resection of the anterior, middle, and posterior columns of the spine. These techniques include PSO and VCR. The complex and highly invasive nature of these procedures yields high complication rates. Consequently, identifying patients at risk of poor-outcomes can help mitigate surgical morbidity. This is the first study to evaluate modified 5-item-frailty-index (mFI-5) as a predictor of 30-day morbidity in patients undergoing 3CO.

Materials/Methods: Adults undergoing 3CO from the 2011-2019 NSQIP datasets were identified by CPT codes 22206 and 22207, with multilevel 3CO identified using 22208. Patients were classified into frailty levels 0, 1, or 2 based on mFI-5 score of 0, 1, or 2-5, respectively. Primary outcome was morbidity. Secondary outcomes included readmission and reoperation. Multivariate modeling was utilized to analyze mFI-5 as a predictor of 30-day outcomes.

Results: There were 983 patients who underwent 3CO. Readmission, reoperation, and morbidity rates were 9.7%, 9.9%, and 70.3%, respectively. In multivariate analysis, frailty-level-1 (p=0.015, OR=1.62, CI95:1.10-2.38) and frailty-level-2 (p=0.004, OR=2.17, CI95:1.29-3.71) independently predicted morbidity. Further, OR-time (OR=1.24) and WBC (OR=1.11) predicted morbidity, while male sex (OR=0.58), BMI (OR=0.97), hematocrit (OR=0.94), and positive smoking status (OR=0.57) were protective against morbidity (Table 1). Frailty-level-2 (p=0.022, OR=2.16, CI95:1.12-4.22) predicted readmission while only increased OR-time (p=0.049) predicted reoperation.

Discussion/Conclusion: In the pediatric literature, complication rates following 3CO have been reported to be almost-60%, with rates of 30-day readmission and reoperation closer to 10%. Our findings are in line with prior literature. In the present study, frailty emerged as a significant predictor of 30-day outcomes. Specifically, mFI-5 of 1 independently-predicted a 62% increased-odds of morbidity following 3CO compared to mFI-5 of 0, while patients with mFI-5 scores of 2-5 had an odds-of-morbidity of almost twice that. Notably, for every 30-minute increase in OR-time, the odds-of-morbidity increased by 24%, likely explained by an increased risk of surgical-site-related-events. This is further supported the finding of OR-time as a predictor of reoperation. The protective finding of increasing BMI suggests that preoperative nutritional status may plays a role in preventing complication for highly invasive surgical procedures such as 3CO. Taken together, our findings can help guide preoperative optimization of patient-related factors prior to 3CO.
Paper 35

The Effect of In-patient Step Count on Complications in the Elderly Patient after Adult Spinal Deformity Surgery

Ani Fares, MD¹, Perrier Gregory, BS¹, Walia Arnaav, BA¹, Bono Julianna, BS¹, O'Connell Brooke, MS², Maglaras Constance, PhD², Burapachaisri Aonnicha, BS¹, Patel Hershil, BS³, Kim Nathan, BS¹, Protopsaltis Themistocles, MD⁴, Raman Tina, MD¹

¹ NYU Langone Department of Orthopedic Surgery, New York, New York, United States, ² Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, ³ Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, ⁴ Department of Orthopedic Surgery, NYU Langone Health, New York, New York, United States

Background/Introduction: The number of elderly patients undergoing adult spinal deformity (ASD) surgery has increased with the advent of new techniques and more nuanced understanding of global malalignment as patients age. The relationship between in-patient physical activity after ASD surgery and post-operative complications in the elderly patient has not been reported. The ability of the elderly patient to walk independently as early as possible following ASD surgery may decrease the perioperative complication rate.

Materials/Methods: We performed a review of 185 ASD patients over 65 years of age (Age: 71.5±4.7; BMI: 30.0±6.1, Levels fused: 10.5±3.4). We derived the number of feet walked over the first three days after surgery from physical therapy documentation and evaluated for association with 90 day perioperative complications.

Results: Within the cohort of 185 patients, the mean number of feet walked within 3 days of the procedure was 165.5±243.8 ft The 185 patients were subdivided into quartiles based on number of feet walked: 1st: > 233.51 ft, 2nd: 62.01 – 233.5 ft, 3rd: 7.01 – 62.00 ft, 4th: 0 – 7.00 ft. There was no difference in patient characteristics between the groups. The rate of postoperative complications, specifically cardiac, pulmonary, and ileus was significantly higher in the 3rd and 4th quartiles of patients that took the fewest steps after surgery. Patients that developed any postoperative complication (106±172 ft vs. 211±279 ft, p=0.001), ileus (26±49 ft vs. 174±248 ft, p=0.001), deep venous thrombosis (DVT) (23±30 ft vs 171±247 ft, p=0.001), and cardiac complications (58±94 ft vs 192±261 ft) walked less than patients who did not. Walking less than 62 feet after ASD surgery was associated with higher incidence of postoperative complications (54.3%, p=0.05), cardiac complications (34.8%, p=0.03), pulmonary complications (21.7%, p=0.01), and ileus (15.2%, p=0.03).

Discussion/Conclusion: Elderly patients who walked less than 62 feet in the first three days after ASD surgery have a higher rate of postoperative complications, specifically pulmonary, cardiac, DVT, and ileus than patients who walked more. Steps walked after ASD surgery may be a helpful and practical addition to the surgeon's armamentarium for monitoring the recovery of their patients.
Paper 36

Effects of Hypovitaminosis-D Diagnosis and Treatment on Hardware Failure in Adult Patients Undergoing Posterior Lumbar Spine Fusion

Robison Bianca, BS\(^1\), Smith Spencer, BS\(^1\), Philipp Travis, MD\(^1\), Yoo Jung, MD\(^1\)
\(^1\) Oregon Health Sciences University, Portland, Oregon, United States

Background/Introduction: Vitamin-D has been shown to play important roles in both calcium homeostasis and bone healing. Few studies have directly examined the relationship between Vitamin-D deficiency and successful lumbar spine fusion, with contradicting results. None of these studies were large enough to provide the statistical power necessary to make definitive conclusions. The main purpose of this study was to define the relationship between Vitamin-D deficiency/treatment and hardware failure in patients undergoing a posterior lumbar fusion.

Materials/Methods: A retrospective analysis was performed utilizing the PearlDiver national insurance claims database consisting of 91 million individual patient records. The study population designated was patients aged 30 and over who underwent a posterior lumbar fusion procedure (CPT-22612) in 2012-2019. Subsequent hardware failure was identified through ICD-9 and ICD-10 diagnosis codes. We identified Vitamin-D deficiency by ICD diagnostic code in the 12 months before and/or after the surgery. Failure rates were compared between Vitamin-D deficient and not-deficient groups. We also analyzed the effects of age, gender, obesity, diabetes, nicotine use, and treatment for Vitamin-D deficiency.

Results: 99,676 patients matching inclusion criteria were identified, with an overall hardware failure rate of 4.3%. Failure rates were significantly higher for patients diagnosed with Vitamin-D deficiency spanning the 12 months before and 12 months after the surgery (5.5% vs 4.1%, OR = 1.35; \(p < 2.2e-16\)). Analyzing for deficiency diagnosed pre-surgery only, higher failure (5.2% vs 4.3%, OR = 1.32; \(p < 5.6e-5\)) and rate of revision (2.9% vs 1.8%, \(p < 2.2e-16\)) were noted in the Vitamin-D deficient patients. There was no difference in failure rates between patients with Vitamin-D deficiency diagnosed in the pre- or post-operative periods (\(p > 0.05\)) or between deficient patients with or without Vitamin-D treatment in the 180 days before or after surgery (\(p > 0.05\)). In a multivariate analysis, Vitamin-D deficiency, age, obesity, and nicotine use were significant factors in failure occurrence.

Discussion/Conclusion: These results demonstrate that pre- and/or post-operative Vitamin-D deficiency increases the risk for hardware failure in lumbar fusion patients. Short-term treatment with Vitamin-D supplementation designed to elevate serum levels of D3 may be inadequate in correcting a functional deficiency of long term hypovitaminosis-D.
Paper 37

Does Cutibacterium acnes (C. acnes, formerly Propionibacterium acnes) Play a Role in Degenerative Disc Disease?

Phan Amy, BS¹, Maqsoodi Noorullah, BS², Elmobdy Karim, BS³, Gill Ann, PhD¹, Gill Steven, PhD¹, Mesfin Addisu, MD, ¹

¹ University of Rochester, Rochester, New York, United States, ² University of Rochester, Univ. of Rochester School of Medicine and Dentistry, Rochester, Minnesota, United States, ³ University of Rochester, New York, Rochester, , United States

Background/Introduction: Recent studies suggest that Cutibacterium acnes (C. acnes), an anaerobic bacterium, may latently reside in intervertebral discs (IVDs) and contribute to degenerative disease.

Materials/Methods: Lumbar IVD specimens from patients undergoing discectomy and interbody fusion from a single institution from 8/21/2019 to 9/25/2020 were collected. Disc degeneration was graded according to the 5-level Pfirrmann classification on MRI. IVD specimens were included in the control group with Pfirrmann grades I-II and IVD specimens were included in the degenerative group with Pfirrmann grades III-V. IVD specimens were processed for DNA extraction, and 16S rRNA libraries were constructed and analyzed for taxonomic data.

Results: There were 40 patients included within the degenerative group, and 5 patients were included within the control group. Within the degenerative group, all specimens were taken from the levels of L1-S1, the average age was 56.0 years old, 23/40 (57.5%) were male, and were 36/40 (90%) were Caucasian. Meanwhile, within the control group, 3 specimens were taken from cervical spine surgeries and 2 were taken from lumbar spine surgeries. The mean age was 39.8 years old, 4/5 (80%) were male, and 4/5 (80%) were Caucasian. There were 11/40 (27.5%) specimens within the degenerative group that were identified with C. acnes: 3/12 (25%) with a Pfirrmann grade of 3, 6/20 (30%) with Pfirrmann grade of 4, and 2/8 (25%) with a Pfirrmann grade of 5. There was no significant difference between the average Pfirrmann grade for specimens that were C. acnes positive versus negative (3.91 vs. 3.90, p=0.96) in the degenerative group. There were 1/5 (20%) specimens within the control group with a Pfirrmann grade of 1 and 4/5 (80%) with a Pfirrmann grade of 2. There were no specimens collected for the control group that were identified with C. acnes.

Discussion/Conclusion: 27.5% of IVD specimens from the degenerative group were identified with C. acnes, while none of the specimens from the control group were identified with this bacterium. These results suggest that indolent P. acnes infection may contribute to degenerative disc disease.
Clinical and Radiographic Differences Between Single- and Multi-Level Lumbar Disc Herniations and Resorption: a Prospective Multi-Imaging and Clinical Phenotype Study

Hornung Alexander, BS1, Rudisill Samuel, BS1, Barajas J. Nicolas, BS1, Harada Garrett, MD2, Fitch Ashlyn, BS1, Roberts Ashley, BS1, An Howard, MD2, Epifanov Anton, MD3, Albert Hanne, PhD, PT, MPH4, Tkachev Alexander, MD3, Samartzis Dino, PhD5
1 Rush University Medical Center, Chicago, Illinois, United States, 2 Midwest Orthopaedics at Rush, Chicago, Illinois, United States, 3 Tkachev and Epifanov Clinic, Volgograd, Russia, 4 The Modic Clinic, Odense, Denmark, 5 Midwest Orthopaedics at Rush University, Chicago, Illinois, United States

Background/Introduction: Lumbar disc herniations (LDH) are amongst the most common spinal pathologies worldwide. As part of a “self-healing” phenomenon, patients often undergo spontaneous LDH resorption. However, the mechanism of this process remains poorly understood, particularly in the context of multiple herniations. The current study, therefore, aimed to identify specific patient characteristics, MRI findings, and resorption features associated with multiple herniations and LDH resorption.

Materials/Methods: A one-year prospective study was conducted in patients presenting with acute symptomatic LDH. All patients were managed by a single clinician between 2017 and 2019. Baseline assessment included patient demographics, herniation characteristics (e.g., herniation location), and MRI phenotypes (e.g., disc degeneration, endplate abnormalities, etc.). Treatment consisted of gabapentin, acupuncture, and avoidance of inflammatory-modulating medications. MRIs were performed approximately every 3 months after initial evaluation to assess disc integrity. P-values <0.05 were deemed statistically significant.

Results: Ninety patients were included (n=73 single herniation, n=17 multi-herniation) with a mean age of 48.7±11.9 years. Baseline demographics did not differ between groups apart from BMI, as the multi-herniation group consisted of patients with higher BMI (p<0.001). Those with multiple herniations were more likely to have greater initial axial disc size (p=0.012). No other baseline herniation characteristics, vertebral dimensions, Cobb angle (CA), sacral slope (SS), or CA:SS differed between groups. Patients with multiple herniations were more likely to have L3-L4 inferior endplate changes (p=0.001), L4-L5 superior endplate changes (p=0.012), and L4-L5 inferior endplate changes (p=0.020). No other differences in MRI phenotypes, resorption rate, or time to resolution were observed between groups.

Discussion/Conclusion: Compared to those with single-level LDH, patients with multiple herniations are more likely to have a higher BMI, greater initial axial measurements, and endplate changes at the inferior L3-L4, superior L4-L5, and inferior L4-L5 levels. Patients of both groups experienced similar rates of resorption and times to symptom resolution when treated with gabapentin, acupuncture, and avoidance of NSAIDs. Taken together, these results indicate conservative management represents an effective strategy for managing patients with LDH regardless of the number of affected levels, and they may assist clinicians in prognosticating recovery within this specific patient population.
Paper 39

Utility of the Erector Spinae Plane Block in Posterior and Transforaminal Lumbar Interbody Fusions

*Makanji Heeren, MD*¹, *Solomito Matthew, PhD*¹, *Esmende Sean, MD*¹, *Maffeo-Mitchell Carla, MD*², *Finkel Kevin, MD, FASA*²

¹ Hartford Healthcare Bone and Joint Institute, Hartford, Connecticut, United States, ² Hartford Hospital, Hartford, Connecticut, United States

**Background/Introduction:** Lumbar interbody fusion from a posterior-based approach is one the most common spine surgical procedures for spinal stenosis and instability. Improving patient comfort and reducing opioid consumption following surgery has become a significant post-operative goal. Therefore, the purpose of this study was to determine the effect of an Erector Spinae Plane Block (ESPB) on post-operative pain and opioid consumption in patients undergoing either a Posterior Lumber Interbody Fusion (PLIF) or a Transforaminal Lumbar Interbody Fusion (TLIF).

**Materials/Methods:** This was a retrospective study evaluating patients who underwent either a PLIF or TLIF between July 2019 and September 2021. Patients that received an ESPB were placed into the study group and those that did not were placed into the control group. It is important to note, that as of November 2020 the use of ESPB became standard of care for all elective PLIF and TLIF cases, prior to this date the ESPB was not used. Pain scores both during activity and at rest and opioid consumption during the first 72 hours post-operatively were extracted from the patient charts. T-tests assuming unequal variances and Chi square contingency tests were used to determine if there were statistically significant outcomes between the two groups.

**Results:** A total of 88 patients (43 received an ESPB) were included in this study (Table 1). Patients that received an ESPB had a statistically significant reduction in post-operative opioid usage as measured by morphine milligram equivalents (MME), those receiving the ESPB required 112±71MME compared to 161±113MME for the controls (p=0.016). Although pain at rest was not statistically significant between the two groups (p=0.219), pain with activity was reduced in patients that had received the ESPB. Patients receiving the ESPB has a pain level of 4.7±1.5 compared to controls that reported 5.4±1.7 (p=0.042).

**Discussion/Conclusion:** Patients receiving an ESPB from our regional anesthesia team prior to the start of their elective PLIF and TLIF required less opioids for pain control and reported lower pain with activity compared to those that did not receive a block. Therefore, ESPB may be an effective component of multimodal pain management option in this patient population.
Paper 40

Bone Morphogenetic Protein and Cancer in Spinal Fusion: A Propensity-Matched Analysis

Orina Josiah, MD1, Yoo Jung, MD2
1 Oregon Health & Science University, Portland, Oregon, United States, 2 Oregon Health Sciences University, Portland, Oregon, United States

Background/Introduction: Recombinant human bone morphogenetic protein-2 (rhBMP-2) has been increasingly used in spinal surgery to promote arthrodesis. Because rhBMP-2 stimulates cellular proliferation, its association with tumorigenesis in spinal fusion is an area of concern. Previous research has generated conflicting conclusions on the risk of cancer in patients receiving rhBMP-2 for spinal fusion. The purpose of this study was to compare the incidence of new solid organ and hematopoietic malignancies in patients undergoing spinal arthrodesis with or without BMP in a large administrative database.

Materials/Methods: Patients undergoing thoracolumbar fusion with or without BMP between 2015-2020 were identified in the PearlDiver Patient Claims Database using ICD-10 codes. Patients with pre-existing malignancy diagnosis were excluded. Data was analyzed for incidence of solid organ malignancy (lung, breast, kidney, prostate, thyroid) and hematopoietic malignancy (lymphoma, myeloma, leukemia) diagnosed after spinal surgery. Propensity score matching was performed between patients who did and did not receive BMP. Propensity matched variables included age, sex, and year of surgery.

Results: Among patients without history of solid organ malignancy undergoing thoracolumbar fusion, BMP was used in 9,593 patients and not used in 193,713. In the propensity matched group, 1.5% of the BMP group developed solid organ malignancy following surgery compared to 1.9% of the non-BMP group. The odds ratio (OR) of developing solid organ malignancy after BMP exposure was 0.80 (95% CI 0.64-1.00); P=0.056. Among patients without history of hematopoietic malignancy undergoing thoracolumbar fusion, BMP was used in 9,913 patients and not used in 191,006 patients. In the propensity matched group, 0.3% of the BMP group developed hematopoietic malignancy compared to 0.5% of the non-BMP group. The OR of developing hematopoietic malignancy after BMP exposure was 0.69 (95% CI 0.44-1.07); P=0.12.

Discussion/Conclusion: BMP use in a large patient population undergoing thoracolumbar fusion was not associated with increased risk of new malignancy. Limitations of this study include its dependence on accurate documentation and coding. However, for the subset of patients who had clear documentation of BMP use, this study further supports emerging data on the lack of a causal relationship between BMP use and malignancy.
Outcomes of Indirect versus Direct Decompression in Single-Position Surgery

Ant Fares, MD1, Walia Arnaav, BA1, Perrier Gregory, BS1, Bono Julianna, BS1, O’Connell Brooke, MS2, Burapachaisri Aonnicha, BS1, Patel Hershil, BS1, Kim Nathan, BS1, Maglaras Constance, PhD2, Raman Tina, MD1, Protospsaltis Themistocles, MD4

1 NYU Langone Department of Orthopedic Surgery, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 4 Department of Orthopedic Surgery, NYU Langone Health, New York, New York, United States

Background/Introduction: Single-position surgery (SPS) generally involves anterior lumbar interbody fusion (ALIF) or lateral lumbar interbody fusion (LLIF) and posterior fixation performed in the lateral position, or ALIF and posterior fixation performed in the prone position. The role of direct decompression in SPS has been less widely examined, and there is a paucity of data on outcomes and complications related to performing a direct decompression without repositioning.

Materials/Methods: This was a retrospective analysis of 82 patients ≥18 years with radiculopathy or neurogenic claudication undergoing lateral or prone ALIF, and LLIF with bilateral PSF in the same position, with minimum 90-day follow up. Of the 82 patients, 16(20%) underwent direct decompression without repositioning. The degree of stenosis was determined by measuring the cross-sectional area of the foramina and spinal canal on MRI and CT. Outcomes assessed included neurological deficits, perioperative complications, unplanned reoperation, and resolution of neurologic symptoms.

Results: 82 SPS patients were included: direct decompression (n=16, Age: 64.0±9.0, BMI: 28.2±4.0) and indirect decompression (n=66, Age: 60.0±9.7, BMI: 30.9±5.8). There was no difference in patient characteristics or degree of central and foraminal stenosis as measured on preoperative imaging, between the two groups. There was a higher rate of durotomy in those that received a direct decompression (n=1, 6.3%) compared to those that did not (n=0, 0%, p=0.041). In the post-operative period, the direct decompression group experienced a higher rate of hip flexor weakness (n=4, 33.3%) and motor deficit (n=3, 25%) compared to the indirect decompression group (n=5, 8.1%, p=0.014; n=3, 4.8%, p=0.02 respectively). However, the difference in motor deficit ceased to be significant by 3-months. Patients that had a direct decompression had significantly less leg pain, assessed by VAS score, at 3-months (0.33±0.5) and 1-year (0.29±0.49) compared to those that had an indirect decompression (3-month: 1.35±2.3, p=0.01; 1-Year: 1.6±2.4, p=0.002).

Discussion/Conclusion: The rate of durotomy and immediate post-operative neurological deficit was higher in patients for whom a direct decompression was performed during SPS. At 90 days however, deficits resolved in the direct decompression group. Patients who undergo direct decompression experience less leg pain at 3-months and 1-year compared to those who undergo indirect decompression alone. The acceptable complication profile in this study may support a
direct decompression in patients whose radiculopathy symptoms are severe and debilitating preoperatively.
Bundled Payments in Spine Surgery

Glass Natalie, PhD\textsuperscript{1}, Pugely Andrew, MD\textsuperscript{2}, Stolley Mary, MS, RN\textsuperscript{1}, Hall Ben, MBA\textsuperscript{1}, Eisenberg Joshua, MD\textsuperscript{2}, Kesler Kyle, MD\textsuperscript{1}, Olinger Catherine, MD\textsuperscript{1}, Bell Ashley, BS\textsuperscript{1}
\textsuperscript{1}University of Iowa Hospitals and Clinics, Iowa, Iowa, United States, \textsuperscript{2}Department of Orthopedics and Rehabilitation, University of Iowa, Iowa, Iowa, United States

Background/Introduction: Centers for Medicare and Medicaid (CMS) Bundle Payment Care Initiative Advanced (BPCI-A) is a single, retrospective bundled payment model covering 90-day clinical episodes that was developed to improve patient outcomes/reduce patient costs. Our center instituted care delivery improvements prior to BPCI-A participation including weekly multi-disciplinary stakeholder meetings, assignment of full-time nurse care coordinator for BPCI-A patients and alignment of orthopedic/neurosurgery service lines. The purpose of this study was to compare performance of BPCI-A during year one of participation against medicare claims data before BPCI-A participation.

Materials/Methods: Medicare claims/medical record data from spine surgeries with diagnosis related group (DRG) of cervical spine surgery (C\_PSF, 471,472,473), lumbar spinal fusion (L\_PSF, 459-460) or lumbar decompression/discectomy (Decomp, 518, 519, 520) were collected. Patient and surgery characteristics, 90-day ED or readmission rates and total costs were compared between patients with surgeries prior to BPCI-A participation (pre-BPCI: 1/1/13-11/30/17) and those from year one of BPCI-A participation (BPCI: 10/1/18-9/30/19).

Results: Analyses included 358 pre-BPCI and 82 BPCI patients. There were no significant differences in 90-day ED utilization (Pre-BPCI: 26.5\%, BPCI: 30.2\%, $p=0.551$) between pre-BPCI vs BPCI patients, but there was a slight reduction in 90-day readmissions (Pre-BPCI: 26.8\% vs BPCI: 15.9\%) that did not reach statistical significance ($p=0.065$). The number of post-discharge readmissions per patient significantly decreased after BPCI ($p=0.039$). Analyses adjusted for service line, patient admission type and comorbidities (CCI score) yielded similar results for 90-day ED utilization, but greater odds of readmission in the pre-BPCI group vs BPCI patients (OR=2.53, 95\%CI=1.14-5.58, $p=0.022$). There was a significant increase in total episode costs in BPCI vs pre-BPCI patients (mean=$10,549, 95\%CI=$4,814-$16,284, $p<0.0001$) with significantly higher anchor visit costs ($6,803, 4,160-9,446, p<0.000$) but no differences in post anchor visit costs ($3,709, 0-8,933, p=0.122$).

Discussion/Conclusion: Spine bundled payments (BPCI-A) at a large academic medical center presented significantly lower readmission rates, but no cost savings. Alignment of stakeholder interests via a bundled payment framework may mobilize additional health system resources to improve outcomes.
Paper 43

Social Vulnerability is an Important Contributor to Racial Disparities in the Safety of Spine Surgery

Engler Ian, MD1, Vasavada Kinjal, BA2, Vanneman Megan, PhD, MPH3, Schoenfeld Andrew, MD4, Martin Brook, PhD, MPH5
1 University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States, 2 Tufts University School of Medicine, Boston, Massachusetts, United States, 3 University of Utah, Salt Lake City, Utah, United States, 4 Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, 5 University of Utah Orthopaedic Center, Salt Lake City1, Utah, United States

Background/Introduction: People of color in the United States have an increased risk for delayed surgery, complications, readmissions, and mortality following spine surgery. The contribution of the Center for Disease Control’s community-level Social Vulnerability Index (SVI) as a social determinant of racial disparities in the safety of spine surgery is unknown.

