

120. Development of an Intraoperative Assessment Tool for Predicting Critical Care Transfer Following Major Posterior Spine Surgery

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Hypothesis

An intraoperative risk scoring algorithm, using patient and surgical variables, can accurately predict the likelihood of unplanned critical care transfer within 24 hours following major posterior spine surgery.

Design

This single-institution retrospective study used patient-specific intraoperative measures to develop a clinical risk score for predicting unplanned ICU transfers within 24 hours.

Introduction

Identifying patients at risk of adverse events is a cornerstone of improving outcomes in major surgery, yet allocating care resources remains challenging. This retrospective study aimed to develop a risk score to predict the need for unplanned critical care transfer within 24 hours of major spine surgery.

Methods

This retrospective study (2021–2024) included adults undergoing spine surgery spanning ≥ 7 levels. The primary outcome was unplanned ICU transfer within 24 hours post-surgery, with a stay exceeding 24 hours. Candidate predictors were selected based on clinical relevance and assessed in a multivariable backward selection logistic regression model. Regression coefficients were used to develop a scoring algorithm using Sullivan's method. The performance of this risk score in predicting unplanned ICU transfer within 24 hours was evaluated using the c-index and Brier score.

Results

Among 688 patients, ICU transfer within 24 hours occurred in 28.9% of patients (n=199). The developed scoring algorithm assigned positive scores for male sex (+1), lowest intraoperative systolic blood pressure < 60 mmHg (+2), highest intraoperative diastolic blood pressure ≥ 90 mmHg (+1), use of a central-line (+3), anterior-posterior surgery (+1), duration of lying prone ≥ 300 minutes (+3), without use of CT-navigation software (+2), estimated blood loss ≥ 2000 mL (+2), and intraoperative blood transfusion (+2), with positive scores indicating increased risk of ICU transfer. The resulting risk score ranged from 0 to 17 points. Each 1-point increase in the score was associated with a 56% increase in the odds of ICU transfer (OR 1.56, 95% CI 1.46–1.67; $p < 0.001$; c-index 0.83, 95% CI 0.80–0.87; Brier score 0.13).

Conclusion

We developed a spine-specific intraoperative risk assessment algorithm to identify patients at high risk of early postoperative ICU transfer, providing a tool to optimize postoperative surveillance and resource allocation.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

121. Efficacy of Oral Silodosin for Preventing Postoperative Urinary Retention (POUR) Following Elective Spine Surgery: A Single-Blind Randomized Controlled Trial

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Hypothesis

Oral silodosin in post-operative period reduces the incidence of post-operative urinary retention (POUR) after elective spine surgery

Design

Single-Blind Randomized Controlled Trial

Introduction

Postoperative urinary retention (POUR) is a common complication following elective spine surgery leading to patient discomfort, delayed mobilization, and prolonged hospital stay. Although alpha-1 adrenergic blockers have demonstrated benefit in reducing POUR in other surgical specialties, high-quality randomized evidence in spine surgery remains limited.

Methods

This single-center, single-blind, randomized placebo-controlled trial included adults undergoing elective cervical, thoracic, or lumbar spine surgery. Patients were randomized 1:1 to receive oral silodosin (8 mg administered 8 hours postoperatively and 2 hours before catheter removal) or placebo. Urinary catheters were removed on postoperative day 1. POUR was assessed using a standardized protocol incorporating time to void, voided volume, and ultrasound-measured post-void residual (PVR). POUR was defined as inability to void within 6 hours with bladder volume ≥ 400 mL or PVR ≥ 400 mL after voiding with suprapubic discomfort or palpable bladder. The primary outcome was POUR incidence. Secondary outcomes included recatheterisation, urinary parameters, and length of stay. Multivariable logistic regression identified independent predictors of POUR. Trial Registration: Clinical Trials Registry-India (CTRI/2025/10/096166)

Results

Of 210 patients screened, 151 were analyzed (75 silodosin, 76 placebo). Overall POUR incidence was 22.5%. POUR occurred in 14.7% of the silodosin group versus 30.3% of controls ($p=0.02$), yielding an absolute risk reduction of 15.6% and a number needed to treat of 7. Recatheterisation rates were significantly lower with silodosin (10.7% vs 25.0%, $p=0.02$). On multivariable analysis, silodosin independently reduced POUR risk (adjusted OR 0.22, 95% CI 0.06–0.80), while higher intraoperative blood loss increased risk.

Conclusion

Postoperative silodosin significantly reduces POUR and recatheterisation after elective spine surgery. Routine ultrasound-based bladder assessment revealed a substantial burden of clinically silent retention. Selective $\alpha 1A$ -adrenergic blockade may be a simple and effective adjunct to ERAS-based perioperative spine care.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

Effect of Oral Silodosin on Preventing Postoperative Urinary Retention After Spine Surgery Randomized Controlled Trial – Key Mechanism and Clinical Impact

Mechanism of Action

- $\alpha 1A$ receptors at bladder neck
- Post-operative sympathetic surge $\rightarrow$ outlet resistance
- Silodosin ($\alpha 1A$ selective)
 - $\rightarrow$ bladder neck relaxation
 - $\rightarrow$ improved emptying
 - $\rightarrow$ $\downarrow$ POUR

Trial Design

- Single-center randomized controlled trial
- $n = 151$ elective spine surgeries
- Silodosin 8 mg vs Placebo
- Urinary catheter removal: POD 1
- Ultrasound-based PVR protocol

Key Results

POUR incidence:

- Silodosin: 14.7%
- Placebo: 30.3%

Absolute risk reduction: 15.6%

Number needed to treat (NNT): 7

Re-catheterisation rates:

- 10.7% vs 25.0%

Take-Home Message

Selective $\alpha 1A$ blockade with silodosin significantly reduces POUR and the need for recatheterisation after spine surgery. Routine ultrasound identifies clinically silent POUR. A simple, low-cost adjunct to ERAS spine pathways.

Key Findings of the RCT

122. Delayed Extubation following Corrective Surgery for Severe Kyphoscoliosis: What are the Roles of Pulmonary Arterial Hypertension and Chronic Respiratory Failure?

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Hypothesis

The coexistence of PAH and T2RF is associated with a significantly increased risk of major postoperative complications following corrective surgery

Design

Patients were divided into four cohorts based on PAH/T2RF status

Introduction

Severe kyphoscoliosis can lead to pulmonary dysfunction, pulmonary arterial hypertension (PAH) and type 2 respiratory failure (T2RF). Untreated patients often progress to fatal cardiorespiratory failure. Although corrective surgery significantly improves outcomes, it carries high perioperative risks.

Methods

This retrospective single-center study analyzed 120 severe kyphoscoliosis patients with pulmonary dysfunction. Patients were divided into four cohorts based on PAH/T2RF status: Group A (PAH-/T2RF-; n=91), B (PAH-/T2RF+; n=17), C (PAH+/T2RF-; n=4), and D (PAH+/T2RF+; n=8). Collected data included demographics, preoperative cardiopulmonary function, surgical details, and postoperative outcomes. The impact of PAH and T2RF on outcomes was assessed through intergroup comparisons of delayed extubation rates and postoperative adverse events.

Results

Patients with both PAH and T2RF (Group D) demonstrated the worst outcomes, exhibiting significantly higher rates of delayed extubation (>24 hours: 37.5% vs. others, $p = 0.030$; >12 hours: 75.0% vs. others, $p < 0.001$), prolonged ICU stays (median 65.2 vs. others, $p = 0.016$), and the highest incidence of adverse events (75.0%, $p < 0.001$). Group D specifically showed elevated risks of respiratory failure (50.0%, $p=0.001$), severe hypotension (62.5%, $p=0.001$), heart failure (25.0%, $p=0.001$), reintubation (25.0%, $p=0.033$), and mortality (25.0%, $p=0.005$). Groups B demonstrated moderate risks on the delayed extubation (>24h: 11.8%), while Group C exhibited high adverse event rate (50.0%).

Conclusion

The coexistence of PAH and T2RF is associated with a significantly increased risk of major postoperative complications following corrective surgery, including delayed extubation, prolonged ICU stays, and elevated rates of complications such as cardiorespiratory failure.

123. Transitioning from Preoperative Control to Postoperative Risk: Loss of Postoperative Glycemic Control Increases Pseudoarthrosis After Adult Spinal Deformity Surgery

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Hypothesis

Loss of postoperative glycemic control will increase pseudoarthrosis rates in adult spinal deformity patients.

Design

Retrospective cohort study

Introduction

Adult spinal deformity (ASD) surgery is associated with high perioperative risk, and patient-related comorbidities significantly influence outcomes. Diabetes and poor glycemic control have been linked to impaired wound healing, infection, and increased complication rates across surgical specialties. However, the clinical impact of postoperative HbA1c dysregulation in preoperatively well-controlled diabetic patients after ASD surgery remains unclear.

