

140. Intraoperative Neuromonitoring Alerts During Surgery for Congenital Spinal Deformity: Prevalence, Risk Factors, and Outcomes in a Prospective Study of 100 Patients

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Hypothesis

There are multiple preoperative curve characteristics and intraoperative variables responsible for high incidence of IONM alerts in congenital scoliosis

Design

Retrospective

Introduction

Surgical goals for congenital spinal deformity (CSD) include correction of deformity and prevention of progression without affecting neurological function. CSD has a higher incidence of IONM alerts than other scoliosis types and a potential for risk of postoperative neurological deficit. This study investigates incidence, risk factors, and outcomes associated with IONM alerts in surgically-treated CSD.

Methods

A prospectively-collected pediatric database was queried for surgically-managed patients with CSD. Demographic, surgical, and IONM details were analyzed and neurological outcomes were tracked.

Results

100 patients included. Diagnoses: scoliosis, kyphosis, and kyphoscoliosis. Mean dominant-plane curvature was 64°. Hemivertebrae were in 51 patients. IONM alerts occurred in 19%: 11 transcranial motor-evoked potential (TcMEP) alone and 8 both TcMEP and somatosensory-evoked potential (SSEP). 15 alerts occurred in patients undergoing 3-column osteotomy & 4 posterior spinal fusion (PSF) alone. Significant risk factors for alerts: curve magnitude, sagittal-DAR, total-DAR, % blood loss (%BL), & number of levels fused. The 40% alert likelihood values were 98° (Cobb), 17 (S-DAR), 27.1 (T-DAR), and 52% (%BL). Three-column osteotomy was not statistically correlated with a higher IONM alert rate ($p=0.145$); however, higher alerts were seen in patients with osteotomy (23% vs 11%). Twenty-six alerts occurred in 19 patients; 5 had >1 alert. Most occurred during hemivertebrae excision/VCR & rod/correction maneuvers. Intraoperative mitigation measures included increasing MAP and reducing correction. Signals returned to baseline in 58% alerts. Four of 19 cases had a postoperative neurological deficit—all with combined TcMEP and SSEP loss—but all recovered by 4-6 weeks.

Conclusion

This is the first, large, contemporary multicenter prospective study to highlight a 19% incidence of IONM alerts & favorable outcomes of neurologic deficit in CSD. Curve magnitude, sagittal-DAR, total-DAR, more levels fused, & %BL have significant risk associations. Measures adopted by spine surgeons intraoperatively are described. Combined loss of TcMEP and SSEP should be considered threatening.

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

Variable	IONM alert		Total	Categorical analysis	Binary logistic regression analysis			40% likelihood value
	Yes	No		p value	OR	95% CI	p value	
Gender (F:M)	16:3	47:34	100	0.034	0.242	0.64-0.916	0.037	
Curve magnitude	77°	61°	64°	0.006	1.030	1.007-1.054	0.010	98°
C-DAR	11.1	8.6	9.1	0.048	1.019	0.996-1.234	0.058	
S-DAR	10.3	5.9	6.8	0.005	1.101	1.023-1.184	0.010	17
T-DAR	21.4	14.5	15.8	0.001	1.094	1.031-1.162	0.003	27.1
Osteotomy (VCR/PSO)	15	50	65	0.160	2.447	0.735-8.144	0.145	
PSF	4	31	35					
% blood loss	30	17.4	19.82	0.004	1.036	1.009-1.063	0.008	52
% correction	41	42	42	0.931	1.002	0.978-1.027	0.863	

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

141. Impact of Age at Growing Rod Insertion on Final T1-T12 Spinal Height

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Hypothesis

Children with idiopathic early-onset scoliosis who receive growing rods at a younger age will have a shorter final T1-T12 spinal height compared to children who receive growing rods at an older age.

Design

Retrospective

Introduction

Growing rod (GR) surgery for early-onset scoliosis (EOS) does not reliably achieve a T1-T12 spinal length comparable to children without scoliosis. Autofusion is a potential contributing factor. A recent study found that autofusion is 10 times more likely when GR are inserted in children aged ≤ 7 . This study aimed to determine whether the age of GR insertion is associated with the final T1-T12 height.