Materials/Methods: We performed a retrospective analysis of Medicare claims from 2015-2017 to identify racial differences in the rates of mortality, readmission, and complications among patients undergoing spine surgery. We included fee-for-service beneficiaries aged 65 or older with a hospital Diagnosis Related Group (DRG) code for spinal surgery as defined by Medicare. Our primary independent variable was race, which was coded as “black” (Black or African American), “white” (white or Caucasian), and a combined “other” (includes other, Asian, Hispanic Ethnicity, and North American Native). The SVI reflects community disadvantage at the U.S. Census Tract level in socioeconomic, household composition and disability, minority and language, and housing and transportation domains. Logistic regression and propensity-matched analyses adjusted for age, sex, comorbidities, and spine cohort were used to calculate the percentage of disparities between black and white patients explained by SVI.

Results: A total of 209,137 Medicare beneficiaries were included in this analysis, with 89.8% white and 5.6% black. Unadjusted rates of surgical safety measures among black and white patients, respectively, were 2.3% and 1.7% for mortality, 17.1% and 14.4% for readmission, 22.3% and 18.6% for complications without associated readmission, and 27.2% and 25.1% for complications with readmission. Logistic regression and propensity-matched analyses without factoring in SVI showed significantly increased rates of mortality, readmission, and complications in black patients compared to white patients. Adding SVI into the models explained 9.4-28.6% of the difference in safety measures between black and white patients, depending on the measure. Most notably, SVI explained 20.0-28.6% of the disparity in mortality rates between black and white patients.

Discussion/Conclusion: Social vulnerability explains up to nearly 30% of the racial health disparities in safety measures between black and white Medicare beneficiaries following spine surgery. Policies to support vulnerable communities may lead to a meaningful reduction in racial health disparities.
Paper 44

Telemedicine Improves Access to Care for Spine Patients with Low Socioeconomic Status

Ye Ivan, BS¹, Thomson Alexandra, MD¹, Miseo Vincent, MD¹, Jauregui Julio, MD¹, Cavanaugh Daniel, MD¹, Koh Eugene, MD, PhD¹, Gelb Daniel, MD¹, Ludwig Steven, MD¹
¹ University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore, Maryland, United States

Background/Introduction: The incorporation of telemedicine into the post-COVID-19 pandemic spine practice remains unclear. The objective of this study is to compare the likelihood of missing an appointment between scheduled telemedicine visits and in-person appointments for spine patients of varying socioeconomic status.

Materials/Methods: Patients with scheduled outpatient appointments with the orthopaedic spine division between 2019 and 2021 were retrospectively evaluated. Patients were divided into the two cohorts by appointment type: telemedicine visit (N=4,387) and in-person appointment (N=3,810). Home addresses were used to calculate the Area Deprivation Index (ADI), a validated measure of socioeconomic status reported as a percentile with 100 representing the most disadvantaged neighborhood. ADI was also stratified into low (<25), medium (25-75), and high (>75) levels of deprivation. The primary outcome measure was missed clinic appointments, which was defined as having at least one appointment that was cancelled or labeled as ‘no show’. Statistical analysis included Student’s T-test or Wilcoxon’s rank-sum test for continuous variables and Chi-square analysis for categorical variables.

Results: Patients with in-person appointments were significantly more likely to miss an appointment compared with patients with telemedicine visits (51% versus 25%, p<0.001). Patients with high ADI were also more likely to miss in-person appointments than patients with medium and low ADI (60% versus 52% and 48%, p<0.001). However, there was no significant difference in the likelihood of missing a telemedicine visit between patients with high, medium, and low ADI (28% versus 25% versus 24%, p=0.294). Patients who missed an appointment were 42% more likely to be high ADI (OR 1.42, 95% CI 1.20-1.68, p<0.001) and 13% more likely to be medium ADI (OR 1.13, 95% CI 1.03-1.26, p=0.015) and compared with patients with low ADI.

Discussion/Conclusion: Patients with low socioeconomic status were more likely to miss in-person appointments than patients of higher socioeconomic status. However, there was no difference in the likelihood of missing a telemedicine appointment among patients of different socioeconomic status, suggesting that telemedicine may aid in reducing the barriers to healthcare access. Spine surgeons should consider offering telemedicine as an option to patients, particularly those with low socioeconomic status.
Paper 45

Changes in Plasma Cytokine Markers are Predictive of Persistent Postsurgical Pain Following Complex Spine Surgery

Chilakapati Sai, MS¹, Adogwa Owoicho, MD², Burton Michael, PhD³
¹ University of Texas Southwestern Medical Center, Dallas, Texas, United States, ² University of Cincinnati College of Medicine, Cincinnati, Ohio, United States, ³ The University of Texas at Dallas, Richardson, Texas, United States

Background/Introduction: Spine surgery in older adults is beneficial and often results in decreased pain. However, in a subset of older adults, surgical outcomes are less desirable, with up to 20% experiencing persistent postsurgical pain (>3 months). The physiological mechanisms underlying persistent post-surgical pain remain unclear. An emerging hypothesis focuses on the immune system’s interplay with the nervous system wherein immune responses modulate the excitability of pain pathways, eventually driving chronic pain hypersensitivity. The aim of this study was to correlate immune activity with postoperative pain states by analyzing cytokine levels following complex spine surgery.

Materials/Methods: 15 patients undergoing complex spine surgery for adult spinal deformity were enrolled in this study. Whole blood samples were collected at three timepoints: preoperatively (Pre-Op), postoperative day 0 (POD0), then at postoperative day 3 (POD3). Plasma was isolated using Ficoll density centrifugation. Plasma IL-4, IL-6, IL-8, IL-10, IL-22, TNF-α were measured using a Quanterix Multi-Plex cytokine assay. Pearson correlation and linear regression models were used to assess the association between cytokine profile and patient reported pain outcomes at 3 months (VAS Back and PROMIS pain scores).

Results: Compared to baseline there was a 2.7-fold and 5-fold increase in IL-6 at POD0 and POD3, respectively (p<0.01). There were no statistically significant differences in other cytokines expression levels following surgery. On linear regression analysis, increase in IL-6 levels from baseline to POD3 were correlated with increased opioid utilization on POD3. At 3-months, cytokine expression levels in IL-6, IL-10, and TNF-α at POD0 were inversely correlated with 3-month VAS Back Pain scores and PROMIS scores.

Discussion/Conclusion: Following spine surgery, patients exhibited a robust increase in IL-6, a pro-inflammatory cytokine. Patients with higher pain scores at 3-months postoperatively had a more blunted immune response immediately after surgery (POD0). Further biochemical and ex-vivo studies are needed to fully characterize immune response to surgery.
Sex Differences in Response to Recombinant Human Bone Morphogenetic Protein-2 (rhBMP-2) in a Rat Posterolateral Fusion Spine Model

Lanzetta Nicholas, BS1, Furman Andrew, MBA1, Linton Alexander, BS1, Foley James, MD2, Fred Elianna, BS3, Wintring Allison, BS2, Plantz Mark, MD2, Patwardhan Avinash, PhD4, Stock Stuart, PhD5, Hsu Wellington, MD2, Hsu Erin, PhD2, Phan Eileen, BA2

1 Northwestern University Department of Orthopaedic Surgery, Chicago, IL, United States, 2 Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States, 3 Northwestern University, Feinburg School of Medicine, Chicago, Illinois, United States, 4 Loyola University of Chicago, Maywood, Illinois, United States, 5 TO BE FIXED

Background/Introduction: Estrogen modulates bone activity largely through inhibition of osteoclast bone resorption and bone morphogenetic protein-2 (BMP-2) signaling pathways in osteoblasts. Minimal data exist concerning potential sex-dependent differences in BMP-2-mediated bone regeneration. Here, we aimed to quantify sex-dependent differences in the bone healing response to recombinant human BMP-2 (rhBMP-2) treatment in a rat posterolateral spinal fusion model.

Materials/Methods: Forty-eight female and male Sprague-Dawley rats (N=24/group), underwent L4-L5 posterolateral fusion with bilateral placement of recombinant human BMP-2 (rhBMP-2) implants. At 8 weeks post-operatively, spines were evaluated for mobility and bone fusion by range of motion (ROM), blinded manual palpation, and microCT. Adipocyte concentration quantification was accomplished by counting adipocytes in equally sized fields of view on histological imaging.

Results: Males had significantly higher rates of fusion compared to females when assessed by manual palpation. ROM was significantly greater and more variable for females versus males. microCT showed fine bone structures developing in both sexes at the 8 week time point. In females, there was significantly smaller total volume of fusion masses, but significantly higher bone volume fraction when compared to males. Mean trabecular thickness was not different, but trabecular number was significantly greater in females. Adipocyte concentration quantification showed a higher adipocyte concentration in males versus females.

Discussion/Conclusion: This study demonstrates that sex-based factors may influence both the quantity and quality of bone formation in patients receiving rhBMP-2 for a variety of orthopaedic applications. We found that male rats had significantly higher fusion scores, greater fusion-mass volume, and lower ratio of new bone volume to total volume as well as greater adipocyte concentration compared to female rats. Male and female mean trabecular thicknesses were equal, but the female fusion masses were more densely filled with trabeculae (higher trabecular number) than those of males. Incomplete fusions on three female rats, evidenced by high ROM and small gaps on microCT, suggest that females may have a more variable response to rhBMP-2. Investigation into whether these sex-based differences are specific to rhBMP-2-induced bone formation or are more general to bone regeneration/healing is prudent.
Paper 47

Changes in Plasma Pro-inflammatory Cytokines Robustly Predict Risk for Postoperative Delirium Following Complex Spine Surgery

Chilakapati Sai, MS1, Adogwa Owoicho, MD2, Burton Michael, PhD3
1 University of Texas Southwestern Medical Center, Dallas, Texas, United States, 2 University of Cincinnati College of Medicine, Cincinnati, Ohio, United States, 3 The University of Texas at Dallas, Richardson, Texas, United States

Background/Introduction: Postoperative delirium is a common complication among adults following spine surgery. Older age, pre-existing cognitive decline, and duration of surgery are important clinical risk factors. However, the underlying physiological mechanisms of delirium following spine surgery are unclear. Understanding the robust inflammatory response after spine surgery may elucidate any mechanistic links to developing postoperative delirium. The aim of this study was to correlate postoperative inflammation and delirium by analyzing cytokine levels following spine surgery among patients with and without postoperative delirium.

Materials/Methods: 15 patients undergoing complex spine surgery for adult spinal deformity were enrolled in this study. Whole blood samples were collected at three timepoints: preoperatively (Pre-Op), postoperative day 0 (POD0), then at postoperative day 3 (POD3). Plasma was isolated using Ficoll density centrifugation. Plasma IL-4, IL-6, IL-8, IL-10, IL-22, TNF-α were measured using a Quanterix Multi-Plex cytokine assay. Pearson correlation and linear regression models were used to assess the association between cytokine profile and postoperative delirium.

Results: Three of fifteen patients (20%) developed delirium postoperatively. Patients with delirium had higher levels of IL-8 on POD3 and higher levels of TNF-α on both POD0 and POD3 (P<0.05). On linear regression, POD0 and POD3 TNF-α levels accounted for over 70% of the variance in predicting delirium and remained statistically significant after controlling for age, sex, BMI, and comorbidities. Patients with delirium also had increased IL-6 on both POD0 and POD3, however the difference was not statistically significant. Changes in anti-inflammatory cytokines were not correlated with delirium.

Discussion/Conclusion: Following spine surgery, patients with delirium exhibited an increase in the pro-inflammatory cytokines IL-8 and TNF-α. These findings suggest an underlying persistent inflammatory response in patients who develop delirium postoperatively. Further biochemical and ex-vivo studies are needed to fully characterize changes to the immune response after surgery in patients with delirium.
Paper 48

Percutaneous delivery of Recombinant Human Bone Morphogenetic Protein-2 augments fusion in a nicotine-impaired rabbit fusion model

Virk Sohrab, MD¹, Vaishnav Avani, MBBS², Qureshi Sheeraz, MD³
¹ North Shore University/Long Island Jewish Medical Center, Great Neck, , United States, ² Hospital for Special Surgery, New York, New York, United States, ³ Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States

Background/Introduction: Several experiments have shown that delivery of Bone Morphogenetic Protein-2 (BMP-2) in a delayed fashion from initial surgery may allow for optimal bone growth. Studies of posterolateral spinal fusion in rabbits have shown that BMP-2 expression physiologically peaks from 4-6 weeks out from surgery. The hypothesis of this experiment was that delayed delivery of absorbable collage sponge/BMP-2 (ACS/BMP-2) would augment bone growth in a rabbit spine fusion model. There is a high rate of fusion associated with any BMP use in rabbits, therefore we wanted to inhibit overall bone growth within our model by utilizing an established nicotine pseudarthrosis rabbit spinal fusion model. By percutaneously delivering ACS/BMP-2 we would be able to deliver osteoinductive material at an optimal time point away from the typical time of surgery application and have increased bone formation as compared to a control group of rabbits.

Materials/Methods: 16 male one year old rabbits underwent a posterolateral spinal fusion with iliac crest bone graft at L5-L6 while being given nicotine to prevent spinal fusion as previously published. 8 were controls while 8 had morselized RhBMP-2 (4.2mg) injected at the fusion site at 4 weeks post-operatively. At 12 weeks rabbits were sacrificed. Histologic, radiologic (radiographic, CT scans) and palpation examinations were performed to determine fusion status and the volume of bone formed. Hematoxylin and eosin (H&E) and mallory aniline blue (MAB) stains were used for histology. A student’s t-test was used to compare the CT scan measured volume of bone created between control (CC) and RhBMP-2 delayed delivery cohorts (BMP-DDC).

Results: 7/8 rabbits in the BMP-DDC and 5/8 rabbits in the CC formed definitive fusion with a positive palpation exam, bridging bone between transverse processes on CT scan and a grade of 3 on the Daffner X-ray fusion scale. Histologic analysis revealed new remodeled bone within the BMP-DDC. There was increased average volume of bone formed within the BMP-DDC vs the CC (22.6±13.1 cm^3 vs 11.1±3.6 cm^3, p=0.04)

Discussion/Conclusion: Our study shows that injectable morselized ACS/RhBMP-2 can create twice as much bone within a nicotine-impaired rabbit spine fusion model when delivered 4 weeks out from time of surgery.
Clinical and Patient Reported Outcomes in Revision Lumbar Spinal Fusion Compared to Primary Surgery

Toci Gregory, BS¹, Lambrechts Mark, MD², Siegel Nicholas, BS², D’Antonio Nicholas, BS¹, Lambo Dominic, 1, Karamian Brian, MD², Canseco Jose, MD, PhD², Hilibrand Alan, MD², Kepler Chris, MD³, Vaccaro Alexander, MD, PhD, MBA², Schroeder Gregory, MD³
¹ Rothman Institute, Thomas Jefferson University Hospital, Philadelphia, Pennsylvania, United States, ² Rothman Institute at Thomas Jefferson University, Philadelphia, Pennsylvania, United States, ³ Department of Orthopaedic Surgery, Rothman Institute, Thomas Jefferson University, Philadelphia, Pennsylvania, United States

Background/Introduction: Common indications for revision lumbar procedures include recurrent stenosis, adjacent segment disease (ASD), and pseudarthrosis. Outcomes comparing revision lumbar fusion to primary fusion are lacking in the literature. We therefore categorized patients based on primary versus revision lumbar fusion and analyzed their patient reported outcome measures (PROMs).

Materials/Methods: Patients undergoing lumbar spinal fusion from 2017 to 2021 were identified. Patients were grouped based on primary versus revision status and then subgrouped based on their surgical indication (diagnosis). Statistical tests compared patient demographics, surgical characteristics, and clinical outcomes between groups. Multivariate regression analysis examined for changes in postoperative minus preoperative (delta) PROMs while controlling for age, sex, BMI, and number of levels fused.

Results: Of 2,411 lumbar spinal fusions, 576 were revision procedures (23.9%). Preoperative indications for revision included recurrent stenosis (74.3%), deformity (22.9%), instability (33.9%), adjacent segment disease (3.99%), and pseudarthrosis (18.1%). Patients underwent a revision procedure on average 6.79 (±8.86) years from their primary operation, 86.7% of which were performed at our institution and 57.6% were by the same surgeon. Based on indication, patients undergoing revision surgery for deformity or pseudarthrosis had significantly higher operative duration, length of stay, and levels fused (all, p<0.001), but there were no differences in hospital readmissions or patient reported outcome measures. Compared to primary procedures, revisions had higher ASA (2.47 vs. 2.40, p=0.002), operative duration (277 minutes vs. 238 minutes, p<0.001), levels fused (2.88 vs. 1.87, p<0.001), and intraoperative dural tear rates (21.2% vs. 13.6%, p<0.001). On univariate analysis, patients undergoing revision fusions had significantly worse preoperative, one-year postoperative, and delta PROMs (Table 1). On multivariate analysis, revision fusions were predictors of decreased improvement in Δ VAS Back (β=0.98, p=0.015), Δ MCS-12 (β =-3.52, p=0.012), and Δ PCS-12 (β =-2.62, p=0.043).

Discussion/Conclusion: There were no differences in clinical outcomes based on indication for revision surgery. Patients undergoing revision surgery had a higher rate of intraoperative dural tear but no differences in length of stay or hospital readmission compared to primary procedures. Revision surgery predicted decreased improvement in Δ VAS Back, Δ MCS-12, and Δ PCS-12 compared to primary surgery.
Incidence and Cost Trends of Interlaminar and Transforaminal Epidural Steroid Injections for Neurological Claudication, Radiculopathy, and Sciatica Patients and Their Conversion to Lumbar Fusion or Decompression Surgery

Fresquez Zoe, BS¹, Buser Zorica, PhD², Cheng David, MD², Ornelas Christopher, MD², Tekmyster Gene, DO²

¹Department of Orthopaedic Surgery, Keck School of Medicine, University of Southern California, Los Angeles, California, United States, ²University of Southern California Keck School of Medicine, Los Angeles, California, United States

Background/Introduction: Low back pain is one of the leading causes of disability worldwide and poses a significant economic and societal burden.[1-7] Epidural steroid injection using an interlaminar (ILESI) or transforaminal (TFESI) approach is often used to treat symptoms of neurological claudication, radiculopathy, and/or sciatica, with or without axial low back pain.[4-7] This study aims to delineate trends in incidence of ILESI and TFESI for patients with those pathologies, the conversion rate to lumbar fusion or decompression alone, and the average cost of these procedures.

Materials/Methods: A PearlDiver database containing insurance data from 90,772,632 patients was used. International classification of diseases 9 and 10 (ICD-9 and ICD-10) codes queried patients with spinal pathologies of interest. Current procedural terminology (CPT) codes limited this group to ILESI or TFESI patients who received either a single injection or a second injection within 6 months. These groups were subdivided into those who did or did not have a lumbar fusion or decompression surgery within two years of their last injection.

Results: Of 194,892 ILESI patients, 1.47% (n=2,861) had a fusion within two years of their first injection and 1.58% (n=3,077) of their second injection. 2.35% (n=4,587) had a decompression surgery alone within two years of their first injection and 2.26% (n=4,395) of their second injection. Of 239,716 (TFESI patients, 2.05% (n=4,904) had a fusion within two years of their first injection and 1.96% (n=4,704) of their second injection. 3.54% (n=8,477) had a decompression alone within two years of their first injection and 3.36% (n=8,060) of their second injection. The most common age group for ILESI patients was 70-74 years old (13.15%) and 60-64 for TESI patients (12.59%). 119,753 (61.45%) ILESI and 140,551 (58.63%) TFESI patients were female. Average ECIs for a single injection were 4.12 and 3.76 for interlaminar and transforaminal patients respectively, average ECIs for patients who received a second injection were 4.13 and 3.86 respectively.

Discussion/Conclusion: The majority of ILESI and TFESI patients who receive one or two injections do not go on to have a lumbar fusion or a decompression surgery. The incidence of ILESI and TFESI increased from 2010-2018.
Motorized Hinged Operating Table Facilitated Sagittal Correction after Spinal Osteotomies using Smith-Peterson Osteotomies and Transforaminal Lumbar Interbody Fusion

Holton Kenneth, MD¹, Soriano Paul, MD², Sembrano Jonathan, MD², Martin Christopher, MD², Jones Kristen, MD³, Hendrickson Nathan, MD, MS¹, Polly, Jr David, MD²

¹ University of Minnesota, Minneapolis, Minnesota, United States, ² University of Minnesota, Department of Orthopaedic Surgery, Minneapolis, Minnesota, United States, ³ University of Minnesota, Department of Neurosurgery, Minneapolis, Minnesota, United States

Background/Introduction: Sagittal alignment has shown increasing importance in health related quality of life. Osteotomies allow restoration of appropriate sagittal alignment, but closure of osteotomies can be challenging. Typical closure involves applying forces to pedicle screws, but this loading potentially causes early loosening and early failure. A motorized hinged table has been used at our center to assist with closure of spinal osteotomies. The amount of correction delivered by table angular change versus instrumentation manipulation has not been well quantified.

Materials/Methods: Patients undergoing a SPO or TLIF using the motorized hinged table (Mizuho ProAxis) were prospectively studied. Patients were positioned prone on the motorized hinged table and flexed to 10° for decompression and TLIF. The table was extended in 5° increments and radiographs taken until 10° of extension is achieved (Figure 1). Segmental lordosis change across the operative site for each 5° increment was measured.

Results: 33 patients were available for analysis. Table extension from +10° to +5° yielded 2.3° segmental lordosis change (n=33); +5° to 0° yielded 1.5° segmental lordosis change (n=33); 0° to -5° yielded 1.5° segmental lordosis change (n=29); -5° and -10° yielded 1.5° segmental lordosis change (n=23). Rod placement yielded an additional 3.2° of segmental lordosis.

Discussion/Conclusion: Intraoperative fluoroscopy showed correlation between table extension and segmental lordosis correction. Utilizing a motorized hinged table facilitates controlled osteotomy closure and decreases the need for cantilevering forces across spinal instrumentation. After the TLIF with SPO is performed, approximately 7° of additional segmental lordosis correction can be acquired from 20° of intraoperative table extension.
Poster 04

Closed Incision Negative Pressure Therapy Reduces Incidence of Surgical Site Infection After Spinal Surgery

Ridolfi Dominic, BS\textsuperscript{1}, Oyekan Anthony, MD\textsuperscript{1}, Zheng Aaron, BS\textsuperscript{1}, Ramraj Raghav, BS\textsuperscript{1}, Mirvish Asher, BS\textsuperscript{1}, Couch Brandon, MD\textsuperscript{1}, Gannon Emmett, MD\textsuperscript{2}, Shaw Jeremy, MD, MS\textsuperscript{1}, Donaldson William, MD\textsuperscript{1}, Lee Joon, MD\textsuperscript{1}

\textsuperscript{1} University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States, \textsuperscript{2} University of Nebraska Medical Center, Omaha, Nebraska, United States

Background/Introduction: Surgical site infections (SSIs) remain a prevalent complication following spine surgery. In some cases, SSIs require re-operations associated with significant morbidity and resource utilization. Closed incision negative pressure therapy (ciNPT) has emerged as a potential tool for reducing the incidence of SSIs, but evidence has been limited to smaller studies.

Materials/Methods: A retrospective review of a prospectively collected database was performed with the University of Pittsburgh Institutional Review Board approval. All patients who underwent spine surgery with ciNPT performed by two fellowship-trained spine surgeons at a single institution between July 2017 to July 2021 were included. An age and gender-matched cohort of spine surgery patients treated by the same surgeons with traditional dressings between June 2020 to July 2021 were included for comparison. Patients less than 90 days since surgery or pre-operative spinal infection were excluded. Chi-square analysis was used to determine differences in gender and procedure indication (primary vs. revision operation). Two-tailed unpaired t-tests were used to identify differences in continuous variable demographics and complication rate. \(p < 0.05\) was considered statistically significant.

Results: Nine hundred and six subjects (453 M, 453 F; age 57 ± 14 years) were identified. ciNPT patients (\(n = 498\), 249 M, 249 F; age 57 ± 14 years, BMI 31.21 ± 7.53, CCI 1.6 ± 1.0) when compared to traditional dressing patients (\(n = 408\), 204 M, 204 F; age 57 ± 15 years, BMI 30.34 ± 5.53, CCI 1.2 ± 0.8) had reduced incidence of wound complication requiring revision (1.20% vs. 3.19%, \(p = 0.048\)) and wound infection requiring revision (0.40% vs 1.96%, \(p = 0.036\)) within 90 days despite increased BMI (\(p = 0.042\)) and no other differences in co-morbidities or surgical indication (\(p > 0.05\)).

Discussion/Conclusion: Closed incision negative pressure therapy may be an effective tool for reducing the incidence of spine surgery revision due to wound complication or infection. A cost analysis is needed to ascertain the financial implications of this finding.
Vertebral Bone Quality (VBQ) Score may be Useful in Recognizing Patients at Risk for Secondary Fracture After Vertebroplasty

Kadri Aamir, MS¹, Liu Daniel, ¹, Binkley Neil, MD¹, Ross Andrew, MD², Anderson Paul, MD¹
¹ University of Wisconsin-Madison, Madison, Wisconsin, United States, ² University of Wisconsin Madison School of Medicine and Public Health, Madison, Wisconsin, United States

Background/Introduction: Vertebral compression fractures (VCF) are common in patients age > 50. Vertebroplasty is an effective treatment, but there is a high risk of secondary fracture due to low bone mineral density (BMD). The vertebral bone quality (VBQ) score is a quantitative tool using lumbar magnetic resonance imaging (MRI) to estimate bone quality. The purpose of this study was to determine the prevalence of elevated VBQ in vertebroplasty patients and whether high VBQ may be helpful in identifying patients at risk for secondary fracture.