Methods

Diabetic patients with preoperative HbA1c $\leq 7.5\%$ undergoing adult spinal deformity surgery were identified using a federated research network. Inclusion required at least two years of follow-up and postoperative HbA1c data. Patients were stratified by postoperative glycemic control, comparing those with any HbA1c $> 7.5\%$ during follow-up to those who maintained HbA1c $\leq 7.5\%$. Propensity score matching was used to balance demographics and Charlson Comorbidity Index between cohorts. Multivariate regression was performed examining postoperative medical and surgical complications within 2 years of surgery.

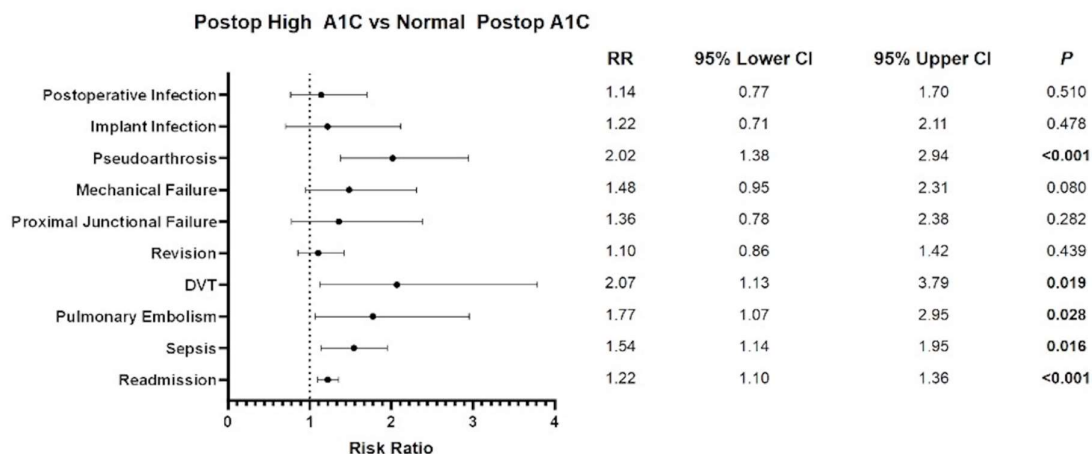
Results

A total of 9,676 patients met inclusion criteria. Following successful matching 574 patients were included in each cohort. Postoperative uncontrolled HbA1C patients were at increased risk of pseudoarthrosis (RR 2.02; 95% CI 1.38-2.94; $p<0.001$), deep venous thrombosis (RR 2.07; 95% CI 1.13-3.79; $p=0.019$), pulmonary embolism (RR 1.77; 95% CI 1.07-2.95; $p=0.028$), and readmission (RR 1.22; 95% CI 1.10-1.36; $p<0.001$). No significant increase in risk of postoperative infection, postoperative spinal implant infection, mechanical failure, proximal junctional failure, or all-cause revision was observed in uncontrolled HbA1C patients.

Conclusion

Despite adequate preoperative glycemic control, loss of postoperative glycemic control confers meaningful risk for fusion failure, highlighting postoperative HbA1C as a critical and modifiable determinant of outcome. These findings emphasize that glycemic optimization should extend beyond the preoperative period and remain a central component of postoperative management to reduce pseudoarthrosis in this high-risk population.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant



Forest plot of relative risks for those with increased postoperative A1C.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
‡SRS Funded Research Grant

124. Recombinant Human Bone Morphogenetic Protein-2 (BMP) Reduces Long-Term Cost by Decreasing Revision Surgery in Adult Spinal Deformity

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Hypothesis

BMP use reduces the aggregate long-term cost of ASD care by decreasing revision surgery.

Design

Retrospective analysis of a multicenter prospective database.

Introduction

BMP reduces pseudarthrosis and revision surgery in ASD, but the long-term cost effectiveness of BMP remains uncertain.

Methods

1355 patients from a multicenter ASD database of 1,355 patients undergoing ≥ 4 -level fusion with ≥ 2 -year follow-up were included. Total cost was defined as index surgery plus all revision costs. Logistic regression on variables such as frailty, number levels fused, and osteotomies created a propensity score reflecting medical and surgical complexity, with 1:1 nearest-neighbor matching to create comparable BMP and noBMP cohorts. Mean total cost, revision rates, and time to mechanical complications were compared. Multivariable regression evaluated cost savings as a function of BMP use and surgical complexity.

Results

Cost data were available for 1029 patients ($60.6\text{y} \pm 14.2$; 74.8% female), of whom 623 received BMP (mean fu $4.6\text{y} \pm 1.3$). BMP patients demonstrated greater surgical complexity which increased over time while noBMP patients remained stable ($p < 0.001$). After 1:1 matching ($n = 288$ each), BMP and noBMP had similar surgical complexity. Revision surgery was reduced with BMP (16.4% vs 26.7%; OR 0.55, $p = 0.002$), as was pseudarthrosis (3.4% vs 7.8%; OR 0.41, $p = 0.03$), with similar complication rates. Time to revision was longer in the BMP cohort (HR 0.59, $p = 0.002$). Index surgery cost (2025 USD) was similar between groups (\$92,757 BMP vs \$100,917 noBMP; $p = 0.08$), while revision costs were lower with BMP (\$7,114 vs \$12,697; $p = 0.005$), resulting in a mean total cost savings of \$13,743 per patient ($p = 0.015$). Cost savings increased with surgical complexity ($r = 0.38$, $p = 0.004$) and scaled with BMP dosage. The break-even threshold for revision cost favored BMP for ≥ 6 fused levels, pelvic fixation, or any osteotomy, with an optimal dosage of 2.4 mg per level.

Conclusion

BMP is cost-effective over time by preventing revision surgeries in more complex patients. The initial investment in BMP is justified by the financial, clinical, and safety efficiencies of reducing revision ASD surgery. Indications for BMP usage include ≥ 6 level fusion, pelvic fixation, and/or any osteotomies result in cost-saving with BMP, with an optimal dosage of 2.4mg per level.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

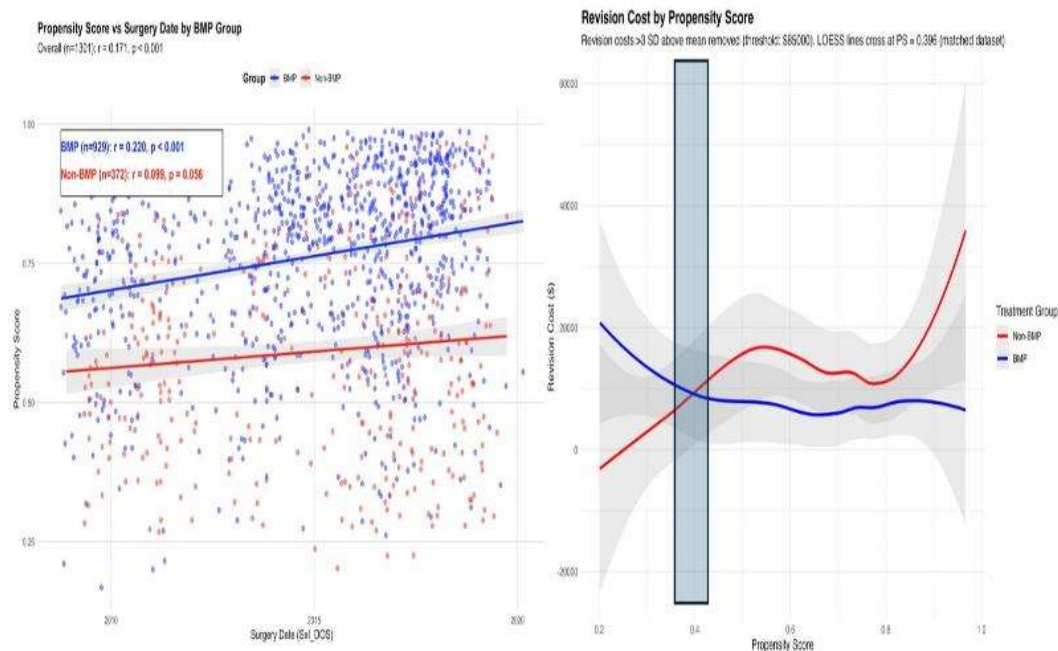


Figure 1. BMP patients are more complex than no BMP patients, and cost savings from reduced revisions scales with patient complexity.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

125. Does Osseointegrative Pelvic Fixation Eliminate Traditional Pelvic Fixation Loosening?

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Hypothesis

Osseointegrative pelvic fixation will experience less loosening than traditional pelvic fixation

Design

Retrospective review of prospectively collected single center data

Introduction

Long fusion constructs to the pelvis are increasingly utilized. These reconstructions carry risks of failure in the lumbopelvic (LP) region as high as 25% with loosening being the most common failure. We aim to investigate the effect of osseointegrative pelvic fixation (OPF) compared to traditional fixation (TF) implant loosening.

Methods

Retrospective review of prospective database of adult deformity patients treated with pelvic fixation in a single institution with 2 year f/u. Patients treated at index operation for infection were excluded. Distal mechanical complications were captured and compared between OPF and TF and defined as: screw loosening (SL), fracture, set screw dislodgement (SD) and rod fracture. Independent student t-tests were used to compare continuous variables and chi-square or fisher exact tests were used to compare categorical variables.