Methods

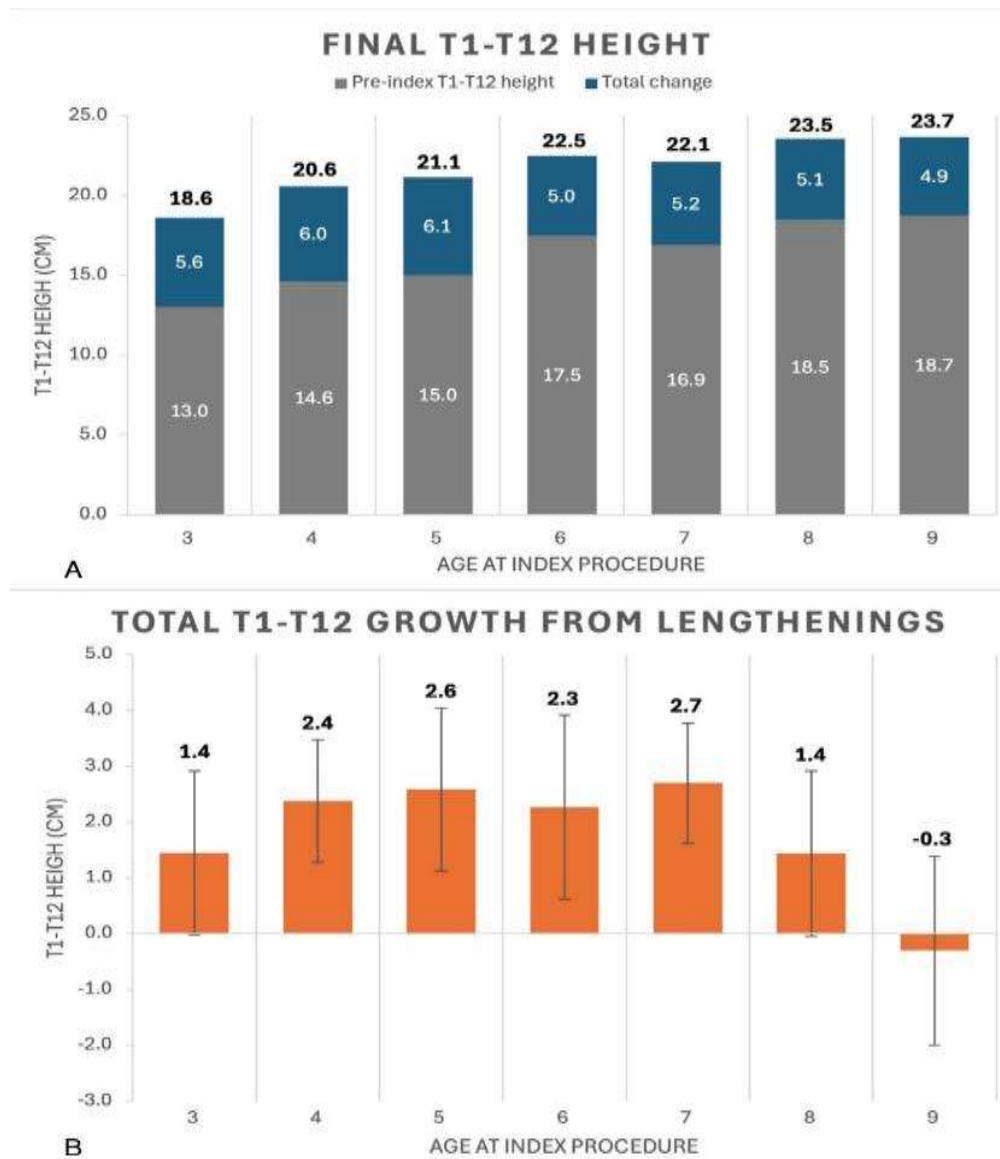
We reviewed a multicenter database. Inclusion criteria were patients with idiopathic EOS who had growing rod surgery from ages 2-9, completed GR treatment, and had pre-insertion and post-definitive X-rays. T1-T12 height was measured at various time points: before and after GR surgery, and before and after definitive fusion. The growing phase was defined as T1-T12 length after GR surgery to immediately prior to definitive fusion. ANOVA, multiple linear regression, and t-tests were performed with significance set at <0.05 .

Results

A total of 149 patients met the inclusion criteria. Final T1-T12 height was shortest when the index procedure was performed at age 3 (18.6 cm [SD: 3.4]) and steadily increased as the age at index surgery increased up to age 9 (23.7 cm [SD: 2.8]). Final T1-T12 height was most influenced by the T1-T12 height prior to the index procedure (13.0-18.7 cm). For every 1-year delay, the final T1-T12 height increased by 6 mm (95% CI 3-9 mm, $p<0.001$). All ages gained less than 3 cm average T1-T12 height during the growth period. Increases in T1-T12 height occurred during GR insertion (1.6-4.3 cm), GR lengthening (-0.3-2.7 cm), and graduation (0.4-1.4 cm).

Conclusion

Final T1-T12 height steadily increases as the age at GR insertion increases and is most influenced by the T1-T12 height prior to the index procedure. There may be a “starting of the clock” when growing rods are inserted, which allows for a finite amount of growth before the spine will no longer meaningfully lengthen.



A) Final T1-T12 height was lowest when index procedure was performed at age 3 and steadily increased as age at index surgery increased. B) Contrary to expectations, younger age at growing rod insertion does not lead to clinically significantly increased T1-T12 growth during lengthening.

142. Physical Function of Early-Onset Scoliosis: An International Multisite Prospective Study

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Hypothesis

The six-minute walk test (6MWT) will correlate with the 1-min and 2-min walk tests (1MWT/2MWT), EOSQ24 physical function domain, pulmonary function test (PFT), and curve magnitude.

Design

Multisite prospective study

Introduction

Early-onset scoliosis (EOS) outcomes are typically limited to radiographs, which do not illustrate physical function. We evaluated correlations between the 6MWT and the 1MWT, 2MWT, EOSQ24, PFTs, and curve magnitude, and compared 6MWT results by EOS etiology.

Methods

4 institutions (3 US; 1 Ghana) prospectively enrolled children with EOS from 2023-25 who could perform a 6MWT and/or 6-min push test (6MPT), PFT, and EOSQ24/self. Children walked (6MWT) or propelled their wheelchair (6MPT) for 6 min. A pulse oximeter monitored heart rate and oxygen saturation. Concomitant 1MWT/1MPT and 2MWT/2MPT were recorded during the 6MWT/6MPT.