Materials/Methods: From January 2016-January 2021, 60 patients who underwent vertebroplasty following a compression fracture due to low BMD and had T1-weighted lumbar MRI were included. VBQ was calculated as the quotient of the median signal intensity from L1-L4 over the L3 CSF, with an elevated score defined as VBQ > 3.0. Secondary fracture included fracture at any site after the index vertebroplasty procedure. Time-to-event analysis was performed to determine secondary fracture occurrence.

Results: The mean (SD) age was 73.7 (10.1), BMI was 28.7 (6.3), and 57% were female. The mean VBQ with and without the level of compression fracture was 3.40 and 3.44, respectively, and was not significantly different (p=0.401). VBQ was elevated in 68.3% of all patients and 85% with secondary fracture. Secondary fracture occurred in 33.3%, most often at another vertebrae (55%). Most secondary fracture occurred after 60 days of the index procedure (71%). Based on time-to-event analysis, secondary fracture occurred more often in elevated compared to low VBQ (Figure 1).

Discussion/Conclusion: There is a high prevalence of elevated VBQ in patients undergoing vertebroplasty, with most who sustained secondary fracture having a high VBQ. Vertebral compression fracture does not appear to affect the VBQ. Most secondary fracture occurred after 60 days from the index procedure, suggesting that these fractures may be avoidable with early initiation of medical therapy. Utilizing the VBQ to identify patients with potential poor bone quality may help guide this management. Secondary fracture occurs earlier and more often in those with an elevated VBQ, suggesting that high VBQ may be helpful in identifying patients at risk for secondary vertebral compression fracture.
Should Patients with Lumbar Stenosis and Grade I Spondylolisthesis Be Treated Differently Based on Spinopelvic Alignment? A Comparison of Patient-Reported Outcome Measures and Clinical Outcomes from Multiple Sites Within a Single Health System

Mohanty Sarthak, BS¹, Kadiyala Manasa, BS¹, Barchick Stephen, MD², Rouhi Armaun, BA³, Lad Meeki, BS⁴, Vadali Chetan, ², Khalsa Amrit, MD², Saifi Comron, MD³, Casper David, MD²
¹ University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, United States, ² University of Pennsylvania, Philadelphia, Pennsylvania, United States, ³ Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, United States, ⁴ Rutgers New Jersey Medical School, Newark, New Jersey, United States, ⁵ Houston Methodist Orthopedics & Sports Medicine, Houston, Texas, United States

Background/Introduction: Degenerative spondylolisthesis of the lumbar spine is one of the most common pathologies addressed by surgeons. Recently, high-level data demonstrated improved outcomes with fusion in conjunction with laminectomy compared to laminectomy alone when addressing this problem. While these studies have adjusted results for possible confounders, degree listhesis, flexion-extension movement, and disc height, this is the first analysis to examine the effect of spinopelvic alignment on patient reported outcomes following decompression alone versus decompression and fusion.

Materials/Methods: The study constituted a sub-group analysis of an observational prospective cohort study. Patients underwent laminectomy alone or laminectomy with instrumented fusion for degenerative grade I lumbar spondylolisthesis and stenosis. Four cohorts were created based on pelvic incidence minus lumbar lordosis (PILL): (1) fusion with PILL>10°, (2) fusion with PILL<10°, (3) decompression alone with PILL >10°, and (4) decompression alone with PILL <10°. Primary outcome was the change in Patient-Reported Outcome Measurement Information System (PROMIS), Global Physical Health (GPH), and Global Mental Health (GMH) scores at baseline and post-operatively at 6 and 12 months. The between-group comparisons of PROMIS GPH/GMH score changes were analyzed using mixed-effects models. Analyses were conducted independently for the following: (1) unmatched cohort, (2) 1:1 propensity score matched patients(PSM), (3) coarsened exact matched(CEM) patients.

Results: 49.9% (339) underwent lumbar decompression with fusion, while 50.1% (340) received decompression. When comparing low spinopelvic mismatch (PILL<10°) patients, those with fusion had worse PROMIS GMH (18.67 vs 21.52, p<0.0001) and GPH (16.08 vs 20.74, p<0.0001) scores at 10-12 months; mixed effect modeling confirmed GPH score improvement was 4.09 [1.36 – 6.82] points lower at 10-12 months in the fusion group. When comparing high spinopelvic mismatch (PILL>10°) patients, fusion-treated patients had improved postoperative PROs (GMH: 26.61 vs 20.75, p<0.0001; GPH: 23.61 vs 18.13, p<0.0001) at 10-12 months. Mixed effect modeling confirmed GPH score improvement was 5.11 [2.08 – 8.13] points higher at 10-12 months in the fusion group (Figure 1).

Discussion/Conclusion: Among patients with degenerative grade I spondylolisthesis, the addition of lumbar spinal fusion to laminectomy was associated with greater improvement in
physical health–related quality of life than laminectomy alone only among patients with PILL>10°.
Poster 07

Results of Minimally Invasive Decompression Compared with Traditional Lumbar Microdiscectomy and Open Laminectomy

Walia Arnaav, BA1, Bono Julianna, BS1, Perrier Gregory, BS1, Ani Fares, MD1, Patel Hershil, BS2, Burapachaisri Aonnicha, BS1, Kim Nathan, BS1, Maglaras Constance, PhD3, O’Connell Brooke, MS1, Fischer Charla, MD4, Protopsaltis Themistocles, MD5, Raman Tina, MD1
1 NYU Langone Department of Orthopedic Surgery, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 3 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 4 Department of Orthopedic Surgery, NYU Orthopedic Hospital, NYU Langone Health, Albany, New York, United States, 5 Department of Orthopedic Surgery, NYU Langone Health, New York, New York, United States

Background/Introduction: Lumbar herniated disc and lumbar central stenosis are among the most common pathology requiring spine surgery, and there has been a shift towards minimally invasive methods in recent years. Very few comparative studies with homogenous cohorts of patients and long term follow up have been performed. In this regard, we sought to evaluate the impact of performing decompression with MIS technique versus standard open, in the setting of microdiscectomy and laminectomy procedures.

Materials/Methods: 460 patients ≥18 years of age who underwent primary lumbar microdiscectomy or laminectomy, using MIS or standard open technique, with 2 year follow up. Retrospective review at a single institution. Outcomes assessed include 90-day perioperative complications, unplanned return to OR, and two year revision rates.

Results: The 460 patients in this cohort underwent: 202 open laminectomies (age 66.7±12.5 BMI 29.3±5.8), 36 MIS laminectomies (age 63.8±13.1, BMI 28.8±4.7), 180 Open MLD (age 46.1±15.2, BMI 27.9±4.7) and 42 MIS MLD (age 49.6±15.1, BMI 28.0±6.0). The MIS MLD group had significant greater operative time (89.2 vs. 74.3 min, p=.004) and higher rate of 90 day return to OR (2.4% vs. 0%, p=.038) compared to open MLD. There were no significant differences in the rate of complications or unplanned return to the OR between the MIS and open laminectomy groups. There were no significant differences between the MIS and open technique for MLD and laminectomy with regards to estimated blood loss, length of stay, intra-operative complications, post-operative complications, and surgical site infection rates. At two year follow-up, no differences were seen in revision surgery rates between any of the cohorts.

Discussion/Conclusion: We report increased operative time and higher rate of unplanned return to the OR at 90 days after MIS MLD compared with open MLD. There was no difference seen in complication rates between the MIS and open laminectomy groups, suggesting that the techniques may be equivalent. At long term follow up, there was no effect on revision rates by technique utilized, MIS or open, for either MLD or laminectomy.
Impact of Time to Surgery for Workers’ Compensation Patients Undergoing MIS TLIF

Patel Madhav, BS1, Jacob Kevin, BS1, Lynch Conor, MS1, Cha Elliot, MS1, Pawlowski Hanna, BS1, Vanjani Nsheka, BS1, Prabhu Michael, BS1, Singh Kern, MD1

1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Previous literature has demonstrated that workers’ compensation (WC) patients may have significantly diminished postoperative improvement compared to the general population. Increased levels of arbitration can significantly contribute to delays in treatment for this population, but it is not clear how this may affect outcomes of spinal surgery. We aim to assess the impact of time to surgery in workers’ compensation patients undergoing minimally invasive transforaminal lumbar interbody fusion (MIS TLIF).

Materials/Methods: WC patients undergoing primary, single-level MIS TLIF were identified. Time to surgery (TTS) and duration of symptoms (DOS) were defined. PROMs were administered at preoperative/6-week/12-week/6-month postoperative timepoints and included Visual Analogue Scale (VAS) back, VAS leg, Oswestry Disability Index (ODI), and 12-Item Short Form (SF-12) physical composite score (PCS) and mental composite score (MCS). Patients were grouped by TTS: <90 days, 90-179 days, ≥180 days. Demographics were compared by chi squared test. Perioperative characteristics, mean PROMs, and postoperative improvement (ΔPROM) were compared using one-way ANOVA. MCID achievement rates were calculated with simple logistic regression. A secondary analysis was performed by grouping patients by DOS: <180 days, 180-364 days, ≥365 days. Mean PROMs, ΔPROMs, and MCID achievement were similarly compared between DOS groups using one-way ANOVA and logistic regression.

Results: 193 patients were included. Prevalence of HNP and initial appointment type were significantly associated with TTS (p < 0.042, all). No significant differences in mean PROMs or ΔPROMs were observed among TTS groups (Table 1). MCID achievement was significantly lower for VAS back at 6-months in the longest TTS group (p = 0.018). Mean PROM scores were significantly different based on DOS for VAS leg at 6-weeks only (p = 0.029). MCID achievement was significantly lower for the longest DOS group for VAS leg at 6-months only (p = 0.043). ΔPROM did not significantly differ among DOS groups.

Discussion/Conclusion: Overall, neither TTS nor DOS was significantly associated with outcomes of MIS TLIF for WC patients. These results indicate that WC patients may be able to achieve similar levels of clinical improvement despite longer symptom burden and substantial delays in operative treatment.
ALIF As a Salvage Procedure for TLIF Pseudarthrosis: A clinical outcome study

Patel Madhav, BS, Jacob Kevin, BS, Cha Elliot, MS, Lynch Conor, MS, Prabhu Michael, BS, Pawlowski Hanna, BS, Vanjani Nisheka, BS, Singh Kern, MD

1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Clinically relevant pseudoarthrosis is not uncommon following minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF). Few studies, however, have characterized the clinical efficacy of salvage procedures undertaken for this indication. We aim to characterize clinical outcomes following anterior lumbar interbody fusion (ALIF) as a salvage procedure for pseudarthrosis of TLIF.

Materials/Methods: A retrospective review of a surgical database was performed for eligible procedures between 2010 and 2020. Time to revision, rates of 1-year arthrodesis, 6-month pseudarthrosis, and postoperative complications were calculated. Visual Analogue Scale (VAS), Oswestry Disability Index (ODI), 12-Item Short Form physical composite score (SF-12 PCS and VR-12 PCS) were collected preoperatively and postoperatively. Radiographic measurements were performed to evaluate sagittal alignment and disc height at the preoperative, and postoperative timepoints. Differences between preoperative and final postoperative radiographic measurements were evaluated using a t-test. Overall achievement of a minimum clinically important difference (MCID) was calculated using established values.

Results: 34 patients met final inclusion criteria. Mean time from index TLIF to salvage ALIF procedure was 21.3 months. Patients demonstrated a 1-year arthrodesis rate of 100.0% with 2/34 patients requiring an additional revision procedure at the index level for neuroforaminal bone growth. A total of 6 postoperative complications were observed with 1 patient suffering from a mild urinary tract infection, 1 with acute renal failure, 1 with a venous thromboembolism, 1 with altered mental status, and 2 with fever of unknown origin. Following ALIF salvage, a significant increase in segmental lordosis, mean anterior and posterior disc height, and average disc height was noted (p≤0.037, all). MCID achievement rates by 1-year were 67.1% for VAS back, 57.1% for VAS leg, 40.0% for ODI, and 37.5% for SF-12 PCS. (Table 1).

Discussion/Conclusion: Use of ALIF as a salvage procedure at either the L4-5 or L5-S1 level for TLIF pseudarthrosis demonstrated a high arthrodesis rate at 1-year. Patients demonstrated high rates of MCID achievement for back pain, leg pain, and disability.
Poster 10

Clinical and Radiographic Outcomes after Bracing for Acute to Subacute Thoracic and Lumbar Compression Fractures: A Meta-Analysis of Randomized Controlled Trials

Squires Mathieu, MD1, Green Jordan, MD1, Patel Rakesh, MD1, Aleem Ilyas, MD1
1 University of Michigan, Ann Arbor, Michigan, United States

Background/Introduction: Vertebral compression fractures are common and result in significant pain and loss of function. Treatment strategy, however, remains controversial. We conducted a meta-analysis of randomized trials to elucidate the impact of bracing on these injuries.

Materials/Methods: A comprehensive literature review utilizing Embase, OVID MEDLINE, and the Cochrane Library was performed to identify randomized trials evaluating brace therapy for adult patients with thoracic and lumbar compression fractures. Two independent reviewers assessed the eligibility of studies and risk of bias. Analyzed outcome measures include pain, function, quality of life, opioid use, and kyphotic progression (anterior vertebral body compression percentage (AVBCP)). Continuous variables were analyzed using mean differences and standardized mean differences, and dichotomous variables were analyzed using odds ratios, all in random-effects models. GRADE criteria were applied.

Results: Of 1,502 articles, a total of 3 studies with 447 patients (96% female) were included. Fifty-four patients were managed without a brace, and 393 with a brace (195 rigid, 196 soft). At 3 to 6 months post-injury, rigid bracing resulted in significantly less pain compared to no brace (SMD = -1.32, 95% CI -1.89 to -0.76, p < 0.05, I2 = 41%), though this diminished at long-term follow up of 48 months. Radiographic kyphosis, opioid use, function, or quality of life were not significantly different at any timepoint. GRADE assessment resulted in moderate quality evidence in support of rigid bracing for pain reduction 3-6 months post-injury.

Discussion/Conclusion: Moderate quality evidence demonstrates rigid bracing of acute to subacute thoracic and lumbar compression fractures may decrease pain up to 6 months post-injury, though there is no difference in radiographic parameters, opioid use, function, or quality of life scores at short or long-term follow up.
Does Karnofsky performance score improve after surgery for metastatic spine tumors in patients with SINS 7-12 with Bilsky grade 2 & 3 cord compression?

Shabani Saman, MD1, Vargas Enrique, BS1, Aabedi Alexander, BS1, Rechav Ben-Natan Alma, BA1, Agarwal Nitin, MD2, Mummaneni Praveen, MD3, Chou Dean, MD3

1 Academic Medical Center, UCSF, San Francisco, California, United States, 2 University of California, San Francisco, San Francisco, California, United States, 3 Department of Neurological Surgery, UCSF Medical Center, San Francisco, California, United States

Background/Introduction: In patients who are potentially unstable, with Spinal Instability Neoplastic Scores (SINS) 7-12, it is unclear if surgery improves their Karnofsky performance score (KPS). The aim of this study was to determine whether patients with SINS 7-12 with Bilsky grade 2 and 3 cord compression will benefit from surgery and have improvement in their KPS score post-operatively.

Materials/Methods: SINS 7-12 metastatic spinal tumor patients were retrospectively reviewed with pre- and post-operative KPS. Follow-up ranged from 1 month to 13 years. Baseline clinical characteristics including age, sex, SINS score, Bilsky grade, neurologic function, and preoperative KPS were collected. Postoperative KPS scores were collected at first follow-up visit which averaged about 3 months post-operatively. Paired, nonparametric Wilcoxon signed-rank test to determine significance of improvement in KPS after surgery. Ordinal logistic regression was used to identify factors associated with the change in KPS.

Results: Sixty six patients were evaluated. The median SINS score was 11 with a mean follow-up of 3.7 years. Postoperatively, significant improvement in KPS occurred from a median of 50 to 70 (p = 0.0003). Ordinal logistic regression showed that patients with pre-operative KPS of 70 and 80 had more improvement compared to patients with KPS at very low (20) or very high (90) ranges. This improvement in KPS was observed independent of the Bilsky grade, (grade 2, p = 0.045; grade 3, p = 0.001). However, improvement in KPS was associated with ASIA motor improvement on univariate ordinal logistic regression (OR = 1.05, CI = 1.02 – 1.10, p = 0.004), and this effect was maintained after controlling for Bilsky cord compression grade on multivariate models (p = 0.005)

Discussion/Conclusion: Potentially unstable metastatic tumor patients with SINS score 7-12 appear to have improved KPS scores with surgery.
Risk Factors for Subsidence following Anterior Lumbar Interbody Fusion

Zavras Athan, BA1, Federico Vincent, MD1, Nolte Michael, MD2, Dandu Navya, BS1, Munim Mohammed, BS1, Harper Daniel, BS1, Lopez Gregory, MD3, Dewald Christopher, MD4, An Howard, MD3, Singh Kern, MD1, Phillips Frank, MD3, Colman Matthew, MD4

1 Rush University Medical Center, Chicago, Illinois, United States, 2 Department of Orthopaedic Surgery, Division of Spine Surgery, Rush University Medical Center, Chicago, Illinois, United States, 3 Midwest Orthopaedics at Rush, Chicago, Illinois, United States, 4 Midwest Orthopaedics at Rush University, Chicago, Illinois, United States

Background/Introduction: As with other interbody fusion techniques, anterior lumbar interbody fusion (ALIF) may be complicated by interbody device or graft subsidence, which can lead to significant morbidity including severe pain, disc height collapse, neural compression, segmental kyphosis, loss of stability, and vertebral body fracture, among others. This study sought to identify patient and procedural risk factors for subsidence in patients undergoing ALIF.

Materials/Methods: This study retrospectively analyzed consecutive patients who underwent ALIF between the years 2006 and 2019 at a single institution with a minimum of 2 years of clinical and radiographic follow-up. The primary outcome was subsidence, defined as 2 mm or more migration of the interbody cage into the adjacent vertebra. Demographic and procedural risk factors were assessed. Patients were grouped as either Non-Subsidence (NS-ALIF) or Cage Subsidence (CS-ALIF) based on the final postoperative radiograph. Demographic variables, operative characteristics, and radiographic outcomes were evaluated between groups to identify significant predictors on univariate statistics. Multinomial logistic regression was employed to identify independent predictors of subsidence while retaining variables with a significance of p < .05 on univariate statistics.

Results: A total of 144 patients (170 levels) were included for analysis. The average age of the cohort was 47.41±13.04 years, and average follow-up was 50.70±28.44 months (4.23 years). The incidence of subsidence was 22.94% (39/170 levels). On univariate statistics, the CS-ALIF group was significantly older (p=.020), had a higher BMI (p=.048), worse ASA (p=.001), higher prevalence of comorbid osteoporosis (p<.001), and a more anteriorly placed interbody device relative to the NS-ALIF group (p=.005). On multivariate analysis, anterior cage placement remained the only significant predictor for subsidence, with more anterior cage placement posing an increased risk (OR: 1.08, 95% CI: 1.03–1.14; p=.003).

Discussion/Conclusion: Significant univariate risk factors for interbody cage subsidence included older age, higher BMI, severe ASA, osteoporosis, and anterior cage placement. On multivariate analysis, anterior cage placement remained the only significant predictor of subsidence. Based on these findings, surgical technique should be focused on optimizing placement of the interbody cage and avoiding overstuffing of the disc space. Further investigation should validate these findings in an external cohort.
Poster 13

PROMIS Physical Function and Pain Interference are Independent Predictors of Unplanned Readmission after Instrumented Lumbar Arthrodesis.

Hendrickson Nathan, MD, MS1, Amoaf Linda, MS2, Zhang Yue, PhD3, Spina Nicholas, MD4, Brodke Darrel, MD2
1 University of Minnesota, Minneapolis, Minnesota, United States, 2 University of Utah, Salt Lake City, Salt Lake City, Utah, United States, 3 University of Utah, Salt Lake City, Utah, United States, 4 University of Utah - Department of Orthopaedics, Salt Lake City, Utah, United States

Background/Introduction: Risk stratification is essential for informed decision making and patient counseling. The PROMIS physical function computer adaptive test (PFCAT) and pain interference (PI) scales directly evaluate physical function and limitation due to pain with low question burden and may be clinically relevant predictors of adverse outcomes in spine patients. We aimed to evaluate whether preoperative PROMIS PFCAT or PI scores are important predictors of unplanned readmission in adults undergoing lumbar arthrodesis.

Materials/Methods: 1,782 adult patients undergoing instrumented posterior lumbar fusion (PLF) between 2015 and 2020 were retrospectively reviewed. Preoperative demographics, surgical variables, and patient reported outcomes (PRO) and clinical outcomes were extracted from electronic health record. All cases with unplanned hospital readmission were adjudicated by manual chart review. We performed random forest prediction modeling to identify variables with the greatest predictive importance to unplanned hospital readmission risk using the mean decrease in Gini index.

Results: Of 1,782 patients included, 146 patients (8.19%) had unplanned readmissions after surgery. Results of random forest modeling of predictive importance according to mean decrease in Gini index are reported in Table 1, with higher values indicating greater importance of the variable in fitting the random forest model. In both model PFCAT and model pain interference, BMI had the greatest importance (68.9, 63.3, respectively). PFCAT and PROMIS PI had the second highest predictive importance (61.3, 50.1 respectively) in their respective models. In both models, age (49.5, 46.7, respectively) and CCI (32.0, 28.7) were the third and fourth most important predictive variables for unplanned readmission, respectively.

Discussion/Conclusion: Random forest modeling is a more flexible modeling technique than linear regression techniques, and therefore, can identify under-explored risk factors. Our analysis using random forest modeling identified BMI as the most important predictive variable for unplanned readmission, with PROMIS PFCAT and PROMIS PI demonstrating the next greatest predictive importance in respective models. Both models also included age and CCI as predictive variables of lesser importance. While traditionally used to assess post-treatment outcomes, PROMIS PFCAT and PI are stronger independent predictors of postoperative readmission than age or CCI. Further research to develop risk-stratification tools incorporating PROMIS measures and random forest models is warranted.
Utility of Spine Surgery for Functional Independence for Thoracolumbar Spinal Cord Injury

Naik Anant, BS¹, Macinnis Bailey, BS¹, Pozin Michael, MSE¹, Najafali Daniel, BS¹, Pappu Suguna, MD, PhD², Arnold Paul, MD³
¹ Carle Illinois College of Medicine, Urbana, Illinois, United States, ² Carle Foundation Hospital, Champaign, Illinois, United States, ³ Carle Neuroscience Institute, Urbana, Illinois, United States

Background/Introduction: Thoracolumbar spinal cord injury (TL-SCI) constitute a large fraction of total SCI cases, and most commonly occur due to high impact collisions from motor vehicle injuries, falls from a height, sports injuries and violence. Surgical intervention for TL-SCI is commonly prescribed; however, there is insufficient evidence whether surgical intervention improves quality of life measures of patients. In this study, we sought to study the impact of surgery on functional independence measures at discharge from in-patient rehabilitation.

Materials/Methods: This analysis queried the multicenter Spinal Cord Injury Model Systems database for all patients with known thoracolumbar injury with documented Functional Independence Measure (FIM) and subscores at admission and discharge. Univariate analysis utilized Fisher's exact test for categorical comparisons and t-test for continuous variables. Multivariate logistic regression was used to determine predictors of independence (subscores 6, 7) of the FIM at discharge.

Results: 369 patients were retrospectively analysed. Univariate analysis demonstrated that female, Black patients and those with lower income were more frequently managed without surgery for TL-SCI. This racial disparity was further emphasized in an adjusted multivariate regression, showing black patients had decreased odds of receiving surgery (OR: 0.13 (95% CI 0.07-0.24), p<0.0001), despite adjusting for income, injury severity, and age. Multivariate models of eleven FIM subscores adjusting for age, sex, race, level of injury, severity of injury, and income, demonstrated that spine surgery did not lead to greater functional independence for patients. Instead, ASA C and D, age, and FIM admission to rehabilitation were consistent predictors of discharge functional outcomes.

Discussion/Conclusion: This analysis demonstrates that surgical intervention may not improve functional independence for TL-SCI patients at discharge from in-patient rehabilitation. This suggests a greater need to determine criteria for patients requiring surgery. This analysis is limited due to inaccessibility of imaging, and insufficient data regarding the timing of surgery from injury. These factors may also influence outcomes, and their effect is not measured as a limitation of the data available.
Poster 15

Does the Use of Smoke Evacuation Reduce Smoke Exposure in the OR? A Prospective Study

Hall James, MD¹, Eisenberg Joshua, MD¹, Carender Chris, MD¹, Lindsay Chris, MD¹, Bell Ashley, BS², Glass Natalie, PhD², Olinger Catherine, MD², Pugely Andrew, MD¹

¹ Department of Orthopedics and Rehabilitation, University of Iowa, Iowa, Iowa, United States, ² University of Iowa Hospitals and Clinics, Iowa, Iowa, United States

Background/Introduction: In June 2018, Rhode Island was the first state to enact a law mandating the use of surgical smoke evacuation. In 2020, nine more states introduced similar legislation. While the presence of dangerous compounds within surgical smoke is established, posing a possible risk to operating room personnel, few have investigated the utility of smoke evacuation in the surgical setting. With increased scrutiny on surgical smoke levels, further study is required. Our aim was to investigate the efficacy of smoke evacuation during spine surgery.