Results

140 patients met the inclusion (54 OPF, 86 TF); mean age 70(+/-11) and 67 (+/-9) in OPF and TF(p=0.15). OPF was 69% female and TPF 76% female(p=0.44). OPF had similar number of levels fused (11.1 vs 11.8; p=0.34). There was a total of 2.2 total bolts in the OPF cohort and 1.9 in TF (p=0.014). Pre-operative alignment between groups was similar for SVA, PT, PI, LL, L1PA, T4PA, C2PA, C2Tilt, and TPA (p>0.15); however, L4-S1 LL was greater in the OPF group (36.5 vs 30 deg; p=0.036). Pre-operative max Cobb angle was greater in the TF group (36.9 vs 21.7; p<0.001). Complication rates were similar between groups(15%, p=0.961). SL was significantly less prevalent in the OPF group (5.6% vs 30.2%; p<0.001). There were similar rates of distal rod fractures in the OPF group (5.6% vs 7.1%; p=1.0). There were more SD in the OPF group (0 vs 3; p= 0.04); Reoperation rates were similar between groups (OPF, 29.5% vs TF, 20.9%; p=0.384).

Conclusion

Osseointegrative fixation experienced significantly less loosening than traditional iliac fixation without differences in distal rod fractures or reoperation rates. There were more set screw dislocations in the OPF group, but this was likely due to open set screw design. The long-term implications of these findings on patient outcomes remains to be studied.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

126. Evolution of Minimally Invasive Adult Spinal Deformity Surgery Over Time: A Multi-Center Study

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Hypothesis

Minimally invasive surgery (MIS) for adult spinal deformity (ASD) has undergone significant technological evolution over the past decade, resulting in improved perioperative outcomes.

Design

Retrospective analysis of two multicenter prospective databases.

Introduction

MIS has become increasingly utilized in ASD. As technology and enhanced perioperative pathways have evolved, it remains unclear whether these advances have translated into improved perioperative outcomes.

Methods

MIS cohorts were categorized as older MIS cohort (2010–2020; n=223) or newer MIS cohort (2021–2025; n=149). Perioperative outcomes were length of hospital stay, length of ICU stay, operative time, blood loss, need for transfusion, 90d complication (any), 90d reoperation, or 90d readmission. A propensity score-derived case-complexity index was created to summarize baseline patient complexity, with logistic regression on baseline clinical (age, gender, ASA, BMI, smoking, osteoporosis, normalized frailty index, abnormal neurological exam) and surgical variables (PI-LL mismatch, SVA, PT, deformity correction, number levels fused).

Results

There was increased baseline patient complexity in the newer MIS cohort (case-complexity index 0.22 vs 0.17; $p<0.001$), driven by greater frailty burden (age 67.7 years $\pm$ 9.3 vs 61.5 $\pm$ 15.2, normalized frailty index +0.19; $p=0.02$) and abnormal baseline neurological exam (48.2% vs 37.9%; $p=0.02$). Surgical variables were all stable (all $p>0.1$). The newer MIS cohort was associated with fewer ICU admissions (6.6% vs 19.3%; $p<0.001$), shorter hospital stays (4.7 days $\pm$ 2.4 vs 5.8 days $\pm$ 3.6, $p=0.025$), lower 90-day reoperation rates (1.2% vs 5.0% older MIS; $p=0.048$), fewer major (2.4% vs 16.1%; $p<0.001$) and minor (9.6% vs 17.9%; $p=0.002$) complications, but similar 90-day readmission rates (4.8% vs 5.5%; $p=0.99$). Operative time was similar (newer MIS 409 min $\pm$ 164, older MIS 414 min $\pm$ 213; $p=0.90$) with similar estimated blood loss (380mL $\pm$ 387 vs 447mL $\pm$ 645; $p=0.96$) but fewer transfusions (9.6% vs 17.5%; $p=0.029$).

Conclusion

These findings suggest that MIS for ASD has evolved over the past decade to allow decreased ICU and hospital stay, lower reoperations, fewer complications, and decreased need for transfusions in the 90-day perioperative period despite treatment of an increasingly frail patient population. As the population continues to age, MIS surgery may be an option as a treatment avenue to decrease perioperative morbidity.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

ISSG MIS 90d outcomes (2010-2020, 2021-2025 periods)			
Outcome	MIS 2021-2025	MIS 2010-2020	p-value
LOS	4.7 days $\pm$ 2.4	5.8 days $\pm$ 3.6	p=0.02
90d readmission	4.8% (8/166)	5.5% (12/217)	p=0.99
90d reoperation	1.2% (2/166)	5.0% (11/217)	p=0.048
90d minor complication (any)	9.6% (16/166)	17.9% (39/217)	p=0.002
90d major complication (any)	2.4% (4/166)	16.1% (35/217)	p<0.001
Operative time	409 min $\pm$ 164	416 min $\pm$ 212	p=0.90
EBL	380mL $\pm$ 387	447mL $\pm$ 645	p=0.96
Transfusion	9.6% (16/166)	17.5% (38/217)	p=0.025
ICU admission	6.6% (11/166)	19.3% (42/217)	p<0.001
ICU LOS	2.3 days $\pm$ 2.0	2.5 days $\pm$ 2.1	p=0.762

ISSG MIS Cases: Case Complexity Index Distribution

Old MIS (2010-2020) vs New MIS (2021-2025)

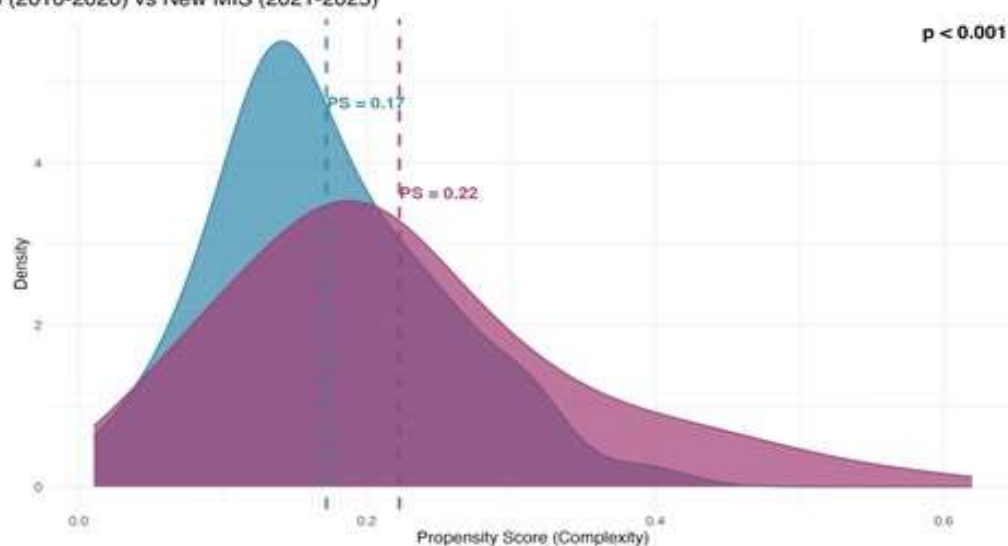


Figure 1. MIS for ASD is becoming more safe and efficient over time, despite increasing patient complexity.

127. Prophylactic Concave-side Decompression and Spinal Cord Medialization Reduces Neurological Complications in Severe Kyphoscoliosis with Type 3 Cord Morphology

Yutong Dai, MD; Ben Long Shi, MD; Zhen Liu, MD, PhD; Saihu Mao, MD; Yong Qiu, PhD; [Zezhang Zhu, MD, PhD](#)

Hypothesis

Prophylactic TTSC reduces the incidence of intraoperative neurological alerts and postoperative deficits in high-risk patients with Type 3 spinal cord morphology undergoing 3CO, thereby providing a neuroprotective effect during deformity correction.

Design

Retrospective comparative cohort study.

Introduction

Severe kyphoscoliosis presents significant risks of cardiopulmonary and neurological compromise. While three-column osteotomies (3CO) provide effective correction, they carry substantial neurological risks. Preoperative Type 3 spinal cord morphology—where the cord is compressed against the concave pedicle—is a critical risk factor. Transvertebral transposition of the spinal cord (TTSC) has been proposed to relieve this tension and restore CSF flow. However, the prophylactic efficacy of TTSC in these high-risk patients has not yet been systematically evaluated.

Methods

This study included 236 patients with severe kyphoscoliosis treated with 3CO, of whom 132 underwent TTSC and 104 did not. Radiographic parameters, neurological status (Frankel grading), patient-reported outcomes (SRS-22), intraoperative neuromonitoring (IONM) alerts, and perioperative complications were analyzed and compared.