Results

142 children (74 Idiopathic [I], 33 Congenital [C], 22 Syndromic [S], 13 Neuromuscular [N]) completed a 6MWT, and 11 a 6MPT. The 6MWT strongly correlated with the 1MWT ($r=0.81$, $p<0.001$) and 2MWT ($r=0.80$, $p<0.001$). The 6MWT moderately correlated with EOSQ24 physical function ($r=0.41$, $p<0.001$) and weakly correlated with EOSQ24 transfer, parental impact, satisfaction, and daily living ($r=0.35-0.30$, $p<0.001$). The 6MWT weakly correlated with FVC% predicted ($r=0.23$, $p=0.018$), and did not correlate with curve magnitude ($r=-0.15$, $p=0.07$). Of the 142 6MWTs, I vs C vs N/S did not differ by age (10.5 yrs vs 10.4 vs 11.0, $p=0.67$), sex (70% vs 61% vs 63%, $p=0.55$), and distance walked (406 m vs. 416 vs 386, $p=0.45$). I had smaller curves than C and N/S (40° vs 59° vs 55° , $p<0.01$), better FVC% predicted (75% vs 62% vs 63%, $p<0.05$), and better EOSQ24 physical function scores (91 vs 83 vs 86, $p<0.05$). The only other EOSQ24 domain difference by etiology was worse financial impact scores for N vs. C (64 vs. 82, $p=0.020$). The distance walked did not differ by geographic location ($p=0.50$).

Conclusion

International multi-site collaboration in reporting physical function in EOS is valid and feasible. Unlike radiographs which quantify structure, the 6MWT provides a clinically meaningful measure of physical function regarding how EOS impacts daily life. Multiple EOSQ24 domains (physical function, transfer, parental impact, satisfaction, and daily living) correlated with the 6MWT. The 1MWT and 2MWT may serve as practical surrogates to the 6MWT.

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6MWT correlations with the 1MWT, 2MWT, EOSQ24, PFT, and curve magnitude

	6MWT	
	Correlation (r)	p-value
1MWT	0.81	<0.001
2MWT	0.80	<0.001
EOSQ24 domain		
General health	0.13	0.133
Pain/discomfort	0.07	0.432
Pulmonary function	0.17	0.052
Transfer	0.35	<0.001
Physical function	0.41	<0.001
Daily living	0.30	<0.001
Fatigue/energy level	0.25	0.003
Emotion	0.22	0.010
Parental impact	0.32	<0.001
Financial impact	0.21	0.016
Satisfaction	0.31	<0.001
PFT		
FVC absolute (L)	0.16	0.106
FVC% predicted	0.23	0.018
FEV1 absolute (L)	0.15	0.129
FEV1% predicted	0.17	0.072
Curve magnitude	-0.15	0.068

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

143. Proximal Junctional Kyphosis in Distraction-Based Growth-Friendly Treatment: Definition, Risk Factors, and Timeline

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Hypothesis

In early-onset scoliosis (EOS) treated with dual growing rod (GR) systems, proximal junctional kyphosis (PJK) occurs in distinct temporal patterns and is associated with specific radiographic and construct-related factors.

Design

Single-center retrospective cohort study of EOS patients treated with dual GRs, using serial radiographs to determine the timing and risk factors of PJK.

Introduction

PJK may complicate distraction-based growth-friendly treatment (DB-GFT) and negatively affect overall treatment success. This study aimed to re-evaluate the definition, timing, and risk factors of PJK.

Methods

95 EOS patients treated with GR systems between 2004 and 2023 and with ≥ 2 years of follow-up were retrospectively reviewed. Radiographic parameters were assessed at preoperative, postoperative, and final follow-up. PJK was defined as a proximal junctional angle (PJA) $\geq 10^\circ$ at the latest follow-up with an increase of $\geq 10^\circ$ compared with preoperative PJA values. Serial lateral radiographs were examined at 3 or 6 month intervals to assess both the occurrence and timing of PJK. Univariate and multivariate logistic regression analyses were performed to identify risk factors.