Materials/Methods: From February 2020 to April 2021, a consecutive series of patients undergoing anterior cervical, posterior cervical and posterior thoracolumbar spine surgery at a single institution were randomized to three separate interventions: electrocautery smoke evacuation pencil (Medtronic Valleylab), smoke evacuation tube (Medtronic RapidVac smoke tubing), or no evacuation. The smoke evacuation pencil (SEP) has suction in line with the cautery tip, while the smoke evacuation tube (SET) uses a large tube at the proximal aspect of the incision. Smoke levels were measured using the PCE instruments particle counter (PCE-PCO 2) positioned at the level of the surgical drape. These evacuators were compared to one another and to no evacuation. Average and peak particle count was measured. Statistical analysis included Spearman Correlation Coefficient, and Chi-Square, examining the effect room size, age, BMI, cautery power, operative region, and number of operative levels has on particle levels. Significance defined as p < 0.05.

Results: The study included 117 patients. SEP was used in 36, SET in 43, and no evacuator in 38. The SEP and SET demonstrated significant smoke reduction and performed equally at reducing average particle level. The SET significantly reduced peak levels compared to the SEP. Furthermore, smaller room size and greater number of operative levels significantly increased particle levels. Patient demographics and cautery setting were compared and found to be equivalent between groups.

Discussion/Conclusion: Our results demonstrate smoke evacuators effectively reduce operating room smoke levels during spine surgery. Furthermore, the smoke evacuation tube shows superiority in reducing peak smoke levels. This study supports the utility of smoke evacuation in reducing smoke exposure during spine surgery.
Poster 16

Patients Undergoing Lumbar Fusion Show Similar Improvement in PROMIS Outcomes and Overall Healthcare Utilization at 2 years Compared to Patients Undergoing Decompression Alone

Gerlach Erik, MD, Plantz Mark, MD, Swiatek Peter, MD, Arpey Nicholas, MD, Marx Jeremy, MD, Weiner Joseph, MD, Divi Srikanth, MD, Hsu Wellington, MD, Patel Alpesh, MD, MBA

1 Northwestern University Department of Orthopaedic Surgery, Chicago, IL, United States
2 Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States

Background/Introduction: The purpose of this study is to compare patient-reported outcomes, opioid use, and healthcare resource utilization in patients undergoing elective lumbar decompression and fusion versus decompression surgery alone for degenerative lumbar disease.

Materials/Methods: Patients were retrospectively identified who underwent elective spine surgery for lumbar degenerative pathology between November 1, 2013 and September 30, 2018 at a single academic center. Baseline patient demographics, underlying comorbidities, surgical variables, and pre-operative opioid use were assessed. Patient Reported Outcomes Measurement Information System (PROMIS) Computer Adaptive Tests (CATs) PROMs– pain behavior (PB), pain interference (PI), and Physical Function (PF) scores – were assessed at 6 weeks, 3 months, 12 months and 24 months postoperatively. Health resource utilization was quantified within 1 year postoperatively (imaging studies, emergency and urgent care visits, opioid prescriptions and others). PROMs, opioid burden, and healthcare resource utilization were compared between patients undergoing lumbar fusion versus decompression procedures alone using univariate and multivariate analyses.

Results: A total of 430 patients were included in the final cohort – 274 (63.7%) undergoing decompression only and 156 (36.3%) undergoing decompression and fusion. Patients undergoing concurrent decompression and fusion procedures had nearly double the rate of persistent opioid use at 180 days after surgery (p=0.012). These patients also underwent more imaging studies (p<0.05), but had similar rates of emergency department visits, urgent care visits, and spinal injections. Patients undergoing decompression surgery only had greater improvement in pain behavior scores at 12-months (p=0.016), but this difference resolved by 24-months post-op. Decompression-only surgery was associated with lower rates of opioid prescriptions at 90-days (OR 0.723; 95% CI: 0.619-0.826), 180-days (OR 0.849; 95% CI 0.763-0.934), opioid persistence at 180 days (OR 0.550; 95% CI: 0.271-0.828), and total number of X-ray (OR 0.288, 95% CI: 0.228-0.348) and CT (OR 0.336; 95% CI: 0.191-0.481) studies at 365 days.

Discussion/Conclusion: Patients undergoing decompression surgery alone had lower rates of persistent opioid use at 180-days post-operatively, less imaging studies obtained, and similar patient-reported outcome measures at 2-years postoperatively relative to patients undergoing decompression and fusion procedures.
Return to Work, Activities of Daily Living and Disability Improvement: 12-month Outcomes of an FDA IDE Trial of Decompression and Tension Band Stabilization for Degenerative Spondylolisthesis

Lavelle William, MD¹, Sasso Rick, MD², Bae Hyun, MD³, Yoon Sangwook, MD, PhD⁴, Bains Ravinder, MD⁵, Kuo Calvin, MD⁶, Stauff Michael, MD⁶, Sandhu Harvinder, MD⁷, Perez-Cruet Mick, MD⁸, Berven Sigurd, MD⁹, Fischgrund Jeffrey, MD¹⁰, Deutsch Harel, MD¹¹, Hassanzadeh Hamid, MD¹², Mermer Matthew, MD¹³, Yu Elizabeth, MD¹⁴, Metkar Umesh, MD¹⁵, Gayer Richard, MD¹⁶, Gum Jeffrey, MD¹⁷, Alamin Todd, MD¹⁸, Fielding Louis, MS¹⁹

¹ SUNY Upstate Medical University, Syracuse, New York, United States, ² Indiana Spine Group, Carmel, Indiana, United States, ³ The Spine Institute, Santa Monica, California, United States, ⁴ Emory University Department of Orthopaedics, Atlanta, Georgia, United States, ⁵ Kaiser Permanente Northern California, Oakland, California, United States, ⁶ University of Massachusetts Memorial Medical Center, Worcester, Massachusetts, United States, ⁷ Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States, ⁸ Oakland University William Beaumont School of Medicine, Royal Oak, MI, Italy, ⁹ Department of Orthopedic surgery, San Francisco, California, United States, ¹⁰ William Beaumont Hospital, Royal Oak, MI, Italy, ¹¹ Rush University Medical Center, Chicago, Illinois, United States, ¹² University of Virginia, Charlottesville, Virginia, United States, ¹³ Kaiser Permanente, Roseville, California, United States, ¹⁴ The Ohio State University, College of Medicine, Columbus, Ohio, United States, ¹⁵ University of New Mexico, Albuquerque, New Mexico, United States, ¹⁶ Texas Back Institute, Plano, Texas, United States, ¹⁷ Norton Leatherman Spine Center, Louisville, Kentucky, United States, ¹⁸ Stanford University Orthopaedic Surgery, Palo Alto, California, United States, ¹⁹ Empirical Spine, Inc., San Carlos, Arizona, United States

Background/Introduction: Symptomatic degenerative spondylolisthesis (DS) may be treated with decompression alone; however, the addition of instrumented fusion is usually considered essential to achieve durable results. As an alternative to fusion, a novel paraspinous tension band is proposed for segmental stabilization after decompression for DS. Return to activities of daily living, work (as applicable) and reduction in disability are important outcomes of both standard of care and novel, investigational procedures. We compared decompression and stabilization with the tension band (D+PTB) to decompression and transforaminal lumbar interbody fusion (D+TLIF) for symptomatic DS.

Materials/Methods: This is a prospective ongoing FDA IDE study (NCT03115983) with 246 subjects (140 D+PTB, 106 D+TLIF) who were ≥12m postoperative. We queried, compared, and analyzed records for preoperative and 12-month postoperative outcomes for work status, return to work (RTW), activities of daily living (ADL) and Oswestry Disability Index (ODI) scores.

Results: Preoperatively, work status=50% of D+PTB subjects and 39% of D+TLIF subjects (p=0.04) and no work due to spinal condition (NWSC) found 7% D+PTB and 12% D+TLIF (p=0.09). At 12-month postoperatively, work status=45% of D+PTB subjects and 34% of D+TLIF subjects (p=0.09) and NWSC=2% D+PTB and 13% D+TLIF (p<0.01). The proportion of D+PTB NWSC was significantly lower 12 months postoperatively compared to preoperative
(p=0.04). Of significance, was mean±SD RTW time for D+PTB subjects=5.3±6.6 vs. D+TLIF subjects=13.6±11.7 weeks (p<0.01) and return to ADL for D+PTB subjects=5.4±6.4 vs. D+TLIF subjects=13.8±18.8 weeks (p<0.01). The mean±SD reduction in disability at 12 months from baseline=38.3±18.2 (D+PTB) vs. 33.0±21.8 (D+TLIF), (p=0.06) with effect sizes of -2.1 and -1.5, respectively.

**Discussion/Conclusion:** Both groups demonstrated significant reductions in disability at 12 months follow-up. These results indicate a significant advantage of earlier recovery in D+PTB patients (sooner return to work and increased ADLs) compared to D+TLIF with similar improvements in disability after one year was seen. Proportion of D+PTB patients not working due to their spinal condition was significantly less at 12 months. Longer-term follow-up assessment of propensity score-selected subjects may demonstrate whether this advantage and long-term outcomes are durable.
Poster 18

Does level selection matter when assessing bone quality on lumbar spine CT?

Devia Luis, MS, BS¹, Aynaszyan Stephan, BS¹, Parry Matthew, BS¹, Badve Siddharth, MD², DelSole Edward, MD²
¹ Geisinger Commonwealth School of Medicine, Scranton, Pennsylvania, United States, ² Geisinger Musculoskeletal Institute, Danville, Pennsylvania, United States

Background/Introduction: Preoperative assessment of bone mineral density (BMD) is of growing importance for spine surgeons. Little has been done to standardize the technique of measurement and specifically the vertebral level chosen for measure. The purpose of this study is to evaluate the specific HU measured at each lumbar vertebral level in patients of varying bone quality to determine if there is a “best level” for measurement.

Materials/Methods: The population consisted of 50 patients who had both a lumbar spine CT and DEXA scan completed within a two-year time frame. Hounsfield Units (HU) measurements were taken by two independent researchers who were blinded to the DEXA values. Mid-sagittal and mid-axial measurements at the L1-S1 vertebral body levels. A circular region of interest (ROI) was used and placed over the anteroposterior diameter of the vertebral body to include maximum trabecular bone, excluding cortical bone. After measurements were completed, patients were separated into three groups by DEXA T-score: Normal (T-score > -1), Osteopenia (T-score -1 and -2.4) and Osteoporosis (T-score < -2.5). Classification into these groups were made based on the lowest DEXA T-score of either the hip, femoral neck, or lumbar spine. ANOVA with posthoc Bonferroni adjustment was performed with significance set at p=0.05.

Results: Among the 50 patients, 14 had healthy bone, 22 had osteopenia, and 14 had osteoporosis by DEXA. At all vertebral levels, HU measures were decreased in patients with osteopenia or osteoporosis compared to healthy bone. However, at multiple levels patients with osteoporotic bone appeared to have elevated HU compared with osteopenic bone. L4 sagittal (p=0.001), S1 sagittal (p=0.001), L1 axial (p=0.01), L3 axial (p=0.002), L4 axial (p=0.001), and L5 axial (p=0.003) levels were the only ones which had an appropriately downtrending HU concordant with bone quality.

Discussion/Conclusion: CT-based HU may be useful in distinguishing healthy bone from abnormal bone, there may be difficulty in distinguishing osteopenia from osteoporosis. Measures taken in the axial cuts may be more accurate than on the sagittal reconstructions. The largest difference in HU across groups was seen at L4, which may be the most appropriate location to make these measures.
Poster 19

Opioid Use after Spine Surgery: How Much Are We Over-Prescribing?

Thomson Alexandra, MD¹, Orosz Lindsay, MS, PA-C², Bhatt Fenil, BS³, Allen Brandon, ², Sabet Andre, MS³, Schuler Thomas, MD³, Good Christopher, MD³, Haines Colin, MD³, Jazini Ehsan, MD³

¹ University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore, Maryland, United States, ² National Spine Health Foundation, Reston, Virginia, United States, ³ Virginia Spine Institute, Reston, Virginia, United States

Background/Introduction: Opioid prescribing practices to control pain after spine surgery are scrutinized due to the opioid epidemic in the US. There is a lack of understanding of postoperative opioid consumption, unused opioids, and standardized prescribing practices with respect to spine surgery type. We aimed to: determine postoperative 90-day opioid consumption after elective spine surgery, identify differences in opioid consumption between subgroups, and determine the distributions of opioids consumed to control pain in the 90th percentile.

Materials/Methods: Adults (>18 years) undergoing elective spine surgery at a multi-surgeon, single center were included. Surgery subgroups include: anterior cervical, posterior lumbar decompression, and short-segment (< 4 levels) circumferential fusion. During the 90-day postoperative period, prescribed MMEs were calculated from opioid prescriptions, consumed MMEs were calculated from pill counts, and then both were compared between subgroups. Consumed MME distributions were analyzed as opioid naïve or tolerant to identify the 50th, 75th, and 90th percentiles within each subgroup.

Results: Of 117 (48.7% male, 52 years) patients (n=48, cervical; n=28, decompression; n=41, lumbar fusion), 41.9% were opioid tolerant. The mean difference between 90-day MMEs prescribed and consumed overall was 540.0. The percentage of unused opioids at 90-days was: 22.5% cervical, 33.7% lumbar decompression, and 23.7% lumbar fusion (p=0.002). The 90th percentile of MMEs consumed was: 660 naïve and 6728 tolerant cervical, 300 naïve and 2490 tolerant lumbar decompression, 4995 naïve and 7710 tolerant lumbar fusion.

Discussion/Conclusion: Greater than 20-30% of total MMEs prescribed were unused at 90-days across surgical subgroups. This suggests the need to develop standardized prescribing practices for postoperative opiates. While the results suggest the number of MMEs prescribed can be reduced to mitigate the effects of leftover pills, larger studies are needed to standardize opioid prescribing practices across elective spine surgeries.
Adjunct Pelvic Fixation in Short-to-Medium Segment Degenerative Fusion Constructs Independently Predicts Readmission and Morbidity

Katz Austen, MD¹, Song Junho, BS², Virk Sohrab, MD³, Silber Jeff, MD⁴, Essig David, MD¹
¹ North Shore LIJ Health System, Manhasset, New York, United States, ² Hospital for Special Surgery, New York, New York, United States, ³ North Shore University/Long Island Jewish Medical Center, Great Neck, United States, ⁴ Northwell Health, New Hyde Park, New York, United States

Background/Introduction: Pelvic fixation (PF) has traditionally been utilized in long-construct deformity surgery to achieve greater control over sagittal and coronal imbalance and construct stability and to improve solid arthrodesis rates. However, outcomes associated with adjunct PF in the degenerative population has not been studied sufficiently. This is the first large-scale database study to compare 30-day outcomes following short-to-medium length multilevel lumbar fusion with and without adjunct PF for the treatment of degenerative lumbar disease.

Materials/Methods: This study utilizes the 2005-2018 ACS-NSQIP datasets. Adults who underwent multilevel degenerative lumbar fusion were included. Short-to-medium length fusion was specifically isolated by excluding patients with >4 additional level codes. Patients were classified into groups with and without PF. Patients were excluded if they underwent single level, traumatic, deformity, non-elective, tumor, or revision surgery; had evidence of prior infection; or underwent additional procedures including osteotomy, arthroplasty, or cervical or thoracic procedures. Univariate and multivariate regression analyses were used to compare readmission, reoperation, morbidity, and specific complications between patients with and without PF, and to control and evaluate for significant predictors and baseline differences between patients.

Results: We identified 38,413 patients (818 with PF). PF independently predicted readmission and morbidity. PF had greater reoperation rates in univariate analysis, but not in multivariate analysis. PF had greater rates of wound complication, transfusion, DVT, and sepsis (Table 2). Multivariate analysis of readmission is provided in Table 3. Obesity, chronic steroids, and ASA-class ≥3 predicted readmission. Obesity, steroids, and preoperative transfusion predicted reoperation. Male gender and inclusion of ALIF within the fusion construct were protective against reoperation. African American race, decreased hematocrit, and bleeding disorder predicted morbidity. Inclusion of ALIF within the fusion construct and navigated surgery were protective against morbidity.

Discussion/Conclusion: PF was associated with a 1.5-times increased-odds of readmission and a 2.7-times increased-odds of morbidity, with significantly greater rates of transfusion, DVT, sepsis, and wound-related complications, despite controlling for patient and procedural-related factors. There were no differences in 30-day reoperation. Thus, these findings suggest that PF may achieve greater construct stability in the degenerative spine population, but at a significantly elevated risk of medical and surgical morbidity.
Poster 21

Floseal versus Surgiflo: Similar Outcomes, Different Costs in a Matched Cohort Analysis

Ye Ivan, BS¹, Thomson Alexandra, MD¹, Donahue Jack, BS¹, Miseo Vincent, MD¹, Jauregui Julio, MD¹, Cavanaugh Daniel, MD¹, Koh Eugene, MD, PhD¹, Ludwig Steven, MD¹
¹ University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore, Maryland, United States

Background/Introduction: Floseal (Baxter International Inc.) and Surgiflo (Ethicon Inc.) are two commercially available gelatin-based hemostatic matrices commonly used in spine surgery. The primary objective of this study is to compare the rate of blood transfusions following the use of Floseal and Surgiflo in elective lumbar spine surgery. The secondary objective is to compare the utilization and cost.

Materials/Methods: Consecutive patients who received elective lumbar spine surgery by an orthopaedic spine surgeon between 2019 and 2021 were identified for this retrospective study. Since the surgeon switched hemostatic agents in 2020, patients were divided into two cohorts based on which gelatin-based hemostatic agent was used during the spine surgery: Floseal 10mL (N=102) and Surgiflo matrix 8mL (N=108). The primary outcome was blood transfusion (intraoperative or postoperative). To control for surgical complexity, the Surgical Invasiveness Index (SII) and the Adult Spinal Deformity Invasiveness Score (ASD-S) were calculated. A 1:1 propensity score matching was then performed using demographic information, SII, ASD-S, and tranexamic acid (TXA) use. Standardized differences of 0.1 (or 10%) was used to indicate a meaningful difference between cohorts. Using the matched cohorts, statistical analysis included Student’s T-test or Wilcoxon’s rank-sum test for continuous variables and Chi-square analysis for categorical variables.

Results: Following propensity score matching, the Floseal and Surgiflo cohorts each consisted of 77 patients. There was no significant difference in the rate of blood transfusion (13.0% vs. 9.1%, p=0.441) between matched cohorts. Furthermore, there was no difference in operative time (p=0.503), estimated blood loss (p=0.541), hospital complication (p=0.841), or length of stay (p=0.391). Multiple units of the Surgiflo were more likely to be used during spine surgery than Floseal (p=0.004). Using internal hospital cost data, Surgiflo cost $22.69 more per unit, $9.04 more per mL, and $102.45 more per surgery compared to Floseal. With practice of 1000 surgeries a year, switching from Surgiflo to Floseal represents a cost-savings of $102,450 per year.

Discussion/Conclusion: There was no significant difference in transfusion rates between the matched Floseal and Surgiflo cohorts. However, Surgiflo had higher costs and usage compared to the Floseal, providing evidence for spine surgeons and hospitals to help reduce costs for their practice.
Poster 22

6-month Outcomes for Patients Undergoing Posterior vs Circumferential Surgical Approach for Isthmic Spondylolisthesis

Arnold Paul, MD¹, Ludwig Steven, MD², Vaccaro Alexander, MD, PhD, MBA³, Brodke Darrel, MD⁴, Smith Justin, MD⁵, Harrop James, MD⁶, Mroz Thomas, MD⁷, Fehlings Michael, MD, PhD, FRCS(C)⁸

¹ Carle Neuroscience Institute, Urbana, Illinois, United States, ² University of Maryland School of Medicine, University of Maryland Medical Center, Baltimore, Maryland, United States, ³ Rothman Institute at Thomas Jefferson University, Philadelphia, Pennsylvania, United States, ⁴ University of Utah, Salt Lake City, Salt Lake City, Utah, United States, ⁵ University of Virginia, University of Virginia School of Medicine, Charlottesville, Virginia, United States, ⁶ Thomas Jefferson University, Philadelphia, Pennsylvania, United States, ⁷ Cleveland Clinic Foundation, Cleveland, Ohio, United States, ⁸ University of Toronto, Toronto Western Hospital, Toronto, Ontario, Canada

Background/Introduction: There is no consensus on the optimal surgical approach in treating isthmic spondylolisthesis (IS). Both posterior and circumferential surgical approaches are used.

Materials/Methods: This is an interim analysis of a prospective, multicenter; observational, comparative study of surgically naïve patients with IS grade I-III at a single level between L4 and S1. Subjects are between 18 and 80 years of age, are enrolled at one of 15 sites in North America, and will be followed for two years. Patients with significant scoliosis or cauda equina syndrome are excluded. This interim analysis compares 6-month follow-up outcomes between posterior and circumferential surgical approaches.

Results: So far, 175 patients have been enrolled (126 posterior and 49 circumferential). The majority of patients were operated at L5/S1 (75.2% posterior and 95.9% circumferential). Six-month data is available for 135/175 subjects (96 posterior and 39 circumferential). At this time point, there are no differences in age, race, gender, or the baseline score values between the groups. There has been an improvement in all endpoints in both groups. While pain outcomes trend better in the circumferential group and EQ-5D scores in the posterior group, neither of these is significant. There are no differences between the posterior and circumferential groups in change in Oswestry Disability Index (ODI) (19.8 and 17.6 respectively, p = 0.496); lumbar pain (2.6 and 3.2 respectively, p = 0.417); buttocks and leg pain (3.1 and 3.5 respectively, p = 0.436); EQ-5D Index (0.23 and 0.15 respectively, p = 0.061); SF-36 Physical Component Score (PCS) (10.2 and 10.9 respectively, p = 0.730); and SF-36 Mental Component Score (MCS) (7.2 and 3.1 respectively, p = 0.07).

Discussion/Conclusion: Patients in both treatment groups have improved in quality of life, pain, and functional outcomes. The extent of improvement is clinically meaningful. There are no differences in outcomes between the posterior and circumferential surgical approaches; however, this is an ongoing study and the current sample size is insufficient to provide confirmatory evidence.
Poster 23

Rate of Recurrent Infections and Implant Removal After Initial Debridement in Spine Surgery

Oyekan Anthony, MD\textsuperscript{1}, Ridolfi Dominic, BS\textsuperscript{1}, Zheng Aaron, BS\textsuperscript{1}, Chang Audrey, BS\textsuperscript{1}, Carlos Noel Bien, BS\textsuperscript{1}, Lin Ryan, BS\textsuperscript{1}, Couch Brandon, MD\textsuperscript{1}, Shaw Jeremy, MD, MS\textsuperscript{1}, Lee Joon, MD\textsuperscript{1}  
\textsuperscript{1}University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States

Background/Introduction: Surgical site infections (SSIs) in spine surgery are associated with increased morbidity, hospital length of stay, and reoperation. Treatment frequently requires the removal of implants. Despite a paucity of literature on infection rates, there is limited data on the rate of infection recurrence after index treatment or implant removal rates.

Materials/Methods: A retrospective review of a prospectively collected database was performed with the University of Pittsburgh Institutional Review Board approval. All patients who underwent spine surgery performed by two fellowship-trained spine surgeons at a single institution between July 2017 to July 2021 were included. Patients less than 90 days since surgery or pre-operative spinal infection were excluded. Infection was defined as gram stain or culture-confirmed growth of organisms from an operative debridement. Recurrent infection was defined as failure of operative debridement and at least 4 weeks of antibiotics before a repeat operative debridement was required. Chi-square analysis was used to determine differences in gender and procedure indication. Two-tailed unpaired t-tests were used to identify differences in continuous variable demographics, infection rate, and implant removal rate. \( p < 0.05 \) was considered statistically significant.

Results: Nine hundred and thirty-three subjects (469 M, 464 F; age 56 ± 15 years) were identified. Post-operative infection patients (n = 19, 9 M, 10 F; age 63 ± 19 years, BMI 29.2 ± 7.9, CCI 2.2 ± 2.7) were older (\( p = 0.035 \)) and had a greater CCI (\( p = 0.046 \)) than non-infected patients (n = 914, 460 M, 454 F; age 56 ± 15 years, BMI 31.0 ± 7.5, CCI 0.9 ± 1.5) despite no differences in gender (\( p = 0.798 \)), BMI (\( p = 0.343 \)) or revision procedure (\( p = 0.174 \)). The rate of post-operative infection requiring debridement was 2.03%. Three patients (15.79%) had a recurrent infection and 3 patients (16.67%) with prior instrumentation required removal of implants during operative debridement. 47.37% of infections required multiple debridements. The average number of debridements needed to clear an infection was 1.6 ± 0.8.