Results

The cohort comprised patients of self-reported Asian (Chinese) race and ethnicity. Baseline demographics and preoperative radiographic profiles were comparable between groups. Both cohorts achieved substantial deformity correction. The TTSC group showed significant reductions in coronal Cobb angle (80.8° to 42.2°) and global kyphosis (71.7° to 27.6°), similar to the non-TTSC group (76.7° to 39.6° and 66.3° to 25.2°, respectively). TTSC was associated with lower rates of permanent neurological deficits (1.5% vs. 6.7%, $p = 0.046$) and IONM alerts (8.3% vs. 20.2%, $p = 0.012$). Among patients with preoperative deficits, neurological recovery was more frequent in the TTSC group (86.7% vs. 50.0%, $p = 0.009$). Perioperative complication rates were not significantly different (10.6% vs. 18.3%, $p = 0.130$).

Conclusion

TTSC appears to offer neuroprotective benefits in high-risk 3CO procedures for patients with type 3 spinal cord morphology, with reduced neurological complications and improved functional outcomes. Its use as a preparatory step prior to osteotomy is recommended in selected severe deformity cases.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

128. Long-Term Neurological Outcomes Following Significant Intraoperative Neuromonitoring Alarms: A Longitudinal Study of 115 Patients With Severe Spinal Deformities

Tianyuan Zhang, MD, PhD; Junlin Yang, MD, PhD; Yaolong Deng, MD

Hypothesis

Patients with severe spinal deformities who experienced significant IONM alarms could gradually neurologically improve over the 2-year follow-up.

Design

A retrospective cohort study.

Introduction

Intraoperative neurophysiological monitoring (IONM) is crucial for detecting impending iatrogenic neurological injury during high-risk scoliosis surgery. However, the implication of significant IONM alarms on long-term neurological function remains unknown for complex deformity correction. This study aims to report the longitudinal neurological outcomes and identify predictors of long-term neurological survivorship for patients with severe spinal deformities.

Methods

A total of 115 patients who encountered significant intraoperative neuromonitoring alarms (excluding systematic and non-operative confounders) during high-risk surgical maneuvers were analyzed. A longitudinal clinical dataset containing baseline information, surgical details, multimodal IONM data, and follow-up neurological function was collected. Cox regression analysis was performed to identify prognostic factors that could predict long-term neurological survivorship. Kaplan-Meier curves were plotted for these predictors, and a nomogram facilitated the clinical prediction of 2-year neurological function.

Results

Immediately after surgery, 57 patients (49.6%) showed neurological deficits, which decreased to only 5 cases (4.3%) at the 2-year follow-up. Multivariate Cox regression analysis for long-term neurological survivorship identified decreased hazard ratios (HRs) for grade six osteotomy (HR, 0.311; $P = 0.028$), a positive wake-up test (HR, 0.216; $P < 0.001$), and no recovery of descending neurogenic evoked potentials (DNEPs) (HR, 0.162; $P < 0.001$). A nomogram based on osteotomy grade, wake-up test, and DNEP recovery status was established to predict 2-year neurological function.

Conclusion

Overall, patients with severe spinal deformities who experienced significant IONM alarms demonstrated gradual neurological improvement over the 2-year follow-up. Osteotomy grade, wake-up test results, and DNEP recovery status were identified as valuable predictors that could facilitate surgical decision-making, prognostication, and counseling.

129. Current Intra-Operative Neuromonitoring Protocols Fail to Reliably Detect New Neurological Deficits in 3COs Performed Below the Conus

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Hypothesis

IONM can provide realtime feedback during 3 column osteotomies

Design

Prospective, observational, multicenter study

Introduction

Optimal interpretation of IONM alerts and evidence-based surgical responses remain incompletely defined, particularly during 3COs. Appropriate interventions can reduce the risk of developing new neurological deficits in these complex surgeries.

Methods

Patients undergoing 3CO for spinal deformities were enrolled in a multicenter study and completed detailed forms of events related to IONM alerts in real-time. Alert criteria: $\geq 50\%$ decrease in MEP or somatosensory evoked potentials (SSEP) from baseline. Cord-level versus non-cord-level (below conus) 3COs were analyzed separately. Alerts were classified as Type I (pre-decompression), Type II (during decompression/bone resection), and Type III (post-osteotomy closure).

Results

IONM alerts occurred in 20 of 146 patients (13.7%): 14 cord-level alerts (70%) and 6 non-cord-level alerts (30%). Cord-level alerts: MEP alerts occurred in 10 VCR (71.4%) and 4 PSO (28.6%) with 2 patients with concomitant SSEP alerts. Alert distribution: Type I (n=2), Type II (n=9), Type III (n=3). Eleven alerts (78.6%) fully resolved intraoperatively. Type I alerts responded to screw repositioning, blood pressure elevation, and transfusion. Type II alerts were managed with steroids, hemodynamic optimization, and expedited osteotomy closure. Type III alerts responded to rod removal, osteotomy opening, and reduced correction. Five patients (35.7%) developed immediate post-op motor deficits; 1 patient (7.1%) had persistent unilateral weakness at discharge. Non-cord-level patients (n=6): Type II (n=3) and type III (n=3) were managed with anesthesia adjustment, steroids, and additional decompression; rods were released in 3 cases. Three patients (50%) developed postoperative deficits, with 2 (33.3%) having unilateral deficits at discharge. Six patients (4.8%) developed new neurological deficits without intra-operative alerts, with 4 (3.2%) having unilateral deficits at discharge.

Conclusion

Appropriate responses reversed the alerts in 11/14 cord-level 3COs. IONM showed limited reliability for predicting nerve root injuries in 3COs below the conus, as evidenced by deficits in 6 patients without alerts. Modifications to our current protocols are needed to minimize the false negative rate in 3COs below the conus.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

Variable	No Alert (N=126)	Alert (N=20)	P value
Demographics			
Age (years)	38.6 ± 23.5	38.2 ± 23.8	0.826
Female gender	68 (54.0%)	16 (80.0%)	0.029
BMI (kg/m ²)	23.5 ± 5.1	24.2 ± 6.5	0.531
Primary diagnosis			0.202
- Scoliosis	47 (37.3%)	10 (50.0%)	
- Kyphosis	52 (41.3%)	9 (45.0%)	
- Other	27 (21.4%)	1 (5.0%)	
Revision surgery	28 (22.2%)	9 (45.0%)	0.030
Duration of surgery (hours)	6.5 ± 2.3	7.8 ± 2.2	0.031
Outcomes			
De novo neurological deficits (postop)	6 (4.9%)	7 (36.8%)	<0.001
De novo neurological deficits (discharge)	4 (3.2%)	2 (10.5%)	0.181
Decrease in ASIA LEMS (postop)	6 (4.8%)	6 (30.0%)	0.002
Decrease in ASIA LEMS (discharge)	3 (2.4%)	2 (10.0%)	0.139

Data of 3CO Patients

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
‡SRS Funded Research Grant

130. Machine Learning (ML) in Intraoperative Neuromonitoring (IONM): Updated Model Integrating Hemodynamic Data Detects Changes 35 Minutes Earlier Than Traditional IONM Surveillance

Varun Arvind, MD, PhD; Anil Mendiratta, MD; Mehdi Elfilali, BA; Madeline C. Monness, BSA; Erik Williams, BS; Miles Bomback, BA, MPH; Michael W. Brown, BS; Alexander Park, BS; Omar Taha, BS; Matthew Weintraub, BS; *Michael G. Vitale, MD, MPH*

Hypothesis

We hypothesized that incorporating hemodynamic variables (mean arterial pressure [MAP] and heart rate [HR]) would improve the performance of our IONM ML model, which previously detected changes 23 minutes earlier than traditional IONM surveillance with motor-evoked potential (MEP) data alone.

Design

IONM and hemodynamic data from pediatric spine surgeries at a single academic center were retrospectively incorporated.

Introduction

IONM improves safety during spinal surgery by providing real-time neurophysiological assessment, enabling the earlier detection and prevention of permanent neural injury. However, current IONM interpretation is subject to variability, relies on human expertise, and does not account for related hemodynamic factors. We introduce an updated ML model for pediatric spinal deformity surgery that integrates MAP and HR with MEP data.

Methods

An ML model was trained using time-series trans-cranial evoked MEPs, MAP, and HR data from each patient to identify changes during surgery. The model continuously analyzed real-time data, creating risk scores. A “red-flag” alert was triggered if the risk score exceeded a set threshold. Model performance was assessed using sensitivity, specificity, predictive values, and accuracy, and compared against standard clinical alerts.