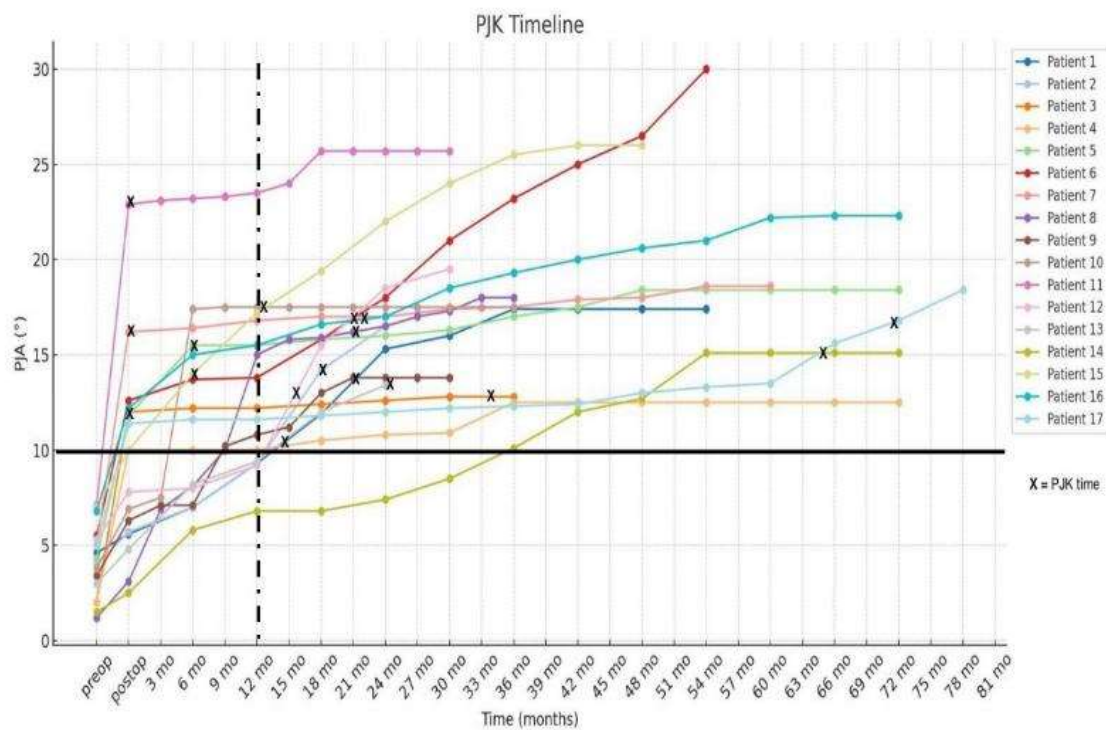
Results

The age of the 95 patients at the time of index surgery was 6.84, the mean follow-up was 5.83 years, and the age at the last follow-up was 12.7 years. PJK developed in 17 patients (17.8%). It developed immediately postoperatively in 3 patients (mechanical) and gradually in 14 others (biological), of whom 12 were diagnosed after the first year. The univariate logistic regression identified the following significant risk factors: upper instrumented vertebra (UIV) at T3 and distal, T5–T12 thoracic kyphosis (TK) correction $\geq 30^\circ$. There was a 3% increase in PJK risk for every 1° increment in preoperative T5–T12 TK and a 3% increase in PJK risk for every 1° increment in the postoperative lumbar lordosis difference. The multivariate logistic regression revealed that UIV at T3 or below was an independent risk factor.

Conclusion

Patients with preoperative T2–T12 TK $\geq 45^\circ$, those undergoing extensive kyphosis correction, or with a UIV located below T3 appear to have a higher risk of developing PJK. Normative segment-adjusted PJA values may serve as a more useful metric for identifying clinically meaningful PJK cases that have the potential to progress to proximal junctional failure (PJF). Since most PJK manifests after 1 year, long-term follow-up is essential.

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



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‡SRS Funded Research Grant

144. Crankshaft Phenomenon and Its Related Factors Following Traditional Growing Rod Surgery in Early-Onset Scoliosis: A Computed Tomography-based Analysis

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Hypothesis

Considering the law of diminishing returns in traditional dual growing rod (TDGR) technique, the crankshaft phenomenon characterized by auto-fusion and progressive vertebra rotation may be inevitable complication in early-onset scoliosis (EOS).

Design

A retrospective cohort study

Introduction

TDGRs are widely used in the treatment of EOS because of their effectiveness in controlling coronal and sagittal alignment while permitting spinal growth. However, auto-fusion and progressive vertebral rotation at the time of final fusion surgery are frequently observed.

Methods

A total of 39 EOS patients who underwent growth-friendly surgery using TDGRs were categorized into two groups according to the development of the crankshaft phenomenon, defined as the presence of autofusion and increased vertebral rotation $>5^\circ$: the crankshaft group (C group) and the non-crankshaft group (non-C group). Computed tomography (CT) scans were obtained at baseline and at the last follow-up before final fusion. Multivariate logistic regression analysis was performed to identify factors associated with the crankshaft phenomenon.