Discussion/Conclusion: Recurrent infection and removal of hardware are common complications in spine surgery. Our findings are a reference for other surgeons.
Poster 24

Postoperative lower lumbar (L4-S1) hypolordosis is associated with worse outcomes after 1-2 level spinal fusion

Sembrano Jonathan, MD\(^1\), Soriano Paul, MD\(^1\), Cosiquien Roj, \(^2\), Holton Kenneth, MD\(^2\)

\(^1\) University of Minnesota, Department of Orthopaedic Surgery, Minneapolis, Minnesota, United States. \(^2\) University of Minnesota, Minneapolis, Minnesota, United States

Background/Introduction: 1-2 level fusion for degenerative conditions is generally not considered as deformity surgery. Moreover, sagittal alignment is deemed to focus mainly on matching lumbar lordosis to pelvic incidence. We sought to explore the role of lower lumbar (L4-S1) lordosis and its correlation with 1-2 level lumbar fusion outcomes.

Materials/Methods: Single-surgeon series of 1-2 level lower lumbar (L4-S1) spinal fusion surgeries from 2016 to 2020 were reviewed. Clinical records were reviewed for demographic data and preoperative and 1 year postoperative Oswestry Disability Index (ODI) scores. The following were measured on pre- and postoperative standing radiographs: lumbar lordosis (LL), pelvic incidence (PI) and L4-S1 lordosis (LLL; lower lumbar lordosis). We calculated ideal lumbar lordosis (ILL = 0.5 PI + 28) and ideal lower lumbar lordosis (ILLL = 0.67 ILL). Patients were categorized as to having lower lumbar hypo-, normo-, or hyper-lordosis, depending on whether LLL is lower than, within, or greater than ILLL +/- 5 degrees.

Results: 83 patients were included (53 females; 64%), mean age 53.7 years (range 18-84) and mean BMI 31.27 (range 17-56). Forty-two (51%) were current or former smokers. Twenty-two (27%) had low bone density (osteopenia or osteoporosis). Thirty patients (36%) had preoperative lower lumbar hypolordosis; 41 (49%) had normolordosis; and 12 (14%) had hyperlordosis. Postoperative lower lumbar alignment as follows: 22 (27%) hypolordosis; 39 (47%) normolordosis; 22 (27%) hyperlordosis. Mean preoperative ODI for the entire cohort was 52% (range 18-89%). Postoperative ODI scores were better in those that ended up with normolordosis (33%) or hyperlordosis (34%) versus those that were left hypolordotic (39%) (p < 0.05).

Discussion/Conclusion: Patients with postoperative lower lumbar flatback deformity after 1-2 level fusion had worse outcomes compared to those whose postoperative L4-S1 alignment is within 5 degrees of ideal value. Sagittal alignment should be strongly considered and measured even for 1-2 level spinal fusion surgeries. Furthermore, subregional alignment, specifically lower lumbar (L4-S1) lordosis should be paid careful attention to, in addition to regional lumbar lordosis.
Utility of the Transversus Abdominis Plane and Rectus Sheath Blocks in Patients Undergoing Anterior Lumbar Interbody Fusions

Esmende Sean, MD1, Solomito Matthew, PhD1, Eisler Jesse, MD, PhD, MBA2, Finkel Kevin, MD, FASA3, Kainkaryam Pranjali, MD3, Maffeo-Mitchell Carla, MD3
1 Hartford Healthcare Bone and Joint Institute, Hartford, Connecticut, United States, 2 Connecticut Back Center, Storrs, Connecticut, United States, 3 Hartford Hospital, Hartford, Connecticut, United States

Background/Introduction: Lower back pain is extremely common and often requires lumbar fusion to address the spinal pathology causing the pain. Improving patient comfort and reducing opioid consumption following lumbar fusions has become a significant goal for spine surgeons. Therefore, the purpose of this study was to determine the effectiveness of a combined transversus abdominis plane block (TAPB) and rectus sheath block (RSB) on pain, postoperative anesthesia care unit length of stay (PACU LOS) and opioid consumption in patients undergoing anterior lumbar interbody fusions (ALIF).

Materials/Methods: This was a retrospective study evaluating patients who underwent an ALIF between January 2018 and August 2021. Patients that received both the TAPB and RSB were placed into the study group and those that did not were placed into the control group. In January 2020, the combine use of TAPB and RSB became standard of care for all elective ALIF cases. Pain scores at rest and with activity, opioid consumption during the first 72 hours post-op, and PACU LOS were extracted from the patient charts. T-tests assuming unequal variances and Chi square contingency tests were used to determine if there were statistically significant outcomes between the two groups.

Results: A total of 175 patients (88 received blocks) were included in this study (Table 1). Patients in the study group had a 24.8% reduction in opioid use (p=0.026) compared to the control group. The study group was also noted to have a 10% reduction in pain at rest scores (p=0.032), and a 13% reduction in pain with activity (p=0.001) compared to the control group. Additionally, the study group required less PACU time with the results indicating an 18.7% reduction in PACU LOS compared to the control group(p= 0.007).

Discussion/Conclusion: Patients receiving a combined TAPB and RSB from our regional anesthesia team prior to the start of their elective ALIF required less opioids for pain control, reported lower pain scores both at rest and with activity, and had shorter PACU LOS compared to those that did not receive the blocks. Therefore, combine TAPB and RSB may be an effective component of multimodal pain management option in this patient population.
Poster 26

Total Intravenous Anesthetic for Posterior Thoracolumbar Fusion Increases Risk of Postoperative Ileus Compared to Inhaled Anesthetic

Sherrod Brandon, MD¹, Kim Robert, MD¹, Hunsaker Joshua, BS¹, Rada Courtney, BS¹, Christensen Clint, MD², Brodke Darrel, MD³, Mazur Marcus, MD², Bisson Erica, MD², Dailey Andrew, ⁴

¹ Department of Neurosurgery, Clinical Neurosciences Center, University of Utah, Salt Lake City, Utah, United States, ² University of Utah, Salt Lake City, Utah, United States, ³ University of Utah, Salt Lake City, Utah, United States, ⁴ Department of Neurosurgery, University of Utah Health Care, Salt Lake City1, Utah, United States

Background/Introduction: Postoperative ileus is common after posterior thoracolumbar spinal fusion (PSF) and carries significant associated morbidity. Although prior studies have identified multiple risk factors for development of ileus, no study to our knowledge has directly compared ileus rates between patients receiving inhaled anesthetic versus total intravenous anesthetic (TIVA) for PSF despite TIVA’s increasing prevalence.

Materials/Methods: Retrospective single-institution cohort study of all patients undergoing PSF from May 2014 to December 2020. Patients undergoing both orthopedic and neurosurgical PSFs were included. Postoperative ileus was defined using radiographic and/or clinical diagnoses (using postoperative radiographs, abdominal CT, ICD-9 or ICD-10 codes for postoperative ileus). The use of TIVA or inhaled anesthetic was captured from the anesthesia record. Exclusion criteria included patients undergoing anterior approach procedures and patients who had a concurrent abdominal procedure in the same admission (unless required due to pre-existing postoperative ileus).

Results: Of 3,451 patients meeting inclusion criteria undergoing PSF, 283 (8.2%) had a radiographic and/or clinical postoperative ileus. Mean (± SD) age at admission of ileus patients was 59.3 ± 15.8 years, 155 (54.8%) ileus patients were male, mean length of stay was 7.7 ± 5.0 days, and mean anesthesia time was 6.0 ± 2.2 hours. Ileus patients had a greater number of levels fused (44% 5+ levels fused vs. 25%, p<0.001). Of the 283 patients with ileus, 187 (66.1%) were orthopedic and 96 (33.9%) were neurosurgical patients. Patients with ileus were more likely to have received TIVA (166 [58.7%] vs. 117 [41.3%] inhalation only). Neurosurgical patients were more likely to receive TIVA (67.7%) vs. orthopedic patients (54.0%). When analyzing the entire cohort, TIVA patients were more likely to experience postoperative ileus compared to inhalation only patients (10.0% ileus rate vs. 6.5%, p=0.0009). However, ileus patients underwent longer procedures in the TIVA group (6.2 ± 2.3 hours anesthesia time vs. 5.6 ± 2.2 hours in inhalation group, p=0.032) and had a greater number of levels fused (5+ levels fused: 53% vs. 35%, p=0.003).

Discussion/Conclusion: TIVA was associated with higher rate of postoperative ileus compared to inhaled anesthetic. However, these patients also had longer operations and greater number of levels fused.
Poster 27

The Influence of Persistent Opioid Use on Healthcare Resource Utilization After Elective Lumbar Spine Surgery

Gerlach Erik, MD1, Plantz Mark, MD2, Swiatek Peter, MD1, Arpey Nicholas, MD1, Marx Jeremy, MD1, Weiner Joseph, MD1, Divi Srikanth, MD1, Hsu Wellington, MD2, Patel Alpesh, MD, MBA2

1 Northwestern University Department of Orthopaedic Surgery, Chicago, IL, , United States, 2 Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States

Background/Introduction: With the rise in chronic opioid dependence in the United States over the last two decades, surgeons have needed to balance providing short-term pain relief and mitigating risk for persistent opioid usage. The purpose of this study is to investigate the incidence of and risk factors for persistent opioid use after elective spine procedures and to quantify post-surgical healthcare utilization within this subpopulation.

Materials/Methods: Patients were retrospectively identified who underwent elective spine surgery for lumbar degenerative pathology between November 1, 2013 and September 30, 2018 at a single academic center. Patients were split into two cohorts, those with and without opioid use at 180 days postoperatively. Baseline patient demographics, underlying comorbidities, surgical variables, and pre-operative opioid use were assessed. Health resource utilization metrics within 1 year postoperatively (imaging studies, emergency and urgent care visits, hospital readmission, opioid prescriptions, and others) were compared between these two groups. Univariate and multivariate logistic regression was used to investigate the relationship between persistent opioid use and increased healthcare utilization in the first year after surgery.

Results: A total of 454 patients were included in the final cohort – 61 (13.4%) patients had persistent opioid use at 180-days after surgery. Patients with opioid persistence had significantly higher rates of post-operative healthcare utilization, including imaging studies (XR, CT, MRI), and emergency department visits, among others (p<0.05) (Table 1). Opioid persistence was associated with number of XR studies (OR 1.256; 95% CI: 1.131-1.380), CT studies (OR 2.250; 95% CI: 1.445-3.055), MR studies (OR 1.447; 95% CI: 1.211-2.289), emergency department visits (OR 1.715; 95% CI: 1.251-2.179), spinal injections (OR 3.211; 95% CI: 1.642-4.779), and pain management referrals (OR 4.008; 95% CI: 2.008-6.811) within the first year after surgery.

Discussion/Conclusion: Persistent opioid use after elective lumbar spine surgery is associated with an increased rate of healthcare resource utilization in the first year after surgery. Targeted interventions to reduce the opioid burden following spine surgery is critical to decrease high healthcare utilization.
Poster 28

The Effects of Florida Law HB21 on Opioid Prescriptions After Lumbar Spine Surgery

Geller Joseph, MD\(^1\), Milner Jacob, BS\(^2\), Pandya Shivani, BS\(^2\), Mohile Neil, MD\(^2\), Massel Dustin, MD\(^3\), Al Maaieh Motasem, MD\(^4\)

\(^1\) University of Miami, Miami, Florida, United States, \(^2\) University of Miami Miller School of Medicine, Coral Gables, Florida, United States, \(^3\) University of Miami Miller School of Medicine, Miami, Florida, United States, \(^4\) University of Miami Miller School of Medicine, University of Miami Miller School of Medicine, Miami, Florida, United States

**Background/Introduction:** The severity of the opioid epidemic in the United States is well documented in medical literature and is directly related to postoperative prescription opioids. On July 1st 2018, Florida implemented state-law HB21 in an effort to reduce opioid prescriptions. The purpose of this study is to evaluate the effects of this law on opioid prescribing patterns after lumbar spine surgery.

**Materials/Methods:** The following variables were evaluated with retrospective chart review before and after implementation of HB21: type of opioid prescribed, number of pills prescribed, morphine milligram equivalents (MMEs) prescribed, unplanned emergency department visits, and unplanned readmissions. In addition to chart review, the Florida Prescription Drug Monitoring Program was queried to determine the average number of pills and MMEs prescribed and sold for the latter cohort. Student’s T-tests and Fisher’s exact tests were used for statistical analysis. p<0.05 was considered significant.

**Results:** We reviewed 77 consecutive patients who underwent lumbar spine surgery from 01/2017 to 07/2018 and 172 consecutive patients from 07/2018 to 01/21. There were no significant differences between the two groups with regards to age, sex, ethnicity, BMI, number of levels fused, or preoperative opioid use. The average number MMEs (877.5 versus 438.9, p=0.02) prescribed per patient decreased significantly after HB21, however, the average number of pills prescribed did not decrease significantly (49.0 versus 44.5, p=0.09). There were no significant differences in unplanned postoperative emergency department visits (7.8% versus 5.2%, p=0.87), hospital readmissions (8.1% versus 9.1%, p=0.21), or reoperations (3.9% versus 4.1%, p=0.63) between the two groups.

**Discussion/Conclusion:** Florida law HB21 was successful in reducing the number of morphine milli-equivalents prescribed per patient after lumbar spine surgery, suggesting that legislation may change prescriber behavior and/or patient demand regarding postoperative opioid prescriptions after lumbar spine surgery. Further prospective studies with larger cohorts over longer periods of time are necessary to confirm that HB21 was successful in decreasing postoperative opioid prescriptions after lumbar spine surgery.
Poster 29

Weekend Admission Increases Risk of Readmissions Following Elective Thoracolumbar Spinal Fusion

Pasik Sara, BA1, Dominy Calista, BS2, Rosenberg Ashley, BS3, Cho Brian, BS4, Arvind Varun, BS2, Valliani Aly, BA1, Kim Jun, MD4, Cho Samuel, MD4
1 Icahn Mount Sinai School of Medicine, New York, New York, United States, 2 Icahn School of Medicine at Mount Sinai, New York, New York, United States, 3 Icahn School of Medicine, New York, New York, United States, 4 Department of Orthopaedic Surgery, Mount Sinai West, Icahn School of Medicine at Mount Sinai, New York, New York, United States

Background/Introduction: Hospital readmission is an important post-operative metric considering its impact on cost and clinical outcome. The effect of weekend admission on multiple surgical outcomes has been studied for decades. In order to further analyze the weekend effect on spine surgery, we investigated elective spinal fusion procedures and looked at 30- and 90-day readmissions as well as other surgical complications.

Materials/Methods: The National Readmission Database (NRD) tracks approximately 50% of all inpatient hospitalizations. Using unique patient linkage codes, patients can be longitudinally tracked, allowing for the study of longer-term readmission data. In this study, we identified all adult patients undergoing elective thoracolumbar spinal fusion procedures in 2016 by ICD-10 codes. Thoracolumbar procedures were analyzed separately. Each sample was divided into two cohorts based on weekday vs weekend admission. Patient demographics, insurance status, and comorbidities were analyzed. The primary outcomes were 30- and 90-day readmission which were investigated using logistic regression and analyzed with regard to day of admission (weekday vs weekend).

Results: A total of 48,632 undergoing thoracolumbar fusion were identified. There was no difference in comorbidity burden between weekend vs weekday. The 30-day readmission rates were 5.19% on weekdays and 10.35% on weekends; 90-day readmission was 8.67% on weekdays and 16.74% on weekends. Results indicated that, adjusting for sex, age, insurance status, and Charlson comorbidities, 30-day readmission was greater for weekend admission (OR 2.08 95% CI: 1.54-2.83; p<0.001). 90-day readmission was also greater (OR 2.09 95% CI: 1.63-2.68; p<0.001) for weekend admission. Complication rates were analyzed to explain the difference between readmission rates. The complication with the greatest difference between weekday vs weekend admission was post-operative infection (weekday was 0.46% vs weekend 1.32%, p=0.027).

Discussion/Conclusion: For elective thoracolumbar spinal fusion procedures, weekend effect increases the rate of 30- and 90-day readmission. Further analysis reveals that post-operative infection is the complication with the greatest difference between weekday vs weekend admission. Considering the impact of readmission on clinical outcomes, familiarity with the factors involved will allow for improved outcomes and health care utilization.
Predictors for Improvement in Low Back Pain Following Lumbar Laminectomy

Mazur-Hart David, MD1, Lopez Ramos Christian, MD2, Obayashi James, BS1, Gehling Hanne, BS2, Nugent Joseph, MHS3, Ryu Won Hyung A., MD2
1 Oregon Health and Science University, Portland, Oregon, United States, 2 Oregon Health & Science University, Portland, Oregon, United States, 3 Oregon Health Sciences University, Portland, Oregon, United States

Background/Introduction: Low back pain (LBP) is one of the most common complaints for patients with degenerative lumbar spine disease. However, there is no clear consensus on predictors of improvement in LBP and patient reported outcomes (PRO) after lumbar decompression. We aim to investigate preoperative clinical parameters that predict this improvement in LBP and PRO following lumbar laminectomy for lumbar stenosis.

Materials/Methods: This was an analysis of prospectively collected database from a single academic institution of patients undergoing lumbar laminectomy from 2017 to 2020. Patients were identified using CPT codes for lumbar decompression and ICD-10 codes for lumbar stenosis. We excluded patients that did not complete the 12-month post-operative questionnaire. Outcomes included back pain score, leg pain score, Oswestry Disability Index (ODI), Patient-Reported Outcomes Measurement Information System (PROMIS), and EuroQol five-dimensional questionnaire (EQ-5D). Patients who achieved minimal clinically important difference (MCID) in LBP were compared to those who failed to achieve MCID at 12-month follow-up. Clinical variables included age, sex, surgery type, levels decompressed, concurrent microdiscectomy, history of prior lumbar surgery, presence of spondylolisthesis, smoking status, insurance type, American Society of Anesthesia (ASA) grade, and body mass index.

Results: There were 185 patients who met inclusion criteria (female, n = 75, 40.5%) with mean age 58.8 years-old. The majority reached MCID for outcomes: back pain (n = 114, 61.6%), leg pain (140, 75.7%), ODI (n = 112, 60.5%), and EQ-5D (n = 98, 53.0%). Only by PROMIS did the majority not reach MCID (n = 77, 41.6%). Baseline clinical variables were comparable between those who achieved MCID in LBP compared to those who did not. However, patients who achieved MCID in back pain had significantly higher preoperative back and leg pain scores as well as greater disability in ODI, EQ-5D, and PROMIS scores.

Discussion/Conclusion: The majority of our patients experienced clinically significant improvements in LBP following lumbar decompression. Interestingly, patients that did reach MCID for back pain score had higher preoperative back pain scores and measures of disability compared to non-improvers. Also, patients with durotomy or prior surgery were not predictors for failure of improvement. Further studies will evaluate radiographic parameters and other clinical predictors.
Operative Treatment of Bertolotti Syndrome: Resection versus Fusion

Mikula Anthony, MD¹, Lakomkin Nikita, MD¹, Ransom Ryan, MD, PhD¹, Waksdahl Laura, CNP¹, Pennington Zach, MD¹, Sharma Manish, MBBS¹, Elder Benjamin, MD, PhD¹, Fogelson Jeremy, MD¹
¹ Mayo Clinic Rochester, Rochester, Minnesota, United States

Background/Introduction: Bertolotti Syndrome is an anatomic abnormality of an enlarged transverse process of the most caudal lumbar vertebrae that creates a pseudoarticulation or fusion to the sacrum and can cause low back pain. Although Bertolotti Syndrome was first described nearly a century ago, the paucity of published literature of this rarely recognized anatomic variant has left uncertainty regarding its clinical significance and the optimal treatment of a symptomatic Bertolotti joint.

Materials/Methods: A retrospective chart review identified patients with Bertolotti Syndrome who underwent operative treatment, consisting of either Bertolotti joint resection or fusion across the abnormal transitional lumbosacral vertebrae. Patients with other symptomatic operative spinal disease were excluded. Collected variables included basic demographics, presenting symptom(s) and duration, Castellvi imaging classification, pre-operative Bertolotti joint injection, and outcomes for operative treatment.

Results: Twenty-nine patients (nine men, 20 women) were identified for inclusion in the study with an average age of 40 ± 16 years, BMI of 27 ± 5, and follow up of 38 ± 46 months. Most patients presented with back pain (79%) or leg pain (45%) for an average duration of 59 ± 52 months. Twenty-one patients (72%) presented with a Castellvi subtype 2a Bertolotti joint with CT as the most common method for radiographic diagnosis (52%). Nineteen patients (66%) had a targeted Bertolotti joint injection with 16/19 (84%) having a positive response. When comparing long term pain improvement (>12 months) after fusion (n=10) versus joint resection (n=19), more fusion patients reported improvement in their pain (80%) compared to joint resection (32%, p-value = 0.007). There was not a statistically significant difference in the short-term pain improvement (<6 months) between the fusion (100%) and resection (79%, p-value = 0.268) patients. There was no statistically significant difference between the two groups in terms of age, sex, BMI, symptom duration, follow up, Castellvi subtype, and complication rate.

Discussion/Conclusion: Patients with Bertolotti Syndrome who underwent surgical fusion across the transitional lumbosacral vertebrae had a higher rate of long-term pain improvement compared to patients who had resection of the abnormal pseudoarticulation.
Poster 32

PROMIS is more sensitive than ODI for the detection of MCID in surgical patients with mild to moderate disability from lumbar degenerative pathology

Lanzetta Nicholas, BS¹, Linton Alexander, BS¹, Furman Andrew, MBA¹, Gerlach Erik, MD¹, Patel Alpesh, MD, MBA², Divi Srikanth, MD¹, Hsu Wellington, MD², Phan Eileen, BA²
¹ Northwestern University Department of Orthopaedic Surgery, Chicago, IL, United States, ² Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States

Background/Introduction: Patient-reported outcome measures (PROMs) are commonly used to assess for Minimal Clinically Important Differences (MCIDs) and serve as primary end points for clinical trials. The Oswestry Disability Index (ODI) is the most commonly used PROM in lumbar spine clinical trials. However due to ODI’s well-studied floor effects, patients with ODI <35 are typically excluded. Patient-Reported Outcomes Measurement Information System (PROMIS) scores, which have negligible floor effects, are a highly validated and a promising alternative to ODI. This study compares the sensitivities of PROMIS and ODI scores for the detection of MCID in lumbar surgical patients with low to moderate disability.

Materials/Methods: 182 patients surgically treated for lumbar degenerative pathology had ODI and PROMIS Pain Behavior (PB), Pain Interference (PI), Physical Function (PF) scores collected pre-operatively and post-operatively at 6-week, 3-month, 12-month, and 24-month time points. 65 patients with pre-operative ODI <35 and were included in the study. MCID thresholds for ODI and PROMIS were set at 15 and 5 points respectively, based on evidence-based literature. Sensitivities of MCID detection were compared via two-tailed t test with a level of significance of p<0.05.

Results: There were significant differences in the detection of MCID between ODI and PROMIS PI at 6 weeks [24/60 (40%) v. 38/60 (63%), (p = .003)], 3-months [29/59 (49%) v. 40/59 (68%), (p = .04)], and 24-months [25/51 (49%) v. 40/51 (78%), (p = .01)], and between ODI and PROMIS PF at 3-months [29/59 (49%) v. 41/59 (69%), (p = .03)] and 24-months [25/51 (49%) v. 39/51 (76%), (p = .01)]. There were no other significant differences between ODI and PROMIS scores for MCID detection at the other time points.

Discussion/Conclusion: PROMIS PI and PF are more sensitive than ODI for the detection of MCID in patients with low to moderate disability level lumbar degenerative pathology requiring surgery. The use of PROMIS PI and PF scores may lead to the justification of including more patients with lower levels of disease severity in important clinical trials for the treatment of lumbar degenerative pathology.
Risk Factors for Requiring Multiple Revision Procedures after previous Lumbar fusion ≤4 levels fused

Ani Fares, MD1, Walia Arnaav, BA1, Perrier Gregory, BS1, Bono Julianna, BS1, Kim Nathan, BS1, Maglaras Constance, PhD2, Patel Hershil, BS3, Burapachaisri Aonnicha, BS1, O’Connell Brooke, MS2, Protopsaltis Themistocles, MD4, Raman Tina, MD1
1 NYU Langone Department of Orthopedic Surgery, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 4 Department of Orthopedic Surgery, NYU Langone Health, New York, New York, United States

Background/Introduction: Surgical treatment for degenerative lumbar disc disease focuses on the patient’s pathological anatomy and relief of neurologic compression. Patients with radiculopathy related to central or foraminal stenosis, and back pain related to instability, generally improve after short segment lumbar fusion. We sought to identify rate of multiple revisions in patients who undergo lumbar fusion ≤3 levels as well as identify patient and surgical risk factors.

Materials/Methods: 455 patients (Age: 60.1±13.4; BMI: 30.3±6.3kg/m²; % Female 53.0%) undergoing revision of a previous 1-3 level lumbar fusion were reviewed. Patient and surgical risk factors for requiring a single revision versus multiple revision were assessed.