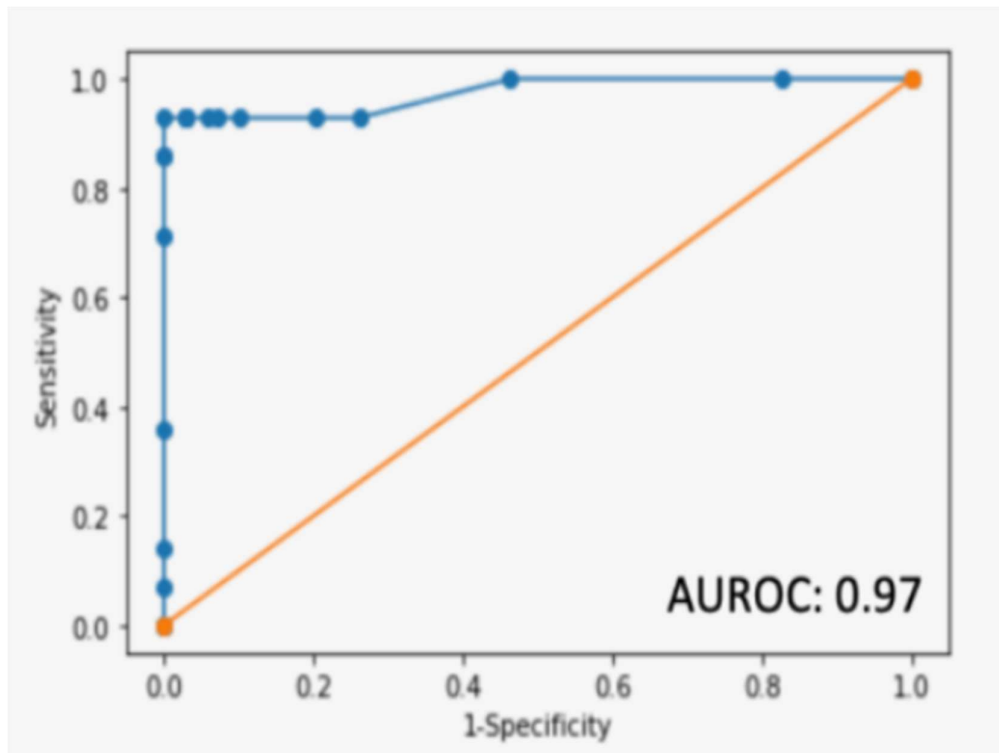
Results

Data from 84 patients (51 female, 33 male; mean age at surgery 14.2 years) were included. Fourteen patients experienced intraoperative MEP signal loss, with six developing postoperative deficits. The model achieved 92.8% sensitivity, 79.7% specificity, 98.2% negative predictive value, and 81.9% overall accuracy (AUC = 0.97). ML-generated alerts preceded clinical IONM alerts by an average of 35.4 minutes. Among patients with postoperative deficits, 6 of 6 were correctly flagged. Among patients with IONM loss, 13 of 14 were correctly flagged.

Conclusion

This ML-based tool demonstrated standardized, near perfect performance with substantially earlier detection of IONM changes compared with clinical alerts. By unifying neurologic and hemodynamic data within a single analytic framework, the model reflects a novel, physiologically informed approach to real-time spinal cord monitoring. While prospective validation is needed, these findings highlight the model’s potential to support intraoperative decision-making and safer surgical care.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant



ROC (AUC - 0.97).

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
‡SRS Funded Research Grant

131. Influence of Baseline IONM Data Quality on Neuromonitoring Performance and Surgical Actions in Pediatric Spinal Deformity Surgery

Christopher K. Bozorgmehr, BS; Leah Rakers, MBS, CNIM; Scott J. Luhmann, MD

Hypothesis

This study examined how baseline intraoperative neuromonitoring (IONM) quality influences intraoperative alerts, responses, and outcomes in pediatric spinal deformity surgery.

Design

Retrospective Cohort

Introduction

IONM detects potential neurologic injury and guides corrective action. Incomplete, inconsistent IONM occurs in a minority of cases and its impact is poorly defined.

Methods

An institutional IONM database (11/1992–4/2024) identified 5317 consecutive patients (0–18 yrs) undergoing pediatric spine deformity surgery at three tertiary hospitals. Pre-incision IONM data were classified as normal or abnormal using established criteria.

Results

Abnormal baseline data was documented in 292 (5.5%) cases. There were 223 cases with IONM alerts and 43 had abnormal baseline data (19.2%). Abnormal baseline data quality was associated with a higher incidence of IONM alerts compared with normal baselines (14.7% vs 3.6%, $p < 0.001$). Abnormal signals were motor only in 44% ($n=19/43$), SSEP only in 44% ($n=19/43$), and both in 12% ($n=5/43$). The alert modality and modality with poor baselines matched in 74% of cases. Diagnoses included idiopathic ($n=8$), kyphosis ($n=11$), neuromuscular ($n=12$), congenital ($n=5$), syndromic ($n=2$), spondylolisthesis ($n=2$), hemivertebrae ($n=1$), and unknown ($n=2$). Abnormal preoperative neurologic status, failure of data return, initial actions taken, and earlier stage of surgery of IONM alerts were all significantly associated with abnormal baseline data and are detailed in Table 1. Immediate (14% vs 14%) and final (5% vs 9%) neurologic deficits were similar between patients with normal and abnormal baselines, respectively.

Conclusion

Cases with poor baseline IONM quality had a 3x increase in alerts which occurred at an earlier stage of surgery, and a 18% decrease in data return, but no difference in postoperative or final neurologic outcomes. Recognition of poor baseline quality at case initiation is essential to guide interpretation and tailor responses (e.g. wake-up tests). Despite intraoperative differences, outcomes were similar, underscoring that proactive strategies can mitigate the risks associated with abnormal baseline data. Future work should focus on optimizing baseline data acquisition, particularly in high-risk patients.

	Normal Baseline Data (n = 180)	Abnormal Baseline Data (n = 43)	
Preoperative Status		(n = 41; 2 unknown)	P = 0.018
Normal	145 (80.6)	26 (63.4)	
Abnormal	35 (19.4)	15 (36.6)	
Alert			P = 0.024
Return	132 (73.3)	24 (55.8)	
Did Not Return	48 (26.7)	19 (44.2)	
Initial Action Taken			P = 0.003
No intervention	10 (5.5)	6 (14.0)	
Abort	1 (0.6)	0 (0)	
Decompression/Further Decompression	8 (4.4)	4 (9.3)	
Correction adjustment	44 (24.4)	4 (9.3)	
Raise blood pressure	47 (26.1)	6 (14.0)	
Other/technical adjustment	4 (2.2)	0 (0)	
Instrumentation adjustment	19 (10.6)	3 (7.0)	
Reduce traction weight	12 (6.7)	0 (0)	
Reposition retractors	6 (3.3)	6 (14.0)	
Reposition patient	20 (11.1)	8 (18.6)	
Non-MAP anesthetic/systemic adjustment	9 (5.0)	6 (14.0)	
Stage of Surgery			P < 0.001
Exposure/Baseline	10 (5.5)	12 (27.9)	
Decompression	40 (22.2)	15 (34.9)	
Placing Instrumentation	46 (25.5)	7 (16.3)	
Correction, Following Correction	81 (45.0)	9 (20.9)	
Wound Closure	1 (0.6)	0 (0)	
Other/unknown	2 (1.1)	0 (0)	

Table 1: Characteristics of IONM Alerts in Cases with Abnormal Baselines

132. Free hand vs navigation guided pedicle screw insertion in scoliosis - an analysis of 5000 screws using intra operative low dose CT scan

Ahmad Hussien, MD; Sai Balasubramanian, MBBS, MS; Paul Cool, FRCS; Jayesh Trivedi, FRCS; Neil T. Davidson, MBBS, FRCS; Sudarshan Munigangaiah, FRCS

Hypothesis

To evaluate whether there is a significant difference in revision rates between pedicle screws inserted using the freehand technique versus navigation-guided placement, assessed using intra operative low-dose CT for assessment.

Design

A retrospective analysis of all consecutive operative cases of scoliosis between 2018 to 2022 at Alder Hey children's hospital, Liverpool , UK.

Introduction

Pedicle screw placement accuracy is critical in scoliosis correction surgery. Previous studies have shown up to 3.6 % rate of malposition despite using navigation. Malposition can lead to a return to theatre up to 2 % in free hand technique.

Methods

All consecutive operative cases of scoliosis between 2018 to 2022 at Alder Hey Children's hospital , Liverpool, UK, was undertaken. patients and a total of 5,006 implanted pedicle screws were included. Of these, 4,449 were inserted freehand and 557 using navigation. Screw positioning was assessed intraoperatively with low-dose CT, and intra operative revisions were recorded. Statistical analyses included the Wilcoxon test, Kruskal–Wallis test, and chi-square test as appropriate.

Results

A total of 5,006 screws were inserted, of which 4,803 (95.9%) were deemed to have been in acceptable position, while 203 (4.1%) were unsatisfactory and required intra operative revision. Counter intuitively the revision rates were similar between the freehand and navigation groups, with no statistically significant difference. No association was found between revision rates and gender, vertebral level, instrumentation length, Cobb angle, or operation time. The median Cobb angle was 75° (IQR: 63–90), median operation time was 300 minutes (IQR: 240–360), and median instrumentation length was 12 levels (IQR: 10–13). Two patients returned to theatre, one for PJK and the second for rod breakage. No patient returned to theatre for screw malposition.

Conclusion

The revision rates for pedicle screws inserted freehand and navigation guided in scoliosis surgery in a high-volume specialist unit are comparable. Intraoperative low-dose CT is an effective tool for real-time assessment after screw placement. It allows for intra-operative revision and eliminated the risk of return to theatre

134. 10-Year Review of 24,140 Freehand Pedicle Screws Placed in the Thoracic, Lumbar and Sacral Spine for Pediatric and Adult Spinal Deformity: Is This Still a Relevant Technique?