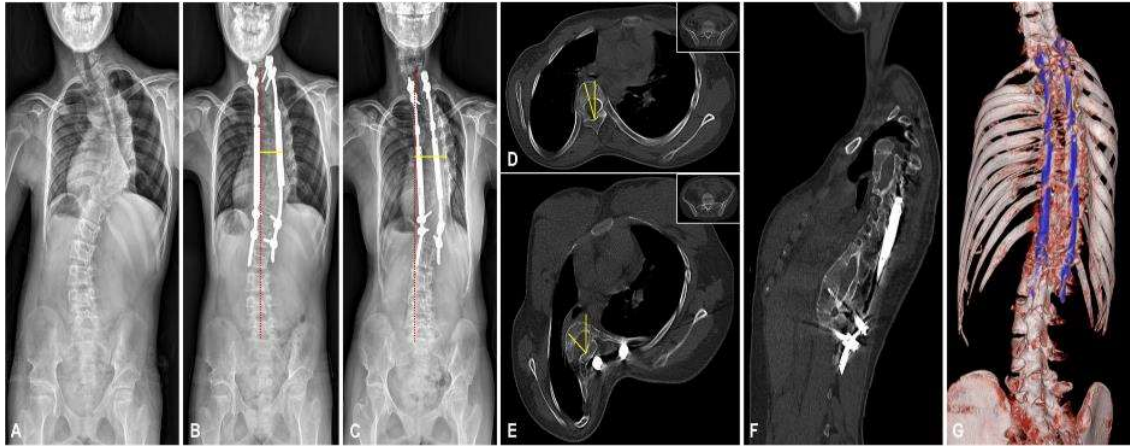
Results

The incidence of the crankshaft phenomenon was 64.1% (25 of 39) over a mean follow-up of 42.7 months. The mean main Cobb angle was significantly higher in the C group (46.2°) than in the non-C group (35.6°) ($P = 0.038$). The mean apical translation (AT) at the final follow-up was greater in the C group (46.2 mm) than in the non-C group (35.6 mm) ($P = 0.014$). The change in apical vertebral (AV) rotation was 13.5° in the C group compared with 0.2° in the non-C group. The rate of autofusion was 100% in the C group and 57.1% in the non-C group ($P < 0.001$), primarily observed on the convex side, involving a mean of 4.9 segments around the AV. Multivariate logistic regression analysis identified AT at final follow-up and the number of autofused segments as significant factors associated with the crankshaft phenomenon.

Conclusion

The crankshaft phenomenon was relatively common following growth-friendly surgery using TDGRs in EOS. AT at final follow-up and the presence of multiple autofused segments were significantly associated with its development. These findings suggest that improved apical control in growing rod techniques may help reduce the risk of the crankshaft phenomenon.

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



Crankshaft phenomenon in the traditional growing rod surgery

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‡SRS Funded Research Grant

145. Implant Survival after Graduation by “Observation” in Patients Treated with Growing Rods: a 10-year Follow-up Study

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Hypothesis

Graduation by observation (with implant retention) at skeletal maturity after growing rod (GR) treatment can provide long-term curve stability and durable implant survival without requiring definitive fusion

Design

Retrospective single-center observational study.

Introduction

The optimal management strategy at skeletal maturity in patients with EOS treated with GR remains controversial. While definitive spinal fusion is traditionally recommended, graduation by observation may avoid final surgery in selected, low risk, well-aligned patients. The aim was to evaluate long-term implant survival, curve stability, and the rate of treatment failure when implants are retained.

Methods

Patients treated with GR who reached skeletal maturity and were graduated by observation with a minimum follow-up of 5 years were retrospectively reviewed. Radiographic evolution was analyzed assessing Cobb angle variation. Implant survival free from mechanical failure: rod breakage, pull-out, proximal junctional kyphosis (PJK), and distal junctional kyphosis (DJK), was assessed using Kaplan–Meier survival analysis. Strategy failure was strictly defined as conversion to definitive fusion, while mechanical failures not leading to fusion were recorded separately.

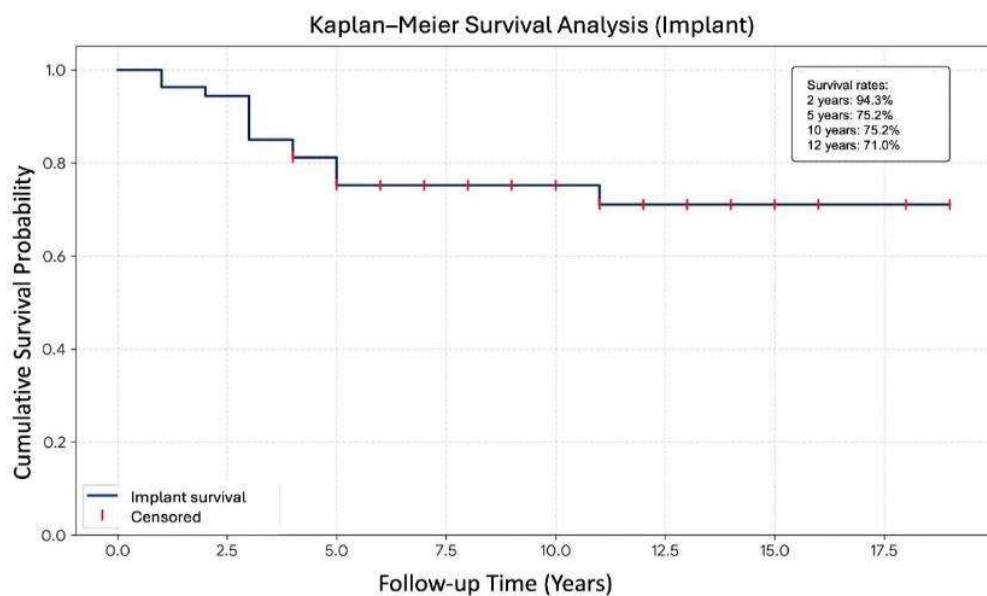
Results

Fifty-three patients were included, with a mean age at graduation of 14.4 ± 1.8 years, mean follow-up of 10.4 ± 4.2 years. The mean preoperative Cobb angle ($88.1^\circ \pm 21.1$) significantly decreased to $40.8^\circ \pm 11.3$ postoperatively ($p < 0.001$). At graduation, the mean Cobb angle was $48.2^\circ \pm 14.3$ and remained stable at $48.6^\circ \pm 14.1$ at final follow-up ($p > 0.05$). Kaplan–Meier analysis showed a mechanical failure-free implant survival of 75% at both 5 and 10 years, with risk stabilization beyond the fifth year. Only 5 patients (9.4%) required conversion to definitive fusion. Two additional patients showed severe progression (110° and 80°) but remained under observation by clinical/family decision. The overall complication rate was 32% (mechanical failure 24.5%, infection 7.5%).