Results: In the 455 patients, the indications for the first revision procedure were: adjacent segment disease (23.1%), herniated nucleus pulposus (28.3%), degenerative spondylolisthesis (41.1%), and pseudarthrosis (27.9%). Of the 455 patients, 39 patients (8.6%) went on to require multiple revisions surgeries for malpositioned instrumentation (17.9%), adjacent segment disease (17.9%), pseudarthrosis (15.4%), to receive additional direct decompression (12.8%), and mechanical failure (5.1%). Mechanical failure primarily consisted interbody cage retropulsion (50%), Upper-instrumented vertebral fracture (25%), and screw fracture (25%). Comparison of patients who were successfully treated with one revision surgery versus those that required multiple revision procedures demonstrated that multiple revision patients were more likely to have had an intra- or post-operative complication during their first revision, particularly intraoperative fracture or mispositioned instrumentation. Patients who required multiple revision surgeries more commonly had a diagnosis of iatrogenic or degenerative flatback deformity at the time of their first revision (7.9% vs 2.5%, p=0.059). The most common pathologies requiring multiple revision surgeries were degenerative spondylolisthesis (52.6%) and pseudarthrosis (39.5%).

Discussion/Conclusion: We found that compared with patients who were treated successfully with a single revision surgery, patients who require multiple revision surgeries more commonly had an iatrogenic or degenerative flatback deformity at the first revision and sustained an intra- or postoperative complications after the first revision. The most common indications for multiple revisions were degenerative spondylolisthesis and recurrent pseudarthrosis.
Modified Frailty Index Independently Predicts Morbidity in Patients Undergoing Instrumented Fusion Following Extradural Tumor Removal

Katz Austen, MD, Strigenz Adam, BA, Seitz Mitchell, BA, Song Junho, BS, Verma Rohit, MD, Virk Sohrab, MD, Silber Jeff, MD, Essig David, MD
1 North Shore LIJ Health System, Manhasset, New York, United States, 2 Northwell Health, New Hyde Park, New York, United States, 3 Hospital for Special Surgery, New York, New York, United States, 4 North Shore University/Long Island Jewish Medical Center, Great Neck, United States

Background/Introduction: Management of spinal neoplasia consists of surgical, radiation, and systemic options. The NOMS and SINS framework help determine optimal therapy and predict need for surgical stabilization in such patients. However, little data exists to guide management based on overall health status, which is particularly challenging when patients who could benefit from surgery may be too frail for it. This study evaluated modified-5-item-frailty-index (mFI-5) as a predictor of 30-day morbidity in patients undergoing instrumented spine-tumor-resection.

Materials/Methods: Adults undergoing extradural-tumor-resection from the 2011-2019 NSQIP-datasets were identified by CPT-codes 63275-63278 with an adjunct instrumentation-code (22840-22843). Patients were classified into frailty-levels 0, 1, or 2 based on mFI-5-score of 0, 1, or 2-5, respectively. Primary outcome was morbidity. Secondary outcomes were readmission and reoperation. Multivariate modeling was utilized to analyze mFI-5 as a predictor of outcomes. Akaike Information Criterion (AIC) was used to compare relative-model-fit based on frailty versus individual comorbidity variables to determine the optimal model, with a difference in AIC >2 indicating a meaningful difference in support.

Results: There were 882 patients. Readmission, reoperation, and morbidity rates were 19.5%, 5.0%, 52.3%, respectively. In multivariate analysis, frailty-level-1 (p=0.027,OR=1.47,C195:1.05-2.09), OR-time (p<0.001,OR=1.18,C195:1.13-1.24), and chronic-steroid-use (p=0.035,OR=1.57,C195:1.03-2.38) independently predicted morbidity (Table 1). BMI (OR=0.96), elective/non-emergency surgery (OR=0.57), and hematocrit (OR=0.90) were protective. Frailty did not predict readmission or reoperation.

Discussion/Conclusion: Frailty-level-1 independently-predicted a 47% increased-odds of morbidity. Frailty-level-2 did not predict morbidity, likely owing to only 17% of patients with mFI-5 >2. Along with high surgical morbidity and readmission rates, this suggests that patients with operative extradural metastases have poor medical reserve, but are not well-represented by the mFI-5 comorbidity framework. Further, every 30-minutes of OR-time predicted a 18% increase in odds of morbidity, suggesting an increased risk of site-related complications events. However, reoperation rates were low, suggesting that revision was either delayed or avoided altogether due to patient-health factors. The protective effects of increasing BMI and hematocrit emphasize the importance of preoperative nutritional optimization. Taken together, while mFI-5 serves as a valid predictor of morbidity in patients with extradural-tumor undergoing
instrumented excision, future research should focus on more specific predictive framework to complement the existing SINS and NOMS models.
Poster 35

Risk Factors for Short-Term Complications Among Octogenarians Undergoing Elective Lumbar Decompression or Fusion Procedures: A Matched-Cohort Study

Weissman Joshua, BBA¹, Plantz Mark, MD¹, Gerlach Erik, MD², Arpey Nicholas, MD², Swiatek Peter, MD², Hsu Wellington, MD¹, Patel Alpesh, MD, MBA¹, Divi Srikanth, MD²
¹ Northwestern University Feinberg School of Medicine, Northwestern, Chicago, Illinois, United States, ² Northwestern University Department of Orthopaedic Surgery, Chicago, IL, , United States

Background/Introduction: The purpose of this study is to assess the incidence and risk factors for short-term complications in patients over the age of 80 years undergoing elective posterior-approach lumbar decompression or fusion procedures.

Materials/Methods: Patients that underwent elective, single-level, posterior-approach lumbar decompression or fusion procedures between January 1st, 2015 – December 31st, 2017 were identified in the ACS NSQIP database. Exact matching was used to match patients aged 80 years and older to patients between 65-79 years-old based on sex, ASA class, BMI, functional status, and several medical comorbidities. The rate of several 30-day outcomes – unplanned readmission, reoperation, prolonged length-of-stay, non-home discharge, mortality, surgical and medical complications – were compared between the matched cohorts. Logistic regression was used to identify independent factors that were associated with the 30-day outcome.

Results: A total of 10,434 patients were included in the final analysis with 7,692 patients that underwent decompression alone and 2,742 patients that underwent decompression and fusion. In the decompression alone cohort, octogenarians had significantly higher rates of readmission, non-home discharge, prolonged length-of-stay, perioperative bleeding, overall medication complications, and urinary tract infections (p<0.001 for all). Similarly in the fusion cohort, octogenarians had significantly higher rates of non-home discharge (p<0.001), perioperative bleeding (p=0.032), and urinary tract infections (p=0.021). Within the octogenarian cohort, those that underwent single-level fusion procedures had a higher rate of readmission, non-home discharge, prolonged length-of-stay, and overall medical complications compared to octogenarians undergoing decompression alone. Significant risk factors for readmission for octogenarians undergoing decompression alone included a history of COPD, steroid use, ASA class III, and partially dependent functional status (p<.001), whereas significant risk factors for readmission for octogenarians after fusion included obesity class I or greater (p<.001).

Discussion/Conclusion: Octogenarians had perioperative and medical complications compared to their younger counterparts undergoing lumbar decompression and/or fusion surgery, however, there was no difference in mortality between both octogenarian groups and their controls. Amongst octogenarians, those undergoing single-level fusions also had a higher rate of complications relative to decompression alone, with COPD, steroid use, ASA class, obesity, and functional status all identified as risk factors.
Poster 36

Stand Alone ALIF vs ALIF with Posterior Instrumentation: Comparison of Clinical Outcomes

Jacob Kevin, BS1, Patel Madhav, BS1, Parsons Alexander, MS1, Chavez Frank, BS1, Pawlowski Hanna, BS1, Vanjani Nisheka, BS1, Prabhu Michael, BS1, Singh Kern, MD1
1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: When considering an anterior fusion approach, a stand-alone anterior lumbar interbody fusion (ALIF) or ALIF with posterior instrumentation (APLIF) can be used. Traditionally, APLIF was thought to provide improved radiographic outcomes with less pseudarthrosis risk and greater biomechanical posterior stability. Few long-term follow-up studies have compared these techniques for long-term clinical outcomes.

Materials/Methods: Primary, elective, single-level ALIFs between 2005-2021 were identified. Patients were grouped as ALIF or APLIF, based on addition of posterior instrumentation. Demographics, perioperative characteristics, and patient-reported outcome scores were collected. Patient-Reported Outcome Measures (PROMs), including Patient Reported Outcome Measurement Information System- Physical Function (PROMIS-PF), Visual Analog Scale (VAS back/leg), Oswestry Disability Index (ODI), 12-item Short Form Physical and Mental Composite Score (SF-12 MCS, SF-12 PCS), were collected at preoperative, 6-week, 12-week, 6-month, 1-year, and 2-year timepoints. Delta PROMs were calculated. Differences in demographics, perioperative characteristics, mean/delta PROMs, and MCID achievement were evaluated by chi-squared or Student’s t-test.

Results: A total of 101 patients were eligible for this study (57 stand-alone ALIF cohort and 44 APLIF cohort). Fusions occurred exclusively at L5-S1. Operative time was significantly greater in the APLIF cohort (p≤0.001, all). Postoperative narcotic consumption on day of surgery and postoperative inpatient pain score on day 1 was significantly greater for patients in APLIF cohort (p<0.040, all). Preoperative PROM scores were not significantly different across all PROMS with the exception of VAS back. The following significant differences in postoperative delta PROMs were demonstrated: SF-12 MCS at 12-weeks (p<0.071, all) (Table 1). Patients in the APLIF cohort demonstrated greater proportion achieving MCID for SF-12 PCS at 6-weeks .(p ≤ 0.019). No other difference in MCID achievement were noted.

Discussion/Conclusion: APLIF cohort demonstrated greater postoperative pain scores and operative times versus stand-alone ALIF. However, the majority of mean postoperative PROMS and MCID achievement rates did not significantly differ. Patients undergoing either procedure can expect a similar medium and long-term clinical postoperative course.
Poster 37

Low Back Pain with Surgical and Nonsurgical Treatment of Closed Pelvic Ring Fractures with Sacral Injuries: A Single Institutional Retrospective Review

Yen Tzu Chuan, MD¹, Huff Haley, BS², Leary Emily, PhD¹, Schweser Kyle, MD², Ghassibi Michael, DO¹, Moore Don, MD, na²
¹ University of Missouri-Columbia, Columbia, Missouri, United States, ² University of Missouri - Columbia, Columbia, Missouri, United States

Background/Introduction: Sacroiliac (SI) joint fusion surgery for chronic back pain has grown in popularity since 2011. A variety of implants have been developed to allow surgeons to perform this technique with ease while decreasing complications. Despite the wide acceptance of the technology, the treatment of SI joint pain is complex and controversial. The purpose of this study is to determine if surgery negates the need for additional intervention for SI joint pain and determine if reduction of displacement with surgery contributes to better outcomes for the patient.

Materials/Methods: A total of 68 patients (56% male) from a Level I trauma center were included between 2015 and 2019. Patients between 18 and 65 years of age who sustained closed pelvic ring fractures with SI joint involvement were included in the study. Exclusion criteria include lack of contact information, history of back pain prior to the injury, lack of appropriate follow up radiographs, and previous history of lumbar surgery or lumbar surgery as a result of the inciting injury. Patients were separated into surgical and non-surgical groups, with additional interventions of chiropractic manipulation, narcotics, physical therapy, non-steroidal anti-inflammatory medications and home exercises. Student’s T test, Wilcoxon rank sum test, and Fischer exact test were used for data analysis with statistical significance achieved when p <0.05. A stepwise regression model was used to determine if comorbidities are associated with increased interventions.

Results: No significant difference was found between the surgical and non-surgical groups in terms of both demographics and comorbidities. There was also no significant difference between the number of interventions needed for patients treated with or without surgery. Increased comorbidities are not associated with an increased number of interventions needed in either the surgical or non-surgical group. Additionally, surgery did not significantly decrease the amount of anterior-posterior and vertical displacement as measured on x-rays.

Discussion/Conclusion: Conservative management is likely just as effective for certain pelvic ring injuries involving the SI joint and surgery for SI joint pain should be presented as a treatment that will likely require additional interventions for patients to return to pre-injury activity levels similar to the interventions required for non-operative patients.
RF Paper 01

The Impact of Socioeconomic Status on Discharge Disposition following 1-2 Level Posterior Interbody Fusion

Varghese Priscilla, MS, BS, MBA\textsuperscript{1}, Kim Lindsay, BA\textsuperscript{1}, O'Malley Nicholas, BS\textsuperscript{2}, O’Connell Brooke, MS\textsuperscript{3}, Maglaras Constance, PhD\textsuperscript{3}, Raman Tina, MD\textsuperscript{2}, Protopsaltis Themistocles, MD\textsuperscript{1}, Kim Yong, MD\textsuperscript{4}, Fischer Charla, MD\textsuperscript{5}

\textsuperscript{1} Department of Orthopedic Surgery, NYU Langone Health, New York, New York, United States, \textsuperscript{2} NYU Langone Department of Orthopedic Surgery, New York, New York, United States, \textsuperscript{3} Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, \textsuperscript{4} Academic Medical Center, NYU Langone Medical Center, New York, New York, United States, \textsuperscript{5} Department of Orthopedic Surgery, NYU Orthopedic Hospital, NYU Langone Health, Albany, New York, United States

Background/Introduction: Disparities in discharge disposition are considered a health inequity. Current orthopedic research has only explored the impact of socioeconomic status (SES) on discharge location. The purpose of this study was to identify the effect of SES on discharge disposition in 1-2-level TLIF/PLIF.

Materials/Methods: This was a retrospective cohort study. Demographics, BMI, smoking status, intra-op comps, post-op comps, discharge dispositions, readmissions, and post-op ED visits were reviewed. Discharge dispositions included subacute nursing facility (SNF), home with self-care (HSC), home with health services (HHS), and acute rehab facility (ARF). Income quartiles were estimated using zip codes. PSM controlled for race, BMI, lvls fused, and Charlson Comorbidity Index (CCI). Analyses were conducted using chi-square and ANOVA.

Results: 326 patients met inclusion. Cardiac comps were higher in females than in males (10.9% vs.2.8%;p=0.005). There was higher incidence of urinary comps (8.59% vs.2.7%;p=0.025) and neuro comps in males (8.5% vs.2.7%;p=0.025). Post-hoc Tukey demonstrated differences between Asians and all other races in age and BMI. Rate of discharge to SNF was higher in females compared to males (25.00% vs.10.56%;p=0.001). Men were discharged home at a higher rate than women (75.4% vs.61.95%;p=0.010). LatinX pts had the highest rate of home discharge (p<0.001). Pts. discharged to SNF had the highest CCI, followed by those at ARF, HHS, and HSC (4.36 vs.4.05 vs.2.87 vs.2.37;p<0.001). Males had higher rates of post-op ED visits than females (7.0% vs.1.1%;p=0.006). There were no differences in re-admission based on race, gender, or income.

Discussion/Conclusion: Males showed greater rates of ED visits and are more likely to be discharged home, while females have higher rates of discharge to SNF. LatinX pts are discharged home at higher rates. No differences in rates of ARF, HHS, and HSC, or readmissions were seen in regard to gender, race, or income. No differences were seen when comparing home vs non-home discharge rates and income.
Social Media Use by Spine Surgeons May NotIncrease the Number of Ratings on Physician Review Websites

Finkel Ryan, MD\textsuperscript{1}, Mustafa Jabra, BS\textsuperscript{2}, Suleiman Rawan, BS\textsuperscript{2}, Caicedo Daniel, BA\textsuperscript{2}, Suleiman Razan, BS\textsuperscript{2}, Murickan Tom, BS\textsuperscript{2}, Ali Rafia, BS\textsuperscript{2}, Ziauddin Lubna, BS\textsuperscript{2}, Zafer Maimuna, BS\textsuperscript{2}, Siyaji Zakariah, BS\textsuperscript{2}, Sayari Arash, MD\textsuperscript{1}

\textsuperscript{1}Cedars-Sinai Medical Center, Los Angeles, California, United States, \textsuperscript{2}Regenerative Pain & Spine, Chicago, Illinois, United States

Background/Introduction: Physician review websites have become a common mode by which patients choose their specialists. Enhancing social media presence is a potential way for spine surgeons to attract patients, but its impact is not well studied. This study sought to analyze the effect of social media on the number of online ratings and overall rating of spine surgeons.

Materials/Methods: Association of Neurological Surgeons (AANS) and the American Academy of Orthopaedic Surgeons (AAOS) directories were probed to identify practicing spine surgeons in the State of Illinois. Surgeon evaluation data (number of ratings, number of comments, overall rating) and demographic variables (information on surgeon training, practice location, surgeon age) were compiled from 3 physician websites: Google.com (i.e. Google), Healthgrades.com (i.e. Health Grades), and Vitals.com (i.e. Vitals). Google was queried to assess for a professional Facebook, Twitter, or Instagram account.

Results: 109 surgeons met the inclusion criteria. The age of surgeons was significantly different between those with and without social media ($p=0.038$). Institution type was also a significant predictor of social media presence with more academic surgeons having social media accounts than private surgeons ($p=0.003$). A minority of the spine surgeons had a social media presence (43%), with Youtube being the most popular (51.1%; $p<0.001$), followed by Facebook (19.1%; $p<0.001$), Twitter (19.1%; $p<0.001$), and Instagram (6.3%; $p=0.077$). Surgeons who had a professional social media presence were significantly more likely to have Healthgrades profiles with more comments ($p=0.002$). Compared to surgeons who graduated before the year 2000, surgeons who graduated after the year 2000 had significantly more comments ($p = 0.014$), higher Care Philosophy ($p = 0.023$), and higher scores ($p = 0.020$).

Discussion/Conclusion: The majority of spine surgeons do not have a professional social media account. Spine surgeons who graduated after the year 2000 had a higher Vitals rating and more comments on Healthgrades despite no difference in presence of social media outlets. Having a professional social media profile was not correlated with ratings, but there was a positive association with the number of comments. Comments are overwhelmingly positive with minimal variability; therefore, a high number of ratings strongly suggests an exceptional reputation. Recent graduates practicing in competitive locations may feel increased pressure to leverage this in an attempt to build their practices.
RF Paper 03

Appropriate Telemedicine Utilization in Spine Surgery: Results From a Delphi Study

Iyer Sravisht, MD¹, Bovonratwet Patawut, MD¹, Samartzis Dino, PhD², Schoenfeld Andrew, MD³, An Howard, MD⁴, Awwad Waleed, MD⁵, Blumenthal Scott, MD⁶, Cheung Jason, MBBS⁷, Derman Peter, MD⁶, El-Sharkawi Mohammad, MD⁸

¹Hospital for Special Surgery, New York, New York, United States, ²Midwest Orthopaedics at Rush University, Chicago, Illinois, United States, ³Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, ⁴Midwest Orthopaedics at Rush, Chicago, Illinois, United States, ⁵College of Medicine, King Saud University, Riyadh, Middle, Saudi Arabia, ⁶Texas Back Institute - Denton, Denton, Texas, United States, ⁷The University of Hong Kong, Pokfulam Road, Hong Kong, Hong Kong, China, ⁸Assiut University Hospital, Assiut, Assiut, Egypt

Background/Introduction: Several studies have shown high patient satisfaction associated with telemedicine during the COVID-19 peak pandemic period as well as after easing of restrictions. As this technology will most likely continue to be employed, there is a need to define appropriate utilization. Therefore, the objective of the current study were to obtain expert consensus on best practices for appropriate telemedicine utilization in spine surgery.

Materials/Methods: An expert panel consisting of 27 spine surgeons from various countries was assembled in February 2021. A two-round consensus-based Delphi method was used to generate consensus statements on various aspects of telemedicine (separated as video visits or audio visits) including themes, such as patient location and impact of patient diagnosis, on assessment of new patients. Topics with ≥75% agreement were categorized as having achieved a consensus.

Results: The expert panel reviewed a total of 59 statements. Of these, 32 achieved consensus. The panel had consensus that video visits could be utilized regardless of patient location and that video visits are appropriate for evaluating as well as indicating for surgery multiple common spine pathologies, such as lumbar stenosis, lumbar radiculopathy, and cervical radiculopathy. Finally, the panel had consensus that video visits could be appropriate for a variety of visit types including early, mid-term, longer-term post-operative follow-up, follow-up for imaging review, and follow-up after an intervention (i.e. physical therapy, injection).

Discussion/Conclusion: This is the first study, to our knowledge, to provide expert consensus on best practices for appropriate telemedicine utilization in spine surgery. To summarize, there was consensus that video-based telemedicine could be utilized regardless of patient location, is sufficient for evaluation and indication of surgery for multiple common spine pathologies, such as lumbar stenosis, lumbar radiculopathy, as well as cervical radiculopathy, and could be appropriate for various visit types. The results of the current study help elaborate optimal conditions and criteria for implementation of telemedicine in the evaluation of patients with spine conditions.
RF Paper 04


Shabani Saman, MD1, Agarwal Nitin, MD2, Huang Jeremy, BS1, Rechav Ben-Natan Alma, BA1, Aabedi Alexander, BS1, Le Vivian, MPH1, Tan Lee, MD1, Mummaneni Praveen, MD3, Chou Dean, MD3

1 Academic Medical Center, UCSF, San Francisco, California, United States, 2 University of California, San Francisco, San Francisco, California, United States, 3 Department of Neurological Surgery, UCSF Medical Center, San Francisco, California, United States

Background/Introduction: Recent technological advances have augmented the use of both robotic and navigated assisted spinal surgery. However, the superior strategy to facilitate screw accuracy remains unknown. The objective of this study was to evaluate the early experience of using robotics in spinal surgery and compare it to the use of navigation alone.

Materials/Methods: A retrospective, propensity score matched cohort study was utilized to compare pedicle screw placement in patients who underwent thoracolumbar fusion with robotic arm assistance versus navigation alone. Spine surgery cases at a quaternary care institution from 2019-2021 were queried. The Gertzbein and Robbins System was utilized to grade screw placement accuracy. Indications included deformity, degenerative thoracolumbar spondylosis, and spinal tumor. Unpaired two sample T-test was used to compare age, sex, body mass index (BMI), and type of surgical approach (i.e. minimally invasive versus open) between the two groups. T-test and Chi-square test were utilized to determine which covariates are confounding.

Results: In the robotic group, a total of 129 screws were placed (121 had perioperative computed tomography (CT) for screw placement verification). In the navigated group, a total of 131 screws were placed (all had perioperative CT for screw placement verification). The pedicle screw placement inaccuracy was statistically significantly greater in the robotic group at 10.7% (13/121) compared to 3.1% (4/131) in the navigated group (p = 0.04, < 0.05). Out of the 13 misplaced screws in the robotic group, only one required revision. There were no significant differences in demographic findings between the groups, including age, sex, and BMI (p > 0.05). The main factor contributing to screw misposition was medial or lateral displacement of the robotic trocar by a hypertrophied lumbar facet and sloped transverse process.

Discussion/Conclusion: Early experiences with robotics in spine surgery may be correlated with higher rates of screw malposition. Future developments for robotics must include solutions to prevent drill or trocar skiving to minimize medial or lateral screw deflection.

©AANS 2022, except where prohibited by US copyright law
Comparing Health-related quality of life (QoL) between Decompression and Paraspinous Tension Band Stabilization (D+PTB) and Transforaminal lumbar interbody fusion (TLIF) for Lumbar Degenerative Spondylolisthesis (DS)

Shahzad Hania, MBBS1, Bhatti Nazihah, BS1, Fielding Louis, MS2, Sasso Rick, MD3, Bae Hyun, MD4, Yoon Sangwook, MD, PhD5, Lavelle William, MD6, Bains Ravinder, MD7, Kuo Calvin, MD7, Sandhu Harvinder, MD8, Staff Michael, MD9, Perez-Cruet Mick, MD10, Berven Sigurd, MD11, Fischgrund Jeffrey, MD12, Deutsch Harel, MD13, Hassanzadeh Hamid, MD14, Guyer Richard, MD15, Gum Jeffrey, MD16, Alamin Todd, MD17, Yu Elizabeth, MD18
1 Wexner Medical Center, The Ohio State University, Columbus, Ohio, United States, 2 Empirical Spine, Inc., San Carlos, Arizona, United States, 3 Indiana Spine Group, Carmel, Indiana, United States, 4 The Spine Institute, Santa Monica, California, United States, 5 Emory University Department of Orthopaedics, Atlanta, Georgia, United States, 6 SUNY Upstate Medical University, Syracuse, New York, United States, 7 Kaiser Permanente Northern California, Oakland, California, United States, 8 Hospital for Special Surgery/Weill Cornell Medical College, New York, New York, United States, 9 University of Massachusetts Memorial Medical Center, Worcester, Massachusetts, United States, 10 Oakland University William Beaumont School of Medicine, Royal Oak, MI, Italy, 11 Department of Orthopedic surgery, San Francisco, California, United States, 12 William Beaumont Hospital, Royal Oak, MI, Italy, 13 Rush University Medical Center, Chicago, Illinois, United States, 14 University of Virginia, Charlottesville, Virginia, United States, 15 Texas Back Institute, Plano, Texas, United States, 16 Norton Leatherman Spine Center, Louisville, Kentucky, United States, 17 Stanford University Orthopaedic Surgery, Palo Alto, California, United States, 18 Ohio State University Wexner Medical Center, Columbus, Ohio, United States

Background/Introduction: The complications and risks associated with instrumented fusion have warranted surgeons to simply decompress patients, which often results in postoperative instability. The paraspinous tension band is a new stabilization option that also maintains motion in patients in whom stabilization in addition to decompression is desirable without adding the potential risks, morbidity, and complications of a fusion. We present interim results of QoL improvement in 220 subjects at a 90-day follow-up.