Meredith Luhmann, BS; Amrit Singh, MPH; Erik Lewerenz, BS; Lawrence G. Lenke, MD

Hypothesis

The freehand technique of pedicle screw placement in pediatric and adult spinal deformity is safe and accurate.

Design

Single surgeon independent retrospective study.

Introduction

Recent studies on freehand pedicle screw placement are limited due to the increased use of Navigation and Robotic screw placement which espouse safer and more accurate placement. Previous studies investigating the freehand technique for thoracolumbar (TL) screws note a screw-related return to OR (RTOR) rate of 0.4% and a screw revision rate of 8.97%.

Methods

A single-surgeon consecutive patient (pt) independent review was performed on adult and pediatric spine deformity pts who underwent true de novo freehand pedicle screw placement (using anatomic landmarks, a blunt gearshift and without any image guidance) in levels from T1-S1 from 2015 to 2025. Screws were assessed for any placement-related intraoperative (intraop) neuromonitoring (IONM) data changes, low triggered screw electromyography (t-EMG) thresholds (<10mA), or altered positioning on intraop imaging. Screw redirect and RTOR rates for malpositioned screws were determined by the percentage of total revised screws and RTORs out of all the included cases.

Results

A total of 24,140 pedicle screws were placed in 1,148 consecutive cases. 908 (3.76%) screws were removed and the track checked after intraop imaging or low t-EMG thresholds. 686 (75.55%) of these screws were redirected, resulting in a screw revision rate of 2.80%. Of the 625 screws redirected based on imaging, 22 (3.52%) were from x-ray and 603 (96.48%) were from intraop CT. 71 of the 179 (40%) screws checked for low t-EMG thresholds were redirected (39.66%). There were 4 (0.35%) cases where a screw impacted IONM data, and in all 4 cases, the affected screw was removed with recovery of IONM data and no postop neurologic sequelae. 3 (0.26%) pts. had RTOR due to lumbar screw malposition causing radiculopathy with resolution following screw removal.

Conclusion

In this largest single surgeon study of 24,140 pedicle screws placed from T1-S1 for pediatric and adult deformity, the true freehand technique was found to be extremely safe and accurate. There was a low (0.26%) RTOR rate for screw malposition and no screw-related neurologic sequelae, thus confirming the technique as still relevant in this evolving era of Navigation and Robotics.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

135. How Low Can We Go? Can We Further Reduce Radiation Exposure During Scoliosis Radiographic Examination?

Rachelle Imbeault; Marjolaine Roy-Beaudry, MSc ; Justin Dufresne; Sylvain Deschenes, PhD; Stefan Parent, MD, PhD

Hypothesis

We hypothesized that a new biplanar imaging system with dose modulation emits lower radiation than a standard stable dose biplanar imaging system, while maintaining image quality.

Design

Prospective clinical trial.

Introduction

From diagnosis, pediatric patients with idiopathic scoliosis need to undergo frequent radiological evaluations. Due to their longer life expectancy and higher sensibility to ionizing radiation, using technologies that optimize image quality according to the dose received is advisable in the pediatric population. This study intends to compare two biplane radiography systems, one using dose modulation and one using fixed dose throughout the entire acquisition.

Methods

Fifty patients were recruited between February 2024 and July 2024. All patients had a diagnosis of idiopathic scoliosis with an average Cobb angle of $29.7 \pm 15.0^\circ$ and with a mean age of 13.7 years (8-18). Each patient underwent two successive biplanar examinations (PA and lateral views), one using the dose modulating device and the second one using a fixed dose device. Entrance skin dose was measured for 30 patients using optically stimulated luminescence dosimeters located near seven radiosensitive anatomic areas. The minimum detection value of the dosimeters is $50 \mu\text{Sv}$, with an accuracy of $\pm 10\%$ (Landauer). Acquired X-rays were randomized and evaluated by one pediatric orthopedic surgeon and one pediatric radiologist. Statistical analysis was performed using Wilcoxon signed-rank tests.

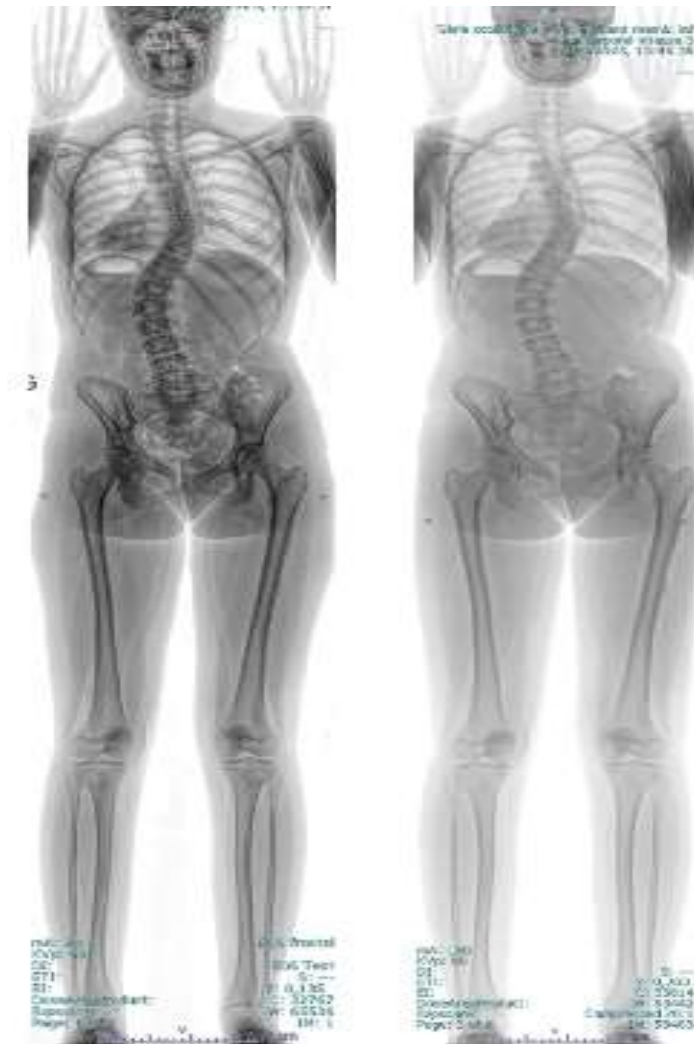
Results

Dose analysis on 30 patients allowed to observe an average dose reduction of 48% (range: -26% to 71%) when dose modulation was used. Dose distribution shows a 63% reduction in the cervicothoracic region, while the reduction was 29% in the lumbosacral region. X-ray analysis revealed that while decreasing the dose, dose modulation also improves global image quality (p-value = < 0.001). Furthermore, analysis of specific anatomical structures showed that visibility is improved for more than 84% of the anatomical landmarks being scored (p-value = < 0.05).

Conclusion

Results indicate that dose modulation can reduce patient exposure to radiation by 48%, while improving global image quality. The greater reduction in the cervicothoracic region suggests better protection of the radiosensitive organs located in this area.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant



Dose Modulated

Standard Dose

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
 ‡SRS Funded Research Grant

136. Implant Density and Deformity Angular Ratio Predict Risk of Complications in Three-Column Osteotomies

Travis S. CreveCoeur, MD; Alexander J. Schupper, MD; Amer F. Samdani, MD; Joshua M. Pahys, MD; Terrence G. Ishmael, MBBS; Benjamin A. Schmidt, BA; Joshua McCalister-Afflick, BS; Emily Nice, BS; Steven W. Hwang, MD

Hypothesis

Within three-column osteotomies (3CO), greater deformity angular ratio (DAR) is associated with a greater number of complications.

Design

Retrospective single-center cohort

Introduction

We sought to describe outcomes and identify risk factors for complications after 3CO.