Conclusion

Graduation by observation at skeletal maturity in selected cases represents a viable alternative to definitive fusion, providing long-term radiographic stability in most patients. Although conversion to fusion is uncommon, isolated mechanical complications and cases of significant curve progression underscore the need for rigorous follow-up.

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



§ Hibbs Award Nominee – Best Clinical Paper, † Hibbs Award Nominee – Best Basic Science/Translational Science Paper,
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146. Staged Growing-Rod Implantation Is Associated With Lower Rates of Reoperation-Requiring Complications in Extremely Severe Early-Onset Scoliosis

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Hypothesis

Staged growing-rod (GR) implantation reduces complications requiring reoperation in extremely severe early-onset scoliosis (EOS) without compromising radiographic correction.

Design

Retrospective cohort study.

Introduction

Complication-related reoperations remain common after growing-rod surgery for EOS, particularly in extreme deformity. Staged implantation (anchor placement followed by delayed rod insertion) was adopted to mitigate implant-related failure in the most severe cases.

Methods

EOS patients treated with dual-rod GR and ≥ 2 -year follow-up were reviewed (N=54). Same-day implantation (anchors+rods) was compared with staged implantation (median 4.6 months [IQR 3.5–5.1] from anchor placement to rod insertion). Complications were categorized as requiring reoperation or not (patient-level incidence, ≥ 1 event). Primary analysis included severe-eligible cases defined a priori as preop max Cobb $>100^\circ$ or thoracic kyphosis (TK, T2–T12) $\geq 60^\circ$. Sensitivity analysis used Cobb $\geq 90^\circ$ or TK $\geq 60^\circ$. Max Cobb and TK were measured preop, 1 month post-op, and at final follow-up.

Results

Overall, 39 patients underwent same-day and 15 staged implantation (age at index surgery 7.8 ± 3.1 years; follow-up 9.0 ± 4.2 years). In the severe-eligible cohort (same-day N=6; staged N=12), reoperation-requiring complications occurred in 5/6 (83.3%) vs 2/12 (16.7%) ($P=0.013$; RR=0.20, 95%CI 0.05–0.74). Non-reoperation complications occurred in 5/6 (83.3%) vs 4/12 (33.3%) ($P=0.131$). Final max Cobb ($44.4 \pm 25.1^\circ$ vs $39.7 \pm 18.4^\circ$, $P=0.85$), pre-to-final Cobb correction ($54.4 \pm 21.8\%$ vs $50.5 \pm 27.4\%$, $P=0.82$), and final TK ($50.7 \pm 27.2^\circ$ vs $48.2 \pm 16.7^\circ$, $P=0.71$) were similar. In the sensitivity cohort (N=26; 13 each), reoperation-requiring complications occurred in 7/13 (53.8%) vs 2/13 (15.4%) ($P=0.097$; RR=0.29, 95%CI 0.07–1.13).

Conclusion

Staged GR implantation was associated with markedly fewer reoperation-requiring complications in extremely severe EOS while maintaining comparable radiographic correction; the benefit was most evident using Cobb $>100^\circ$ or TK $\geq 60^\circ$.

147. Growth guidance or posterior based distraction in EOS: Can the modified Clavien-Dindo-Sink Classification System Tell Them Apart?

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Hypothesis

TGR and MCGR will demonstrate more severe complications than Shilla growth guidance as designated by the mCDS classification system.

Design

Retrospective analysis of a multicenter database.

Introduction

The Shilla growth guidance (SGG) system was developed to treat spinal deformity without repeated lengthenings associated with posterior based distraction (PBD) techniques, including traditional growing rods (TGR) and magnetically controlled growing rods (MCGR). The modified Clavien-Dindo-Sink (mCDS) classification system is a validated method of evaluating complications in pediatric spine surgery. Previous studies have compared SGG and PBD in early onset scoliosis (EOS), but none have compared rates of severe complications using a standardized classification system like the mCDS.

Methods

We identified 2021 EOS patients who were treated with index SGG, TGR, or MCGR procedures, were less than 10 years-old when receiving their index procedure, had minimum 2-year follow-up from their index procedure, had no prior spine surgery, and had mCDS grading for associated complications. After dividing patients by etiology, a negative binomial regression model was used to compare rates of severe complications (mCDS $\geq$ IIIa) between patients receiving SGG and MCGR. Descriptions for mCDS ratings can be found in Table 1. This analysis was repeated comparing SGG and TGR patients.