Materials/Methods: Patients with Grade 1 DS were enrolled in the FDA IDE study comparing D+PTB (NCT03115983) and decompression and fusion (D+F). Patients were interviewed to assess their QoL (using the 12-Item Short-Form Health Survey [SF-12]). Patient-reported outcomes were recorded at baseline and three-month follow-up. All prospectively enrolled patients in the IDE study who reached 3m follow-up and had complete records were included in this analysis.

Results: 220 patients (94 TLIF 61 females and 33 males, 126 D+PTB 74 females and 52 males) had complete 90-day follow-up records. Mean characteristics between TLIF vs D+PTB groups were: age 62.91/65.75; BMI 30.22/27.92, CCISum 0.42/0.44. There were no significant differences in physical (p= 0.08) and mental (p= 1.00) components of the SF-12 scores between the groups at baseline. Both the groups demonstrated significant physical and mental well-being
at a 90-day follow-up (all p<0.01).

**Discussion/Conclusion:** Patients receiving D+PTB and D+F both demonstrated significant improvement in health-related quality of life through 90-day follow-up. If these results are durable and generalizable, the D+PTB may offer an alternative to fusion for patients with symptomatic DS. Further study will include longer-term follow-up with propensity score-selected and matched subgroups. Decompression and paraspinous tension band represent a promising alternative to lumbar fusion for symptomatic DS with significant improvement in QoL which is comparable to the current standard surgical technique.
RF Paper 06

**Prediction Models for Length of Stay and Discharge Disposition in Elective Spine Surgery: Analysis of N=3,678 Patients and Comparison to ACS NSQIP Risk Calculator**

*Arora Ayush, BS\(^1\), Lituiev Dmytro, PhD\(^2\), Hadley Dexter, MD, PhD\(^3\), Berven Sigurd, MD\(^4\), Peterson Thomas, PhD\(^1\)*  
\(^1\)UCSF, Orthopaedic Surgery Department, San Francisco, California, United States, \(^2\)UCSF, San Francisco, California, United States, \(^3\)University of Central Florida College of Medicine, Orlando, Florida, United States, \(^4\)Department of Orthopedic surgery, San Francisco, California, United States

**Background/Introduction:** Accurate information regarding length of stay (LOS) and discharge disposition is important for patient informed choice and cost predictions in spine surgery. The purpose of this study is to utilize machine learning to predict LOS and discharge disposition following adult elective spine surgery, and to compare performance metrics of machine learning models to the ACS NSQIP prediction calculator.

**Materials/Methods:** Data was acquired retrospectively on patients undergoing spine surgery from the UCSF Electronic Health Record (EHR). Inclusion criteria consisted of adult patients undergoing an elective spine surgery. Patients were divided into 3 cohorts for stratified analysis: fusion and/or decompression of the cervical spine (≤3 segments), lumbar spine (≤3 segments), or multilevel spine surgery (>3 segments). Patients with neoplasms, infection, and trauma were excluded. Outcome variables were discharge disposition (home vs rehab) and LOS. Predictive variables included demographics, BMI, surgical region, surgical invasiveness, surgical approach, and comorbidities. Regression, classification trees, and Least Absolute Shrinkage and Selection Operator (LASSO) were used to build predictive models. Validation of the models was conducted on 16% of patients (N=587), using area under the receiver operator curve (AUC), sensitivity, specificity, correlation, and root mean squared error (RMSE). Patient data were manually entered into the ACS NSQIP online risk calculator to compare performance.

**Results:** Of 3,678 patients analyzed, 51.4% were male (N=1,890) and 48.6% were female (N=1,788). The average LOS was 3.66 days. 78% were discharged home and 22% discharged to rehabilitation. In Figure 1a, compared to NSQIP correlation of R=0.47 with observed LOS, the linear regression and LASSO models were significantly more correlated with observed LOS (R=0.55, p-value:<0.001 and R=0.53, p-value:0.0036, respectively). Of the models generated to predict discharge location (Figure 1b), logistic regression yielded an AUC of 78.8, which was statistically equivalent to the AUC of 75.2 for NSQIP (p-value:0.135).

**Discussion/Conclusion:** In this analysis of 3,678 patients, multiple predictive models were generated to assess LOS and discharge location. While accuracy in prediction of discharge was same to that of NSQIP, the models built outperformed NSQIP in predicting LOS. The predictive models can be used to guide subsequent preoperative optimization and minimize patient risks.
Impact of Interbody Approach and Lumbar Level on Segmental, Adjacent, and Sagittal Alignment in Degenerative Disease

O'Connor Bailey, BS¹, Leveque Jean-Christophe, MD¹, Nemani Venu, MD, PhD¹, Krause Katie, MD, PhD¹, Shen Jesse, MD¹, Sethi Rajiv, MD¹, Louie Philip, MD¹
¹Neuroscience Institute, Virginia Mason Medical Center, Seattle, Washington, United States

Background/Introduction: Interbody fusion, including: transforaminal (TLIF), posterior (PLIF), anterior (ALIF), and lateral (LLIF); effectively treat lumbar degenerative pathology and provide spinopelvic balance. The objective of this study is to compare changes in spinopelvic parameters six months following one-two level TLIF, PLIF, ALIF, and LLIF.

Materials/Methods: This retrospective study included 18 centers of various practice settings across the United States. Patients were included in the study if they underwent a one- or two-level primary lumbar fusion for degenerative pathology. Measurements of the pre-operative and six-month postoperative lumbar AP and lateral lumbar plain radiographs included: pelvic incidence (PI), pelvic tilt, lumbar lordosis from L1-S1 (LL), as well as segmental lordosis (SL) of each segment between L1-S1.

Results: 474 patients underwent 632 levels of fusion. ALIF/LLIF resulted in significantly more segmental lordosis compared to TLIF/PLIF procedures at both L4-5 and L5-S1 (p < .001). Overall, ALIF/LLIF resulted in significantly more global lumbar lordotic alignment change compared to TLIF/PLIF (p = .01). Whether patients' alignment was preserved versus worsened was not significantly predicted by type of procedure. Similarly, whether patients' alignment was restored versus not corrected was not significantly predicted by type of procedure. Finally, anterior approaches resulted in decreased lordosis at both the supra and infra adjacent levels, thus resulting in a more neutral position.

Discussion/Conclusion: In this large-scale multicenter study of lumbar fusion patients presenting with degenerative lumbar pathology, we report that anteriorly-placed grafts (ALIF/LLIF) led to a greater likelihood of patients being preserved rather than worsened in their spinopelvic mismatch. Posteriorly-placed TLIF or PLIF grafts tended to worsen lordosis both segmentally and globally, yet even the anterior grafts only modestly improved those two measurements. Therefore, A/LLIF procedures maintain pre-operative segmental lordosis more effectively than T/PLIF procedures.
RF Paper 08

Utilizing Previous Patient Opioid Experiences for Pain Plan Implementation: Role of Opioid Use Categorization on Inpatient and Outpatient Opioid Use, Length of Stay, Pain Scores, and Clinic Resource Utilization Following Elective Spine Surgery

Williams Seth, MD1, Rozenfeld Sydney, BA2, Bice Miranda, MD1, Hetzel Scott, MS3, Hesselbach Kristin, Pharmacy Student4, Ludwig Trisha, Doctor of Pharmacy4, Uppal Harjot, BS2
1 University Of Wisconsin-Madison, Department of Orthopedics and Rehabilitation, Madison, Wisconsin, United States, 2 University of Wisconsin Madison School of Medicine and Public Health, Madison, Wisconsin, United States, 3 University of Wisconsin - Madison, Madison, Wisconsin, United States, 4 University of Wisconsin Madison, Madison, Wisconsin, United States

Background/Introduction: A Pain Plan was formulated for all patients undergoing elective spine surgery at our institution. The Pain Plan was based on prior opioid experiences and developed collaboratively between the patient and the surgeon at a preoperative clinic visit. Category 1 – No previous opioid experience Category 2 – Previous opioid experience with acceptable pain control and no side effects Category 3 – Previous opioid experience with unacceptable pain control and/or side effects Category 4 – Opioid use leading up to surgery The purpose of this study is to analyze if Pain Plan categorization is predictive of opioid use, length of stay (LOS), patient-reported pain scores, and pain management-related clinic resource utilization.

Materials/Methods: This is a retrospective cohort study comparing patients within the four different Pain Plan categories over one year (n=313). Demographic data collected included age, gender, ASA class, BMI, smoking status, insurance details, history of substance abuse, and comorbid psychiatric diagnoses. Opioids were converted into morphine milliequivalents (MME). Primary outcome measures assessed include inpatient opioid quantities, outpatient opioid prescription quantities, LOS, patient-reported pain scores, and communication encounter number and complexity.

Results: There was no difference in LOS or complexity of communication encounters amongst groups (Table 1). Inpatient and outpatient opioid use were statistically significant amongst the categories, with prescription quantities being greatest in category 4, followed by categories 2, 3, and 1, respectively. Patient-reported pain scores were also significant and followed the same trend as opioid quantities. The number of communication encounters was only significant for category 3 versus 4.

Discussion/Conclusion: We expected category 3 and 4 patients to require more opioids, report higher pain scores, and use more resources than categories 1 and 2. This was consistent for category 4, but category 3 patients reported lower pain scores and used fewer opioids than categories 2 and 4. Category 4 patients had higher inpatient opioid use and greater pain scores as expected, but there was no difference in LOS. Category 3 and 4 patients required considerably more effort to build the Pain Plan. We feel this extra effort was an effective tool for decreasing postoperative opioid use at our institution.
A Retrospective Review of 110 Prone Lateral Lumbar Interbody Fusion Cases: A Single Surgeon Experience

Patel Ashish, MD1, Paul Ravi, 1, Paul RonJon, MD1
1 Duly Health and Care, Naperville, Illinois, United States

Background/Introduction: Lateral lumbar interbody fusion (LLIF) is a technique used to perform single or multilevel minimally invasive lumbar fusions for over a decade. LLIF allows for indirect decompression of central and foraminal stenosis, restoration of lordosis, and anterior fusion during surgical treatment of lumbar degenerative pathologies. When performed in the prone position (p-LLIF), there could be a substantial improvement in time under anesthesia and cost efficiency from avoiding the flip from the traditional lateral decubitus to the prone position for decompression, osteotomy, and/or screws.

Materials/Methods: A single surgeon retrospective review of prone lateral interbody fusion cases from May 2019 – Dec 2021

Results: There was a total of 208 interbody levels in 110 patients with average age of 66.4 years. There were 65 single level (60%), 21 two level (18%), 20 three level (17%), and 4 four level (4%) surgeries performed. 81 patients (73%) had p-XLIF inclusive of the L4-5 level. Two corpectomies and three anterior column reconstructions were performed. 106 patients (98%) had concomitant posterior work completed. Average surgical time for a single level surgery was 72 mins (min-max 51-105) with average length of hospital stay 1.1 days (min-max 0-5). 3 cases were aborted and converted to a TLIF. There were 2 cases of unintentional anterior longitudinal ligament ruptures requiring interbody implant with plate fixation, 3 cases of femoral nerve palsy, 2 which recovered fully at 6 weeks and a single case which improved to 4/5 at 1 year post op. There was 1 case of revision for implant malposition impinging on the contralateral foramen. There were no cases of vascular, bowel, or complete spinal cord/root/plexus injury.

Discussion/Conclusion: Our data demonstrates the utilization of the p-LLIF technique in treating pathology of the lumbar spine. We found length of hospital stay and complication profile is like that of traditional LLIF performed in the lateral decubitus position. Further long-term studies are required to understand the full utility and safety of this approach. Nevertheless, early data demonstrates an improvement in anesthesia and surgical time and the potential benefit of p-LLIF in the ambulatory surgery center by avoiding the need for prone repositioning.
Impact of Predominant Back Pain versus Predominant Leg Pain on VAS and ODI Satisfaction Scores following MIS LD

Patel Madhav, BS¹, Jacob Kevin, BS¹, Lynch Conor, MS¹, Cha Elliot, MS¹, Prabhu Michael, BS¹, Pawlowski Hanna, BS¹, Vanjani Nisheka, BS¹, Singh Kern, MD¹
¹Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Previous studies have suggested relationships between preoperative patient-reported outcome measures (PROMs) and patient satisfaction following minimally invasive spine surgery. We aim to assess the predictive value of predominant back versus leg pain on postoperative satisfaction following minimally invasive spine surgery lumbar decompression (MIS LD).

Materials/Methods: Primary, single-level MIS LD patients were identified. VAS back/VAS leg measured preoperative back/leg pain. Patients were grouped: predominant back pain(pBP)/predominant leg pain(pLP). Demographic and perioperative variables were descriptively analyzed. PROMs, including Patient-Reported Outcomes Measurement Information System- Physical Function (PROMIS-PF), Visual Analogue Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), 12-Item Short Form Physical Composite Score and Mental Composite score (SF-12 PCS/SF-12 MCS), were collected at preoperative/6-week/12-week/6-month/1-year/2-year postoperative timepoints. Postoperative PROMs and satisfaction scores were compared between groups using Student’s t-test. Simple logistic regression determined differences in minimum clinically important difference (MCID) achievement rates.

Results: A total of 160 MIS LD patients were included with a mean age of 43.2, of which 55.6% were male and 55.6% obese (body mass index ≥30 kg/m²). Patient demographics were similar among pBP and pLP, with the exception of gender, BMI, and Charlson Comorbidity Index (CCI) score (p≤0.047, all). Mean preoperative VAS back scores were 6.6 (pBP) and 4.2 (pLP). Mean preoperative VAS leg scores were 5.2(pBP) and 6.1(pLP). pBP demonstrated higher PROMIS PF at 6-weeks/12-weeks(p<0.001, both), SF-12 PCS at 6-weeks/12-weeks(p≤0.043, both), SF-12 MCS at preoperative/6-weeks/12-weeks/2-years(p≤0.018, all), ODI preoperatively(p=0.002), and VAS back preoperatively(p<0.001). VAS leg was higher for pLP at preoperative/6-months(p≤0.017, both). pBP saw greater MCID achievement rates for PROMIS PF at 6-months(p=0.021), all VAS back measures(p≤0.024, all), and VAS leg at 12-weeks/2-years(p≤0.037, both). pBP cohort showed higher leg pain satisfaction at 6-months/2-years(p<0.026, both)(Table 1).

Discussion/Conclusion: Patients with pBP versus pLP did not demonstrate significant differences in postoperative satisfaction related to disability or back pain. However, pBP patients had greater satisfaction for leg pain in the early and longer-term postoperative period following MIS LD. MCID achievement rates were largely similar among pBP and pLP; however, pBP had higher achievement rates for VAS back at all timepoints and VAS leg at multiple timepoints, suggesting a relationship worth examining further.
RF Paper 11

Prophylaxis Usage Can Mitigate the Effects of Radiographic Complications in Patients Who Maintained a Poor Post-Operative Alignment

Passias Peter, MD1, Krol Oscar, BA1, Tretiakov Peter, BS2, Joujon-Roche Rachel, BS2, Imbo Bailey, BA3, Williamson Tyler, MS2, Vira Shaleen, MD4, Diebo Bassel, MD5, Lafage Renaud, MS6, Lafage Virginie, PhD6, Chou Dean, MD7, Mummaneni Praveen, MD7, Park Paul, MD6, Shabani Saman, MD6, Janjua Burhan, MD10, Schoenfeld Andrew, MD11, Smith Justin, MD12

1 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 New York University School of Medicine, NYU School of Medicine, New York, New York, United States, 4 Department of Orthopedic Surgery, UT Southwestern Medical Center, Dallas, Texas, United States, 5 Department of Orthopedic Surgery at SUNY Downstate Medical Center, Brooklyn, New York, United States, 6 Hospital for Special Surgery, New York, New York, United States, 7 Department of Neurological Surgery, UCSF Medical Center, San Francisco, California, United States, 8 The University of Michigan Health System, Ann Arbor, Michigan, United States, 9 Academic Medical Center, UCSF, San Francisco, California, United States, 10 Mercy Health, Rockford, Illinois, United States, 11 Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, 12 University of Virginia, University of Virginia School of Medicine, Charlottesville, Virginia, United States

Background/Introduction: Prophylaxis usage has been established in literature as an important component of minimizing the risk of PJK and PJF development. However, there remains a paucity in literature on the effects of prophylaxis in patients who have achieved adequate post-operative alignment and those who maintained poor alignment post-operatively.

Materials/Methods: Operative ASD patients (scoliosis >20º, SVA>5cm, PT>25º, or TK>60º) with available baseline (BL) and 2-year (2Y) radiographic, and HRQL data were included. Ideal alignment was defined by a “matched alignment” as per the age-adjusted alignment criteria. PJK prophylaxis was defined by usage of cement, hooks, or tethers. PJF was defined as development of PJK with reoperation. Means comparison tests followed by multivariable logistic regression assessed differences between usage of prophylaxis and effects on PJK/PJF rate, as well as, rates among optimal alignment cohorts.

Results: 512 ASD patients with an UIV at L1 or below met inclusion criteria. Overall, 250 patients (48.7%) developed PJK by 1 years, and 60 patients (11.7%) developed PJF. 31.8% of patients had PJK prophylaxis. Patients who had PJK prophylaxis developed lower rates of PJK by 6M (13% vs 23%, p=.010), and had lower rates of 1Y PJF (6% vs 15%, p=.003). Controlling for age, CCI, osteoporosis, levels fused, 3CO, UIV, and BL deformity, patients who improved in PT with prophylaxis usage had lower likelihood of PJK (OR: .42, 95% CI: .2-.84, p=.02) and PJF (OR: .17, 95% CI: .04-.75, p=.019). Patients who improved in PILL with prophylaxis usage had lower likelihood of PJF (OR: .48, 95% CI: .28-.85, p=.01) and PJF (OR: .40, 95% CI: .16-.95, p=.04). Among patients who remained unmatched in PILL, prophylaxis showed lower rates of PJF (OR: .23, 95% CI: .09-.56, p=.001). The same was true for SVA, PJF (OR: .24, 95% CI:
.09-.65, p=.005), and PT, PJF (OR: .32, 95% CI: .14-.74, p=.007).

**Discussion/Conclusion:** Prophylaxis usage showed strong protective effects against PJK and PJF. In patients with persistent deformity at one-year, prophylaxis usage mitigated the development of PJF.
Clinical and Patient Reported Outcomes (PROs) Comparing Lumbar Laminectomy and Fusion versus Laminectomy Alone in Patients with Radiographic Spino-pelvic Malalignment in the Setting of Lumbar Stenosis and Spondylolisthesis: A Non-Randomized, Prospective Cohort Study

Mohanty Sarthak, BS1, Kadiyala Manasa, BS1, Barchick Stephen, MD2, Lad Meeki, BS3, Rouhi Arnaun, BA4, Vadali Chetan, 2, Safii Conron, MD5, Khalsa Amrit, MD2, Casper David, MD2
1 University of Pennsylvania School of Medicine, Philadelphia, Pennsylvania, United States, 2 University of Pennsylvania, Philadelphia, Pennsylvania, United States, 3 Rutgers New Jersey Medical School, Newark, New Jersey, United States, 4 Hospital of the University of Pennsylvania, Philadelphia, Pennsylvania, United States, 5 Houston Methodist Orthopedics & Sports Medicine, Houston, Texas, United States

Background/Introduction: The importance of spinopelvic harmony [pelvic incidence (PI) = lumbar lordosis (LL) ±10 degrees] is well established. PI-LL discordance correlates with increased degenerative lumbar spondylolisthesis. Recent evidence favors management of lumbar spondylolisthesis with concomitant fusion and decompression. This prospective study examined clinical outcomes and PROs in patients with pelvic incidence-lumbar lordosis (PILL) mismatch, single-level, degenerative grade I spondylolisthesis and canal stenosis. We hypothesized that fusion and decompression is beneficial to decompression alone in patients with spinal misalignment.

Materials/Methods: Patients underwent decompression by laminectomy alone or laminectomy and fusion. Post-operative Patient-Reported Outcome Measurement Information System (PROMIS) Global Physical Health (GPH) and Global Mental Health (GMH) scores were primary outcomes. Secondary outcomes included operative complications, PROs at 6 and 12 months postoperatively, and reoperation. Radiographs/MRIs assessed stenosis, pelvic incidence, lumbar lordosis, sacral slope, and pelvic tilt. The study assessed if fusion and decompression is superior to decompression alone for management of grade I spondylolisthesis with comorbid spinal stenosis. Propensity score matching (PSM) and coarsened exact matching (CEM) created matched cohorts of “cases” (fusion) and “controls” (decompression). Binary comparisons used McNemar test; continuous outcomes used Wilcoxon rank-sum test.

Results: 190 (54.0%) of 352 patients with high PILL mismatch were treated with decompression and fusion. Those undergoing fusion experienced greater operative blood loss (308.9 vs 203.2 mL, p=0.0005), operative time (233 vs 149 min, p=0.0006), and length of stay (4.75 vs 2.83 months, p<0.0001) and fewer months of outpatient physical therapy (1.61 vs 3.65 months, p<0.0001) compared to decompression-only patients. Additionally, postoperative PILL mismatch at 3 months was lower in the fusion group due to increased lumbar lordosis (48.78 vs 39.8º, p<0.0001). Postoperative PROs demonstrated significant differences with improved GMH and GPH at 5-7 months (GMH: 17.61 vs 14.48, p<0.0001; GPH: 16.24 vs 14.21, p=0.007) and 10-12 months postop (GMH: 26.61 vs 20.75, p<0.0001; GPH: 23.61 vs 18.13, p<0.0001) and a decreased 2-year readmission rate (12.63% vs 17.89%, p=0.0442)(Table 1).
Discussion/Conclusion: Patients with spinopelvic mismatch were more likely to benefit from fusion and decompression for management of single-level, grade I spondylolisthesis with comorbid spinal canal stenosis. Improvement is associated with significantly increased lumbar lordosis from pre-operative measures.
RF Paper 13

Percutaneous Vertebral Augmentation does not Alter Refracture Rate in Osteoporotic Compression Fractures, but Anti-Osteoporotic Medications Do

Mills Emily, MD1, Hah Raymond, MD2, Fresquez Zoe, BS1, Buser Zorica, PhD3, Alluri Ram, MD3, Anderson Paul, MD4
1 Department of Orthopaedic Surgery, Keck School of Medicine, University of Southern California, Los Angeles, California, United States, 2 Keck Medical Center of USC, Los Angeles, California, United States, 3 University of Southern California Keck School of Medicine, Los Angeles, California, United States, 4 University of Wisconsin-Madison, Madison, Wisconsin, United States

Background/Introduction: Osteoporotic compression fractures (OCFs) place a large burden on the healthcare system. The purpose of this study was to determine 1) does percutaneous vertebral augmentation (PVA) increase the rate of refracture following osteoporotic compression fracture? And 2) do anti-osteoporotic medications alter the rate of refracture following percutaneous vertebral augmentation?

Materials/Methods: The PearlDiver Humana database was queried for all patients with a diagnosis of an OCF from 2015-2019. We then divided these patients into those who underwent either vertebroplasty or kyphoplasty within 3 months following initial OCF and those who did not undergo PVA. We then further subdivided the PVA group into those who received antiosteoporotic medications within 1 year following OCF and those who did not. We compared the refracture rate of those who underwent PVA versus those who underwent nonoperative management, as well as the refracture rate of patients who underwent PVA and received antiosteoporotic medications compared to those who underwent PVA and did not receive antiosteoporotic medications.

Results: A total of 20,495 patients suffered an osteoporotic vertebral compression fracture during the study period. Of those, 14,770 (72.1%) underwent nonoperative management, and 5,725 (27.9%) underwent PVA. Of those who underwent nonoperative management, 20.2% suffered a refracture following initial OCF, compared to 17.2% in the operative cohort. This was not significant in univariate or multivariate analysis (OR 1.01, CI 0.94-1.09, p=0.816; aOR 1.01, CI 0.94-1.09, p=0.774). Of those who underwent operative treatment, 412 (7.2%) received anti-osteoporotic medications and 5,313 (92.8%) did not. Patients who received medications had a refracture rate of 6.5% compared to a refracture rate of 18.0% in those who did not receive medications, which was significant on both univariate and multivariate analysis (OR 1.24, CI 1.08-1.43, p=0.003; aOR 1.20, CI 1.04-1.39, p=0.012). Only 7.3% of patients received a prescription for anti-osteoporotic medications following initial osteoporotic vertebral compression fracture.