Methods

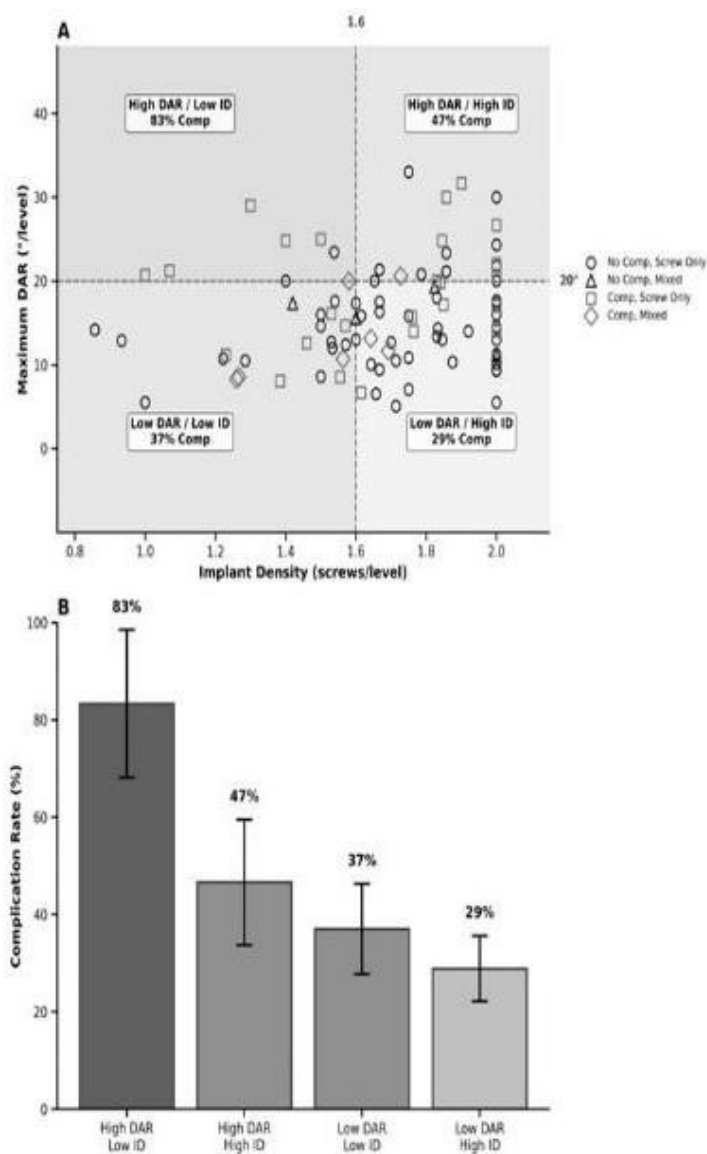
Patients ≤ 21 years of age who underwent single-level 3CO were identified. Demographics, operative details, radiographic parameters, and complications were recorded. Univariate analyses identified risk factors for complications.

Results

97 patients (51% female, mean age 13.1 ± 4.4 years, mean follow-up 51.9 months) were included. Etiologies included: congenital (59%), idiopathic (19%), neuromuscular (12%), syndromic (4%). The most common location was thoracolumbar (57%) with a mean curve angle of $87 \pm 31^\circ$ and a coronal/sagittal DAR of $17 \pm 6^\circ/\text{level}$. 22% had prior spine surgery and 27% underwent pre-op halo gravity traction. OR time was 481 ± 254 minutes with EBL of 1365 ± 1653 mL. Mean implant density was 1.7 ± 0.3 ; 88% had screw-only constructs and 12% had hybrid (hooks/screws). At last follow-up, coronal correction was 66% and sagittal correction was 48%. The overall complication rate was 37% (intra-op 20%, post-op 22%). New neurologic deficits occurred in 5%; with 1 permanent deficit. Revision rate was 6% mostly for instrumentation failure. Lower implant density was the only factor associated with complications (1.6 ± 0.3 vs. 1.7 ± 0.3 , $p=0.03$). Hybrid constructs had more complications, but this was not statistically significant (64% vs. 33%, $p=0.10$). When including only index surgery patients (no revisions), DAR ($19 \pm 7^\circ/\text{level}$ vs. $16 \pm 5^\circ/\text{level}$; $p=0.012$) was predictive of complications. Patients with complications had higher residual sagittal DAR ($9 \pm 6^\circ/\text{level}$ vs. $6 \pm 4^\circ/\text{level}$; $p=0.01$). There were no significant factors associated with the overall need for revision surgery; however, higher pre-op DAR ($20 \pm 6^\circ/\text{level}$ vs. $16 \pm 7^\circ/\text{level}$; $p=0.045$) was associated with instrumentation complications. Decision tree analysis revealed that pre-op DAR $>20^\circ/\text{level}$ combined with implant density ≤ 1.6 identified a high-risk cohort with an 83% complication rate, while patients with DAR $\leq 20^\circ/\text{level}$ and implant density >1.6 screws/level had the lowest risk at 29%.

Conclusion

Single-level 3CO carries a 36% complication rate, but this may be partially mitigated with higher implant density and, if possible, intervention when DAR <20 .



§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
‡SRS Funded Research Grant

137. Rod Diameter, Material, and Texture Influence Screw-Rod Fixation Strength in Spinopelvic Construct

Cale J. Hendricks, BS; Samuel Hendricks, BS; David W. Polly Jr, MD; Arin M. Ellingson, PhD

Hypothesis

Rod diameter, material, and surface finish influence gripping capacity.

Design

This study aimed to evaluate the influence of rod diameter, material, and surface texture on axial gripping capacity (AGC) of the screw–rod interface.

Introduction

Spinopelvic fixation is critical in adult spinal deformity surgery, yet mechanical failure rates range from 4.5–38%. Failure often involves the screw–tulip–rod interface, where rod diameter, composition, and surface texture may affect fixation strength. However, the combined biomechanical effects of these variables remain understudied.

Methods

Axial gripping capacity tests were performed in accordance with ASTM F1798-21 using porous fusion/fixation screws (iFuse Granite, SI-Bone). Rods of 5.5 mm and 6.0 mm diameter were tested in cobalt-chrome (CoCr) and titanium (Ti) with three finishes: grit blast, bead blast, and anodized bead blast. Maximum AGC was defined as the peak load within 1.5 mm of displacement; ultimate AGC (UAGC) within 5 mm. Ten trials per condition were performed. A two-way ANOVA with Bonferroni correction evaluated effects of diameter and material/surface combinations ($\alpha=0.05$).

Results

Each tested variable significantly affected AGC ($p<0.001$). Independent of material or finish, 6.0 mm rods had significantly higher AGC than 5.5 mm (2518.0 ± 30.9 N vs. 2091.1 ± 30.9 N; $p<0.001$). Among material/finish groups, bead-blasted Ti rods produced the highest AGC (2776.0 ± 61.9 N for 5.5mm; 2910.3 ± 61.9 N for 6.0 mm), while anodized bead-blast Ti rods yielded the lowest (1656.6 ± 61.9 N and 2076.8 ± 61.9 N, respectively). CoCr grit-blast rods outperformed bead-blast CoCr. UAGC trends mirrored AGC, with minor differences in select comparisons. Pairwise comparisons are in Figures.

Conclusion

Rod diameter, material, and surface finish each significantly influenced gripping capacity. Larger diameters consistently improved fixation, but surface finish strongly modulated outcomes within each material. Bead-blasted Ti rods provided the highest fixation strength, while anodized bead-blast Ti rods performed worst. Among CoCr rods, grit-blast outperformed bead-blast, reinforcing that surface texture can alter performance even within a single material class. These findings emphasize that rod selection should consider both size and finish, as optimization at the screw–rod interface may reduce mechanical failure in spinopelvic constructs.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

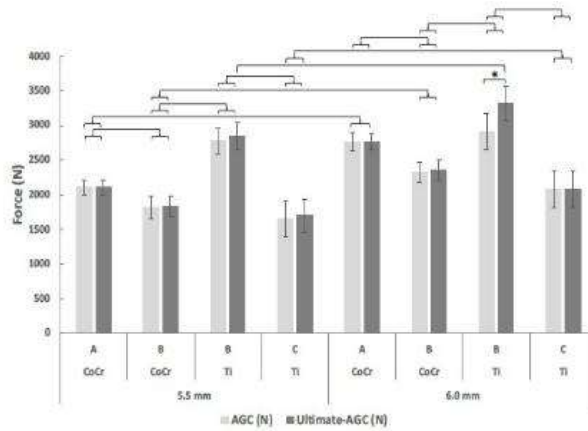


Figure 1: Axial and Ultimate Gripping Capacity (AGC, UAGC). Eight conditions were tested with variation in rod diameter (5.5 mm, 6.0 mm), material (CoCr, Ti), and surface texture (A: grit-blast; B: bead-blast; C: bead-blast + type 2 anodized). Vertical error bars represent $\pm$ standard deviation, and horizontal bars mark statistically significant differences ($\alpha < 0.05$). Comparisons testing for significant difference was performed only between conditions differing by a single parameter.

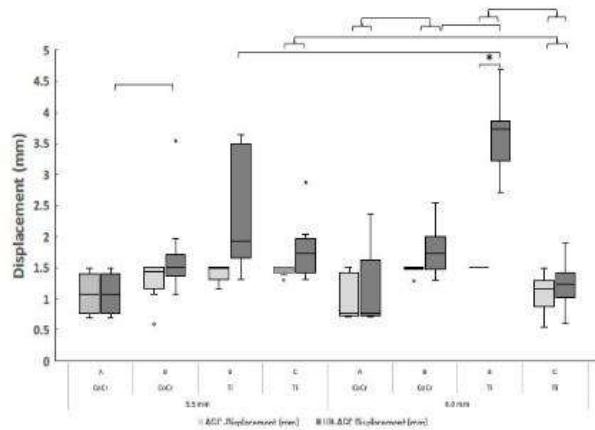


Figure 2: Displacement of Axial and Ultimate Gripping Capacity (AGC, UAGC). Eight conditions that were tested with variation in diameter (5.5 mm and 6.0 mm), material (CoCr and Ti), and surface coating (A: grit-blast, B: bead-blast, C: bead-blast + type 2 anodized). The vertical error bars represent the minimum and maximum values (excluding outliers) and horizontal bars mark statistically significant differences ($\alpha < 0.05$). Comparisons testing for significant difference was performed only between conditions differing by a single parameter.