Results

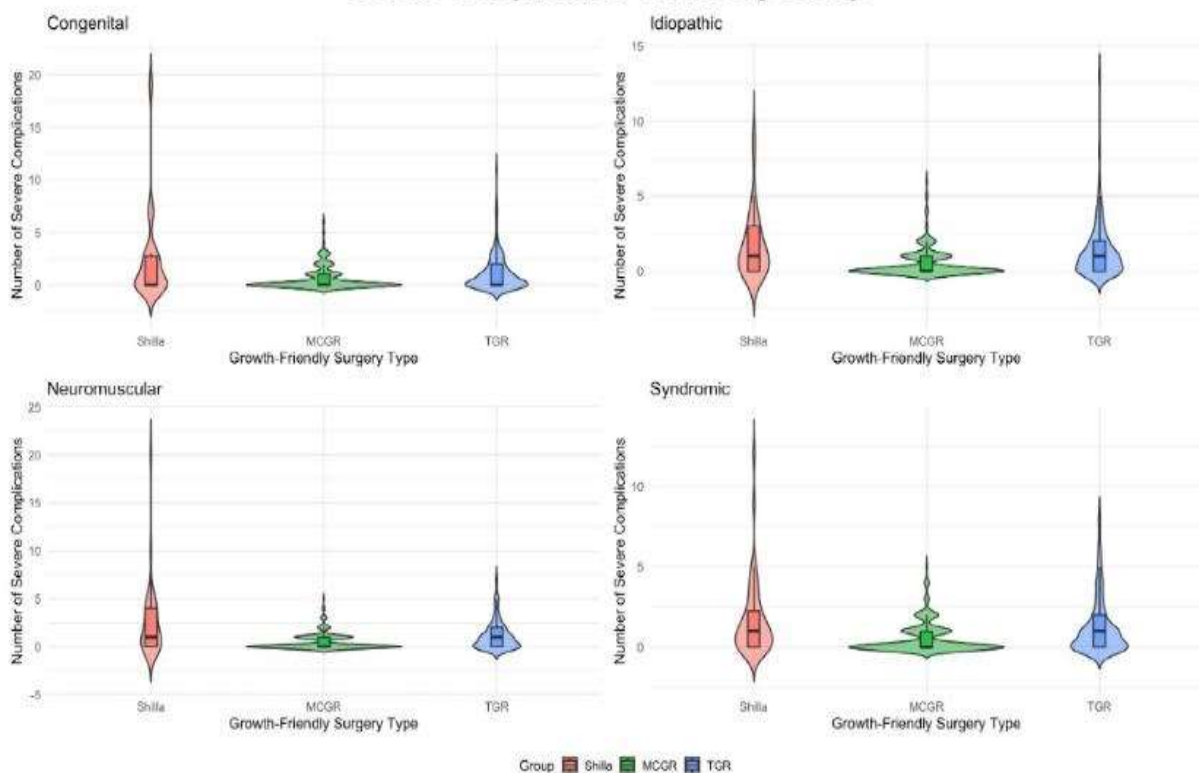
Among all etiologies, patients treated with SGG experienced more severe complications than those receiving MCGR and TGR despite undergoing fewer surgeries than patients with TGR. MCGR patients generally underwent fewer surgeries than both groups but also had shorter follow-up from index procedure. Mean complications for SGG were greatest among syndromic patients at 2.6. Incidence rate ratio (IRR) comparing MCGR and SGG was lowest among neuromuscular patients at 0.21 (95% CI:0.15-0.30), indicating greater rates of severe complications among SGG patients. The IRR comparing TGR and SGG was lowest among congenital patients at 0.49 (95% CI:0.24-0.92) and neuromuscular patients 0.49 (95% CI:0.34-0.70). Shilla GG also had greater rates of severe complications than MCGR and TGR for all etiologies (Table 2).

Conclusion

Patients receiving SGG demonstrated greater rates of severe complications than TGR and MCGR patients despite undergoing fewer surgeries than patients with TGR. This relationship holds true for all etiologies.

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Severe Complication Counts by Group



mCDS Complication Grade*	Definition
0	No change in protocol, no change in routine follow-up, does not result in a return to the operating room.
I	Does not result in deviation from routine follow-up in the postoperative period and requires minimal or no treatment.
II	Unplanned clinic visits that require close monitoring/outpatient treatment or results in prolonged initial inpatient hospital stay.
IIIa	Treatable but requires an unplanned hospital readmission.
IIIb	Unplanned surgical or interventional procedure(s).
IVa	Life threatening, and/or requires ICU admission. Potential for permanent disability but treatable. No long-term disability.
IVb	Life threatening, and/or requires ICU admission. Not treatable, a complication that requires salvage surgery. With long-term disability.
V	Death

Table 1. Description of mCDS Complication Grades

*Bolted grades are considered "severe"

	n	Mean Severe Complications	Incidence Rate Ratio	95% CI Confidence Interval	Mean Number of Surgeries	Mean Follow-up (yr)
Congenital						
Shilla CG	22	2.3 ± 4.3	-	-	5.5 ± 9.5	5.0 ± 5.3
MCGR	148	0.6 ± 1.1	0.27	0.15, 0.51	3.1 ± 2.3	2.8 ± 1.6
TGR	160	1.3 ± 1.7	0.68	0.34, 0.99	8.0 ± 4.9	4.4 ± 3.1
Idiopathic						
Shilla CG	32	1.8 ± 2.3	-	-	6.8 ± 5.4	5.2 ± 5.0
MCGR	242	0.6 ± 1.0	0.29	0.18, 0.47	7.0 ± 6.7	2.8 ± 1.6
TGR	140	1.2 ± 1.7	0.72	0.44, 1.15	10.0 ± 5.4	4.3 ± 3.0
Neuromuscular						
Shilla CG	50	2.4 ± 3.4	-	-	6.2 ± 5.4	5.1 ± 5.0
MCGR	490	0.5 ± 0.9	0.21	0.15, 0.30	3.2 ± 3.4	2.8 ± 1.2
TGR	233	1.2 ± 1.5	0.49	0.34, 0.70	7.0 ± 4.2	4.1 ± 3.1
Syndromic						
Shilla CG	40	2.6 ± 2.4	-	-	6.5 ± 5.8	4.5 ± 5.5
MCGR	252	1.6 ± 0.8	0.21	0.20, 0.48	5.4 ± 6.0	3.7 ± 1.4
TGR	244	2.2 ± 1.7	0.86	0.64, 1.01	9.0 ± 5.2	5.0 ± 3.5

Table 2. Relative Rates of Severe Complications, Surgeries, and Follow-up by Etiology

*Ref Shilla 0.0

148. Revision Surgery for Deep Surgical Site Infection Differs by Instrumentation Type but Is Not Associated With Inferior Patient-Reported Outcomes in Early-Onset Scoliosis

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Hypothesis

We hypothesized that infection-related revision would worsen patient-reported outcomes and differ by instrumentation type.