Discussion/Conclusion: PVA does not alter the rate of refracture, whereas anti-osteoporotic medications significantly decrease the risk of subsequent OCF by 20%. Only 7.3% of patients received a prescription for an anti-osteoporotic medication following initial OCF.
Dynamic Changes in Intervertebral Lumbar Spine Kinematics During Gait May Explain Improvement in Back Pain in Hip-Spine Syndrome

Chen Stephen, MD1, LeVasseur Clarissa, MS2, Como Christopher, BS3, Couch Brandon, MD2, Klatt Brian, MD2, O'Malley Michael, MD2, Donaldson William, MD2, Lee Joon, MD2, Anderst William, PhD2, Shaw Jeremy, MD, MS2

1 University of Pittsburgh Department of Orthopaedic Surgery, Pittsburgh, Pennsylvania, United States, 2 University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States, 3 University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States

Background/Introduction: For patients with hip-spine syndrome, improvements in hip and back pain have been demonstrated after total hip arthroplasty (THA), however, the mechanism of improvement in lumbar spine pathology remains unknown, as no corresponding changes in lumbar spine static radiographic parameters have been identified. The objective of this study was to utilize dynamic biplane radiography, which allows dynamic measurements of spine arthrokinematics in multiple planes of motion, to identify changes in lumbar spine intervertebral kinematics during gait to explain improvements in back pain seen in patients with hip-spine syndrome after THA.

Materials/Methods: Twenty patients with severe, unilateral hip osteoarthritis scheduled to undergo THA with concomitant back pain as measured by an Oswestry Disability Index (ODI)≥20 were recruited. At baseline and 6 months after THA, Harris Hip Score (HHS) and ODI questionnaires were completed. Lumbar spine static radiographic parameters – sagittal vertical axis, pelvic tilt, sacral slope, pelvic incidence, and lumbar lordosis angle – were measured on standing radiographs. Lumbar spine intervertebral kinematics was measured during treadmill walking by dynamic biplane radiography. Paired t-tests were used to identify pre-surgery to post-surgery differences in HHS and ODI. Statistical parametric mapping was used to identify pre-surgery to post-surgery differences in kinematics. Significance was set to p<0.05 for all tests.

Results: Eighteen patients completed both pre and postoperative testing. After THA, there was significant improvement in both the ODI (36.3 to 11.3, p<0.001) and HHS (55.7 to 77.9, p<0.001). There were no significant changes in any lumbar spine static radiographic parameters. There was a significant decrease in lumbar lordosis during gait due to a decrease in anterior tilt of the L4 and L5 vertebra.

Discussion/Conclusion: The improvement in the ODI and HHS without corresponding changes in lumbar spine static radiographic parameters correlates with previous research. However, there were dynamic changes in the lumbar spine after THA. Specifically, the lower lumbar vertebrae demonstrate decreased anterior tilt during gait, with a corresponding decrease in lumbar lordosis. The more upright posture of the spine potentially decreases facet loading and may explain the observed improvements in back pain.
Patient Report Outcomes, Complications, and Readmissions in Patients with Parkinson’s Disease Undergoing Elective Lumbar Spine Surgery - a Propensity Matched Analysis

Steinle Anthony, BA1, Pennings Jacquelyn, PhD2, Stephens Byron, MD1, Zuckerman Scott, MD, MPH3, Bydon Mohamad, MD4, Devin Clinton, MD5, Abtahi Amir, MD1
1 Vanderbilt University Department of Orthopaedics, Nashville, Tennessee, United States, 2 Vanderbilt University, Nashville, Tennessee, United States, 3 Vanderbilt University Medical Center, Nashville, Tennessee, United States, 4 Mayo Clinic Rochester, Rochester, Minnesota, United States, 5 Steamboat Spine Center, Steamboat Springs, Colorado, United States

Background/Introduction: Parkinson’s Disease (PD) is a common neurodegenerative condition that has become increasingly prevalent in an aging population. While surgical treatment for lumbar degenerative spine pathology is often required in this population, previous literature has suggested that patients with PD have higher complication rates and inferior outcomes compared to the general population. The purpose of this study was to evaluate complications and patient reported outcomes (PROS) in this patient population.

Materials/Methods: The Quality Outcomes Database (QOD), a longitudinal, multi-center, prospective spine outcomes registry, was queried for patients with or without PD at baseline between 01/2015-12/2020 who underwent surgery for degenerative lumbar pathology. Patients with other neurodegenerative conditions were excluded. Patients with and without PD were propensity matched in a 5 to 1 ratio without replacement based on ASA grade, arthrodesis, surgical approach, number of operated levels, age, and baseline ODI, NRS leg pain, NRS back pain, and EQ-5D. Regressions with cluster-robust standard errors were used to estimate average effect of how the outcome would change if the Parkinson’s patient did not have the disease. The mean difference was used for continuous outcomes (ODI, NRS leg pain, NRS back pain, and EQ-5D at 3 and 12 months after surgery) and the risk difference was used for binary outcomes (patient satisfaction, complications, readmission, revision surgery, and mortality).

Results: 46738 potential patients without PD were matched with 343 patients with PD resulting in an analysis sample of 343 PD and 1715 control patients. At 12-months after surgery, the PD group had a significantly lower mean EQ-5D score (mean difference=-0.053, p=0.005) and a significantly higher risk of revisions (mean difference=0.057, p=0.015) compared to the control group. There was no significant difference in complication rates, readmission rates, revision rates or EQ-5D scores at 3 months, or ODI, VAS back pain, VAS leg pain, or patient satisfaction at 3 months or 12 months.

Discussion/Conclusion: Patients with PD had similar PROs at 12 months following lumbar spine surgery when adjusting for baseline covariates via propensity matching. While PD patients did have a higher revision rate at 12 months, complication and readmission rates were similar.
RF Paper 16

A Prospective Randomized Study Assessing the Impact of a Standardized Educational Curriculum on Resident Rod Bending Proficiency

Pinter Zachariah, MD¹, Honig Rachel, MD¹, Salmons Harold, MD¹, Freedman Brett, MD¹, Elder Benjamin, MD, PhD¹, Fogelson Jeremy, MD¹, Nassr Ahmad, MD¹, Sebastian Arjun, MD¹
¹ Mayo Clinic Rochester, Rochester, Minnesota, United States

Background/Introduction: The purpose of the present study was to evaluate a novel standardized training program for teaching residents to bend rods in thoracolumbar deformity surgery.

Materials/Methods: We prospectively enrolled orthopedic surgery trainees at a single academic institution in a rod bending educational study. Participants performed a timed rod bending test using a spinal fusion model designed to mimic a unilateral T7 to pelvis posterior instrumented fusion construct using 13 contemporary pedicle screws with polyaxial screw heads, a 6.0mm stainless steel rod, standard rod bending instruments. This test was timed, with a maximum allotted time to complete the task of 20 minutes; if participants were unable to complete the task in the allotted time, then the number of incomplete set screws was recorded. After completion of the first rod bending test, participants were immediately randomized in a 1:1 ratio into one of two groups: Group 1 was provided with an educational curriculum regarding rod bending, and Group 2 did not receive any additional education. Three months after the first rod bending test, participants completed a second timed rod bending test. Student’s t-tests were then performed to determine differences between the groups, with a P value < 0.05 representing statistical significance.

Results: Fourteen trainees were enrolled. There was no difference in baseline characteristics between groups (Table 2). Group 2 experienced a significant improvement in the number of participants who completed the task (3 to 6, P=0.04) and the time required to complete the task (18:40 to 10:58; P<0.001). During the second rod bending test, Group 2 outperformed Group 1 in number of participants completing the task (100% vs 37.5%, P=0.01), time to complete the task (10:58 vs 17:11, P=0.005), and number of incomplete set screws (0 vs 3.4, P=0.03)

Discussion/Conclusion: Surgical trainees who received a dedicated educational curriculum improved significantly in rod bending proficiency, while those who received no dedicated training failed to improve. This study both demonstrates the efficacy of this educational curriculum and identifies an avenue for improving resident education.
RF Paper 17

Should Physical Therapy be Incorporated in Patient Care Post 1-2 Level Lumbar Fusions for Degenerative Lumbar Instability? - A Comparative Outcome Analysis

Singh Devender, PhD¹, Truumees Eeric, MD¹, Duncan Ashley, RN, MBA¹, Mayer Eric, MD¹
¹ Ascension Texas Spine and Scoliosis Center, Austin, Texas, United States

Background/Introduction: Evaluate and compare the changes in pain and functional scores between patients who completed physical therapy (PT) versus no-PT after their anterior or posterior 1-2 level lumbar fusions for degenerative lumbar instability.

Materials/Methods: We assembled a clinical database of patients with PT and no-PT visits post anterior or posterior/posterolateral 1 or 2 levels lumbar fusion surgery for degenerative disease from June 1st, 2014-April 30th 2016. Basic demographic and outcome scores such as Oswestry disability index (ODI) and Visual analog scale (VAS) were collected. Independent two-sample with unequal variances were used to assess for differences between the two groups (α=0.05).

Results: 72 and 51 patients in PT and no-PT met the inclusion criteria, respectively. There were higher numbers of females (63.8%) in PT group. No-PT group had similar numbers of males and females. Mean ages for PT and no-PT groups were 61.4(±14.7) and 59.5(±14.1) years, respectively. Both groups were similar with respective to body mass index. Majority of the cases in both groups involved posterior/posterolateral approach. 55.5% of patients in PT group and 50.9% in no-PT had 1 level lumbar fusion. Mean change (pre-operative vs. 1 year post-operative) in ODI between the two groups differed significantly (PT vs. no-PT: 18.8±13.9 and 9.3±17.5; p=0.019). Similarly, mean change in VAS was significantly different between the two groups (PT vs. no-PT: 3.2±2.18 and 1.05±2.08; p=0.026). None of our PT patients reported any change in pre vs. 1 year post-operative follow up employment status (35% retired, 38% employed fulltime, 11% unemployed and 16% homemaker). 98% of No-PT patients reported no change in employment status during the same timeframe (46% retired, 25% employed fulltime, 13% unemployed and 15% homemaker).

Discussion/Conclusion: PT group reported significant improvements in functional and pain scores than their counterparts. Post-lumbar fusion rehabilitation may benefit the majority of adult patients undergoing lumbar fusion surgery for a degenerative indication.
RF Paper 18

Obesity and Low Back Pain in Children: Associations with Lumbar Spine Degeneration, Alignment, and Pain Management

Rudisill Samuel, BS¹, Hornung Alexander, BS¹, Barajas J. Nicolas, BS¹, Mallow G., BS², An Howard, MD³, Samartzis Dino, PhD⁴
¹ Rush University Medical Center, Chicago, Illinois, United States, ² Department of Orthopaedic Surgery, Division of Spine Surgery, Rush University Medical Center, Chicago, Illinois, United States, ³ Midwest Orthopaedics at Rush, Chicago, Illinois, United States, ⁴ Midwest Orthopaedics at Rush University, Chicago, Illinois, United States

Background/Introduction: Low back pain (LBP) is common in children and adolescents, carrying substantial risk for recurrence and continuation into adulthood. Studies have linked obesity to development of pediatric LBP, however its role in lumbar spine degeneration remains debated. Considering the increasing prevalence of pediatric obesity and LBP, this study sought to characterize relationships between obesity, lumbar spine degeneration, alignment, and pain management.

Materials/Methods: Prospective data from pediatric patients presenting to a single institute with LBP and no history of spine deformity, tumor, or infection were reviewed. Demographic and clinical information was recorded, including use of physical therapy, nonsteroidal anti-inflammatory drugs (NSAIDs), paraspinal injections, and opioids. MRI and plain radiographic imaging were assessed for vertebral alignment (pelvic tilt [PT], pelvic incidence [PI], sacral slope [SS], lumbar lordosis [LL], PI-LL mismatch) and degenerative phenotypes (disc bulge, disc herniation, high-intensity zones [HIZ], disc degeneration [DD], disc narrowing, Schmorl’s nodes and endplate phenotypes, Modic changes, spondylolisthesis, osteophytes). Univariate and multivariate regression analyses were performed.

Results: 194 patients (mean age: 16.7+/−2.3 years, 45.3% male) were included, whereby 30 (15.5%) were obese (BMI >30). Obesity was associated with the presence of DD (p=0.004), HIZ (p=0.011), and Schmorl’s nodes (p=0.019), and greater PT (p=0.025) and PI-LL mismatch (p=0.044). Controlling for age and sex, associations with DD (OR: 5.82, 95% CI: 1.56–21.77) and HIZ (OR: 4.79, 95% CI: 1.45–15.82) remained significant. Moreover, injection (p=0.028) and opioid use (p<0.001) were more common amongst obese patients, though only the relationship with opioid use (OR: 8.30, 95% CI: 2.51–28.00, p<0.001) persisted after accounting for age, sex, and degenerative phenotypes.

Discussion/Conclusion: While the cause of LBP is multifactorial, encompassing environmental, hormonal, biomechanical, and genetic contributions, obesity was found to be associated with DD, HIZ, Schmorl’s nodes, PT, and PI-LL mismatch within the lumbar spine, shedding greater light on the etiology of LBP. Injection and opioid use was also more common amongst obese patients regardless of the presence of degenerative phenotypes. Taken together, our study underscores that pediatric obesity is related to various spinal changes and management, emphasizing maintaining healthy body weight as a promising method of promoting lumbar spine health.
RF Paper 19

Using Big Data to Define Gradations of Functional Recovery after Minimally Invasive Lumbar Fusion Through Smartphone-Based Activity Monitoring

Ahmad Hasan, BS¹, Jiao Kenneth, ¹, Basil Gregory, MD², Yoon Jang, MD¹, Wang Michael, MD², Welch William, MD¹
¹ Perelman School of Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, United States, ² University of Miami Miller School of Medicine, Miami, Florida, United States

Background/Introduction: Contemporary outcomes assessment in spine surgery utilizes patient reported outcome measures, which, though currently the gold standard, can be subjective and unreliable. Recent reports have used smartphone-based activity tracking to provide a more objective and quantitative measure of patients’ improvement in mobility after surgery. Widespread adoption of these objective outcome measures requires a nuanced understanding of how functional recovery can vary between patients. Here, we describe our initial attempt to assess gradations of post-operative improvement in physical activity using data-driven analysis of smartphone-based accelerometry.

Materials/Methods: 3 years of peri-operative activity data (steps-per-day) from 17 awake endoscopic fusion patients were retrospectively extracted from patient smartphones. A data-driven algorithm was constructed to characterize functional improvement following surgical intervention with comparison to a pre-operative baseline normalized to 0. Post-operative recovery was classified into 4 gradations: (1) No Recovery, defined by post-operative activity < pre-operative baseline, (2) Minimal Recovery, defined by activity > baseline but < 0.6 SD baseline, (3) Moderate Recovery, defined by activity > 0.6 SD above but < 1.0 SD above baseline, and (4) Significant Recovery, defined by activity > 1.0 SD above baseline.

Results: A total of 18,615 datapoints were collected and analyzed across all patients. 3 patients had an overall decrease in activity after surgery and 14 patients had improved activity post-operatively. There was a clear distribution of patients and mean normalized activity amongst the No Recovery (18%, mean normalized activity = −0.91 ± 0.65), Adequate Recovery (41%, mean = 0.18 ± 0.11), Moderate Recovery (12%, mean = 0.85 ± 0.09), and Significant Recovery (29%, mean activity = 1.54 ± 0.23) categorizations (Figure 1A, 1B). Pairwise two-tailed non-parametric t-tests were significant between all gradation groups, indicating that the chosen thresholds successfully segregate patients with significantly different recovery profiles.

Discussion/Conclusion: Analysis of large and continuous patient activity datasets allows clinicians to identify subtle differences in the recovery course of lumbar fusion patients, and to remotely monitor the effect of a surgical intervention on patients’ mobility far beyond typical follow-up periods. This preliminary study highlights the potential of using smartphone-based activity data to supplement existing outcome measures and aid in post-operative decision-making.
Two-Level MIS TLIF vs ALIF: A Comparison of Patient Reported Outcomes, MCID Achievement, Post-operative Complications and Recovery Ratios

Patel Madhav, BS1, Jacob Kevin, BS1, Ribot Max, BA1, Chavez Frank, BS1, Parsons Alexander, MS1, Vanjani Nishaka, BS1, Prabhu Michael, BS1, Pawlowski Hanna, BS1, Singh Kern, MD1
1 Rush University Medical Center, Chicago, Illinois, United States

Background/Introduction: Our study compares perioperative and clinical outcomes following minimally invasive transforaminal lumbar interbody fusion (MIS-TLIF) and anterior lumbar interbody fusion (ALIF) for 2-level fusions.

Materials/Methods: Retrospective reviews of lumbar procedures performed between November 2005 and March 2021 were conducted using a prospectively maintained surgical database. Inclusion criteria were set as primary, elective, 2-level MIS-TLIF or ALIF procedures. Patient demographics, perioperative characteristics, postoperative complications and patient reported outcome measures (PROM) were collected. PROMs included Patient-Reported Outcome Measurement Information System -Physical Function (PROMIS-PF), Visual Analogue Scale (VAS) for back and leg pain, Oswestry Disability Index (ODI), SF-12 Mental/Physical composite scores (SF-12 MCS/SF-12 PCS) with all values collected at the preoperative, 6-week, 12-week, 6-month, 1-year, and 2-year follow up time points. Preoperative to postoperative change in PROMs were compared with established threshold values to determine minimum clinically important difference (MCID). Recovery ratios (RR) were calculated for all PROMs. Differences in mean PROM scores, MCID achievement, postoperative complications, and RR were evaluated with Student’s t-test.

Results: Eligible study cohort included 88 patients (54 patients 2-level MIS TLIF cohort; 34 patients 2-level ALIF cohort). Mean operative time was significantly greater for patients in the 2-level ALIF cohort (p<0.001, all). Postoperative narcotic consumption on day 0 and day 1 was significantly greater for patients in 2-level MIS-TLIF cohort (p≤0.005, all). The following significant difference in mean PROMs were demonstrated: PROMIS-PF 6-months/1-year/2-year, SF-12 PCS all timepoints except for 2-years, VAS back 6-weeks, and ODI 12-weeks/6-months, with 2-level ALIF cohort having significantly improved mean values versus 2-level MIS TLIF (p≤0.028, all)(Table 1). A significantly greater percentage of patients in the 2-level ALIF cohort achieved MCID for VAS back 6-weeks and PROMIS-PF 2-years versus 2-level MIS TLIF cohort. ALIF cohort demonstrated significantly improved recovery ratio for VAS back 1-year (p=0.020).

Discussion/Conclusion: Patients receiving 2-level MIS-TLIF had significantly decreased operative times, but greater postoperative narcotic consumption in the early postoperative period, while 2-level ALIF demonstrated more favorable physical function, disability, and back pain PROMs at multiple timepoints. MCID attainment was also significantly higher among 2-level ALIF for VAS back 6-weeks and PROMIS-PF 2-years.
RF Paper 21

What Degree of Coronal Correction is Needed in Adult Spinal Deformity Patients to Reduce Radiographic Complications in Patients with Ideal Post-operative Sagittal Alignment?

Passias Peter, MD1, Krol Oscar, BA1, Tretiakov Peter, BS2, Williamson Tyler, MS2, Imbo Bailey, BA3, Joujon-Roche Rachel, BS3, Vira Shaleen, MD4, Diebo Bassel, MD5, Lafage Virginie, PhD6, Chou Dean, MD7, Munmaneni Praveen, MD7, Park Paul, MD8, Shabani Saman, MD9, Janjua Burhan, MD10, Schoenfeld Andrew, MD11, Smith Justin, MD12

1 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, New York, New York, United States, 2 Department of Orthopedic Surgery, NYU Langone Orthopedic Hospital, NYU Langone Health, New York, New York, United States, 3 New York University School of Medicine, NYU School of Medicine, New York, New York, United States, 4 Department of Orthopedic Surgery, UT Southwestern Medical Center, Dallas, Texas, United States, 5 Department of Orthopedic Surgery at SUNY Downstate Medical Center, Brooklyn, New York, United States, 6 Hospital for Special Surgery, New York, New York, United States, 7 Department of Neurological Surgery, UCSF Medical Center, San Francisco, California, United States, 8 The University of Michigan Health System, Ann Arbor, Michigan, United States, 9 Academic Medical Center, UCSF, San Francisco, California, United States, 10 Mercy Health, Rockford, Illinois, United States, 11 Brigham and Women's Hospital, Harvard Medical School, Boston, Massachusetts, United States, 12 University of Virginia, University of Virginia School of Medicine, Charlottesville, Virginia, United States

Background/Introduction: Adult spinal deformity (ASD) is a debilitating condition that is increasing in prevalence as the elderly population continues to grow. Surgery has been shown as an effective treatment modality for correcting malalignment, however, the degree of coronal correction needed in the case of a suitable sagittal alignment is still unclear.

Materials/Methods: Operative ASD pts (scoliosis>20, SVA>5cm, PT>25, or TK>60) with available baseline(BL) and 2-year(2Y) radiographic and HRQL data with a one-year SVA classified as “0” according to SRS-Schwab criteria were included. Coronal deformity patients were ranked into 4 quartiles(Q) by C7PL, with 1st being the lowest coronal deformity. Conditional inference tree analysis (CIT) was used to develop threshold cutoffs for target coronal alignment in C7PL or degree of correction from BL to 2Y. Logistic regression analysis confirmed results of CIT.

Results: 402 ASD patients met inclusion criteria (59.9yrs±14.0, 79%F, BMI: 27.7 kg/m2). Mean coronal measurements: C7PL: 2.8cm, Max Cobb Angle: 51, Thoracic Cobb Angle: 29, Lumbar Cobb Angle: 21. It was found patients in Q1, with a mean coronal offset of .6±.4cm and SVA of 3.8±5.5cm, when correction was maintained near below .7cm had lower rates of PJK by 1Y (OR: .30, 95% CI: .11-.81, p=.018). For Q2, with a mean coronal offset of 2.0±.4cm and SVA of 2.6±5.5cm, when correction was maintained below 3.2cm had lower rates of PJF by 1Y (OR: .18, 95% CI: .04-.88, p=.018). For Q3, with a mean coronal offset of 3.5±5.5cm and SVA of 6.3±5.3cm, patients corrected below 3.5cm had lower likelihood of PJF by 1Y (OR: .23, 95% CI: .06-.90, p=.04). For Q4, with a mean coronal offset of 7.5±6.5cm and SVA of 7.5±6.5cm,
correcting patients to below 3.6cm midline resulted in lower rates of PJK by 1Y below 3.6cm (OR: .36, 95% CI: .15-.84, p=.02).

**Discussion/Conclusion:** When stratifying by degree of coronal malalignment severity, results show an increasing degree of deformity requires correction to a comparable range of milder frontal plane deformity, suggesting a possible coronal target between 3.2 to 3.6cm post-operatively.
RF Paper 22

Propensity-score matched analysis of subsidence and reoperation after LLIF using 3D porous titanium vs. Polyetheretherketone

Muthiah Nallammai, BS¹, Vodovotz Lena, BS², Deng Hansen, MD¹, Dembinski Robert, BS², Ozpinar Alp, MD¹, Agarwal Nitin, MD³, Hamilton David, MD¹, Kanter Adam, MD¹, Okonkwo David, MD¹, Alan Nima, MD¹

¹ University of Pittsburgh Medical Center, Pittsburgh, Pennsylvania, United States, ² University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania, United States, ³ University of California, San Francisco, San Francisco, California, United States

Background/Introduction: Porous 3D-printed titanium (pTi) interbody cage has a stiffness that mimics that of the modulus of elasticity of native vertebra. This property results in reduction of stress at bone-hardware interface, theoretically lowering the risk of subsidence after lateral lumbar interbody fusion (LLIF). The objective of this analysis was to compare the rate of subsidence and reoperation after LLIF using pTi versus Polyetheretherketone (PEEK).

Materials/Methods: We performed a retrospective cohort analysis of consecutive adult patients who underwent LLIF from 2016 to 2020. Propensity scores were calculated to balance potential confounding factors, including age, obesity, posterior instrumentation, smoking, and osteoporosis. Operated levels were matched by propensity scores in a 1:1 ratio without replacement. Match quality was assessed with standardized mean differences (SMD). Chi-squared or Fisher’s exact tests were utilized to compare subsidence and reoperation rates between lumbar levels treated with PEEK versus pTi.

Results: We identified a total of 192 patients (309 lumbar levels), of whom 137 underwent LLIF with PEEK (212 levels) and 55 underwent LLIF with pTi (97 levels). After propensity score matching, a total of 55 patients remained in each treatment group (97 levels). Treatment groups were well-matched, given SMDs <9%. There were no statistically significant differences in baseline characteristics. In levels treated with PEEK, subsidence grade frequencies were as follows: 71 (73.2%) grade 0, 14 (14.4%) grade I, 7 (7.2%) grade II, and 5 (5.2%) grade III. In levels treated with pTi, subsidence grade frequencies were as follows: 89 (91.8%) grade 0, 5 (5.2%) grade I, 2 (2.1%) grade II, and 1 (1.0%) grade III. Levels treated with pTi were significantly less likely to exhibit grade I-III subsidence compared to those treated with PEEK (p=0.001). While 5 levels (5.2%) treated with PEEK required reoperation for subsidence, only 1 level (1.0%) treated with pTi required reoperation for subsidence, though this difference was not statistically significant (p=0.12).

Discussion/Conclusion: In a well-matched cohort of patients who underwent LLIF using pTi versus PEEK, the former was associated with a lower rate of radiographic subsidence. Larger samples are needed to compare reoperation rates due to low incidence.