Captions are embedded in the figure

138. Time-to-Failure Analysis of Implant Constructs in Severe Spinal Deformity Surgery: Seven-Year Outcomes From a West African Cohort

Kwadwo Poku Yankey, MD; Derrick Nyantakyi Owusu, MS; Arthur Sackeyfio, MD; Sarah K. Obiri, BS; Liudmila Gross, MD; Irene A. Wulff, MD; Francis Addai, MD; Benjamin H. Blackson, MD; Oheneba BoachieAdjei, MD

Hypothesis

Clinical and surgical factors are not significantly associated with time to implant construct failure in severe spinal deformity surgery.

Design

Retrospective cohort review

Introduction

Implant construct failure remains a significant complication following surgical instrumentation for severe spinal deformity, with profound implications for patient outcomes and health system burden. This challenge is particularly profound in low-resource settings. Identifying the factors associated with long term implants failure may be beneficial in the development of more effective surgical strategies

Methods

We conducted a longitudinal cohort study of 402 pts undergoing surgical correction of severe spinal deformity. Implant failure was defined as clinically significant construct-related complications requiring revision. Kaplan–Meier (KM) methods estimated implant survival, and Cox proportional hazards models identified independent predictors. Model discrimination was assessed using Harrell’s concordance index (C-index).

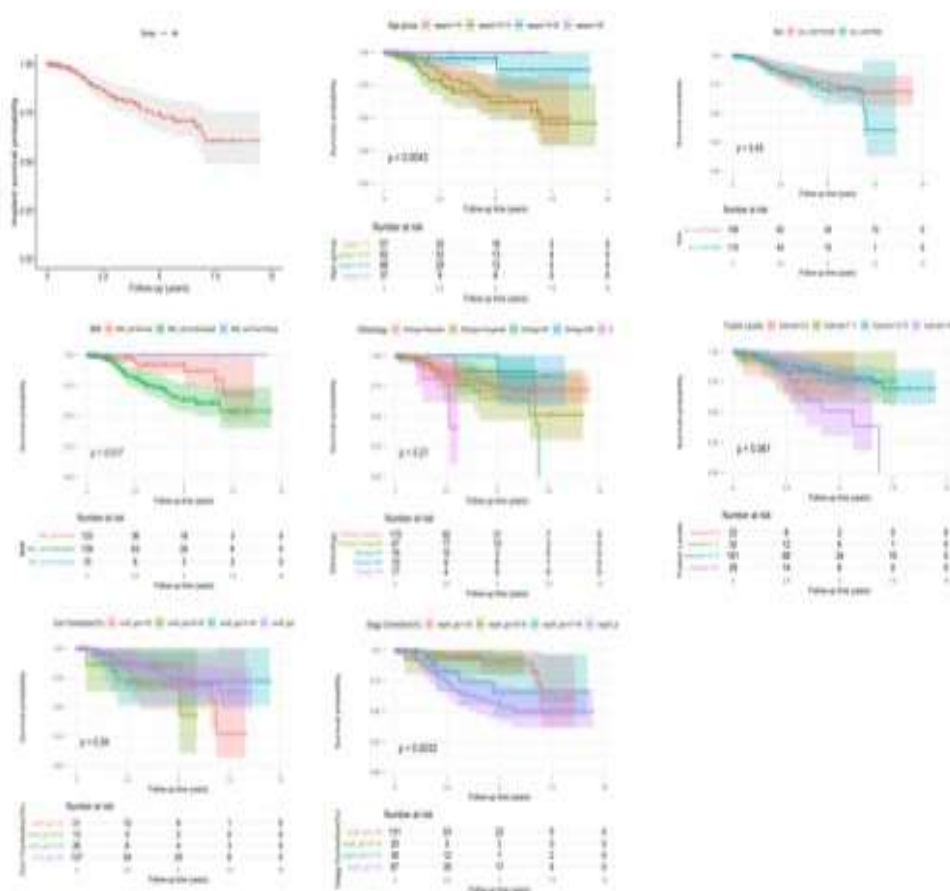
Results

The cohort had a mean age of 14.7 years and was 57% female, with a mean follow-up of 865.1 days. Implant failure occurred in 38 pts (9.5%). KM survival estimates were 97.4% at 1 year, 88.8% at 2 years, 82.9% at 3 years, 72.8% at 5 years, and 60.7% at 7 years. In adjusted analyses, age 10–15 years was associated with increased hazard of failure compared with <10 years (AHR 2.5, $p = 0.017$). Post TB kyphosis had higher failure risk compared idiopathic etiology (AHR 1.4, $p < 0.001$). Sagittal correction above 40% was a strong independent predictor of failure (AHR 4.5, $p < 0.001$). Longer fusion constructs showed lower adjusted hazards compared with short fusions (7–11 levels: AHR 0.07, $p = 0.010$; 12–15 levels: AHR 0.06, $p < 0.001$; ≥ 16 levels: AHR 0.19, $p < 0.001$). The C-index was 82% $p=0.03$

Conclusion

In this West African cohort, implant survival declined to approximately 61% at seven years. Younger patients (10–15), Post TB Kyphosis, and aggressive sagittal correction were major predictors of construct failure. These findings highlight the need for context-specific construct planning, cautious sagittal correction strategies, and enhanced long-term surveillance to improve implant durability in low-resource settings.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant



KM survival estimates of implant survival.

139. Do Patient-Specific Precontoured Rods Justify a Ten-Fold Increase in Cost Compared With Manual Contouring in Adolescent Spinal Deformity Surgery?

Matthew Miyasaka, AB; Alexander Fleisher, BS; Kingsley Ogelle, BS; Alexander Kucherina, BS; Mina Eskandar, MS, BS; Garima Paul, MD; Constance Maglaras, PhD; Themistocles S. Protopsaltis, MD; Juan Carlos Rodriguez-Olaverri, MD

Hypothesis

Patient-specific precontoured rods offer limited clinical benefit over manually contoured rods.

Design

Single-center retrospective cohort study

Introduction

Patient-specific precontoured rods derived from three-dimensional planning have been introduced to improve precision and reproducibility in adolescent spinal deformity correction. However, these constructs are associated with substantially higher implant cost (approximately \$2,000 per construct) compared with standard manually contoured rods (approximately \$200). Whether this cost differential translates into clinically meaningful alignment benefits remains uncertain.

Methods

Adolescents ≤ 25 years undergoing posterior spinal fusion above L4 with an apex osteotomy and complete preoperative and 24-month postoperative standing radiographs were included. Patients were stratified into patient-specific precontoured (PC) and manually contoured (MC) rod cohorts. PC constructs used a 6.0-mm cobalt-chrome rod on the concave side and a 6.0-mm titanium rod on the convex side; MC constructs reflected standard surgeon-directed contouring. Coronal and sagittal alignment parameters and shoulder balance metrics were analyzed. Achievement of normative thoracic kyphosis ($20\text{--}40^\circ$) and PI–LL mismatch within $\pm 10^\circ$ was compared. Independent t-tests and χ^2 analyses were performed.

Results

A total of 129 patients were included (PC = 79, MC = 50), with no preoperative demographic or radiographic differences. At two-year follow-up, PC patients demonstrated greater pelvic tilt ($15.1 \pm 9.7^\circ$ vs $10.8 \pm 11.2^\circ$, $p = 0.029$), thoracic kyphosis ($33.4 \pm 11.6^\circ$ vs $28.9 \pm 9.9^\circ$, $p = 0.020$), and T1 tilt ($7.1 \pm 4.9^\circ$ vs $5.4 \pm 4.4^\circ$, $p = 0.049$). However, the proportion of patients achieving normative thoracic kyphosis and optimal PI–LL alignment did not differ between cohorts ($p > 0.05$). Coronal correction and postoperative shoulder balance were equivalent.

Conclusion

Despite statistically greater pelvic tilt and thoracic kyphosis, patient-specific precontoured rods did not improve the likelihood of achieving normative global alignment or shoulder balance compared with manual contouring. Given the ten-fold increase in implant cost, these modest radiographic differences may not justify routine use in adolescent spinal deformity surgery. Selective application may be appropriate for specific sagittal alignment phenotypes.

§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper, ‡SRS Funded Research Grant

COST COMPARISON (VISUAL ANCHOR)		ALIGNMENT YIELD (CLINICAL REALITY)	
Patient-Specific Precontoured	Manually Contoured	Normative Thoracic Kyphosis (20-40°)	PC: 58% MC: 66% <i>No significant difference</i>
\$2,000	\$200	PI-LL within ±10°	PC: 61% MC: 46% <i>Trend but not significant</i>
10x cost increase		Shoulder Balance (T1 Tilt, Clavicle Angle)	PC ≈ MC <i>Equivalent outcomes</i>

Cost vs Clinical Comparison between Rods

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