Design

A multicenter registry cohort of surgically treated EOS patients younger than 10 years at index surgery was analyzed.

Introduction

Deep surgical site infection is a common complication in the surgical treatment of early-onset scoliosis (EOS) and often necessitates reoperation. The impact of revision surgery for infection on patient-reported outcome measures remains unclear.

Methods

Unplanned revision surgeries performed to treat a deep surgical site infection were identified: 78 children underwent surgery with traditional growing rods (TGR), 46 with magnetically controlled growing rods (MCGR), 143 with VEPT, and 20 with Shilla. All patients had a minimum 2-year follow-up. Only the first infection-related postoperative revision per patient was considered for analysis. Revisions were classified as early (<90 days) or late (≥90 days) following index surgery. EOSQ-24 domain scores were compared within patients before and after the first infection-related revision. Logistic regression was used to compare revision risk between instrumentation types.

Results

Within-patient PROM changes were not statistically significant following infection-related revision surgery, with Wilcoxon signed-rank p-values ranging from 0.052 to 1.00 for early revisions (minimum p adjusted for etiology = 0.54) and from 0.086 to 0.97 for late revisions (minimum adjusted p = 0.37). Revision rates due to infection differed significantly by instrumentation type. Compared with TGR, MCGR was associated with a lower risk of late revision (OR 0.35, 95% CI 0.22–0.54, p<0.001) and VEPT was associated with higher risk (OR 2.19, 95% CI 1.60–3.04, p<0.001). There were no statistically significant differences between Shilla and TGR. No significant differences were observed for early revisions. Compared with idiopathic EOS, syndromic patients demonstrated a lower risk of early revision (OR 0.25, 95% CI 0.08–0.74, p=0.013) but a higher risk of late revision (OR 4.00, 95% CI 1.36–12.42, p=0.013).

Conclusion

EOSQ-24 scores did not change following early or late infection-related revision surgery. There were significant differences in infection-related revision risk by instrumentation type.

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

	Early infection	OR (95%CI)	Late infection	OR (95%CI)	
MCGR	18 (28.6%)	0.87 (0.43–1.74)	28 (12.4%)	0.35 (0.22–0.54)	
Shilla	5 (7.9%)	1.88 (0.61–4.89)	15 (6.6%)	1.46 (0.78–2.57)	
TGR	16 (25.4%)	Reference	62 (27.4%)	Reference	
VEPTR	23 (36.5%)	1.54 (0.81–2.99)	120 (53.1%)	2.19 (1.60–3.04)	
Female	29 (46.0%)		117 (51.8%)		
Congenital	17 (27.0%)	0.57 (0.23–1.45)	67 (29.6%)	1.76 (0.69–4.36)	
Idiopathic	9 (14.3%)	Reference	20 (8.8%)	Reference	
Neuromuscular	31 (49.2%)	0.77 (0.33–1.87)	84 (37.2%)	1.30 (0.54–3.03)	
Syndromic	6 (9.5%)	0.25 (0.08–0.74)	55 (24.3%)	4.00 (1.36–12.42)	
	Early infection	Median [IQR]	Late infection	Median [IQR]	Significance Early vs. Late
Age at Surgery		6.35 [3.80, 7.99]		5.19 [3.19, 7.52]	0.141
Age at Infection		6.39 [3.93, 8.03]		9.03 [6.73, 11.27]	<0.05
Preoperative weight	51	17.10 [12.40, 21.66]	189	15.47 [12.20, 20.00]	0.182

Risk of Early and Late Infection-Related Revision

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

149. Radiographic and Functional Outcomes for Sagittal Alignment in Growth Rod Graduates: Are We Able to Rebuild it?

Anuj Gupta, MD; Brett Shannon, MD; Benjamin Crain, MD; Petya Yorgova, MS; Paul D. Sponseller, MD; Lindsay M. Andras, MD; Pediatric Spine Study Group; Suken A. Shah, MD

Hypothesis

Final fusion does not change sagittal alignment significantly

Design

Retrospective

Introduction

Role of sagittal alignment is extensively studied in adults and has been extended to pediatric. The inability to restore the sagittal parameters has direct impact on functional outcomes. Sagittal alignment in EOS managed with growth-friendly implants is modifiable, but what about after definitive fusion?

Methods

A prospective database was queried, patients managed with dual TGR or MCGR & anchors at spine were included. Anchors to the ribs, and follow-up of less than 2 years were excluded. The variables were collected at pre-index (before growth rod implantation), post-index, pre-definitive, post-definitive (final fusion), & at latest follow-up.

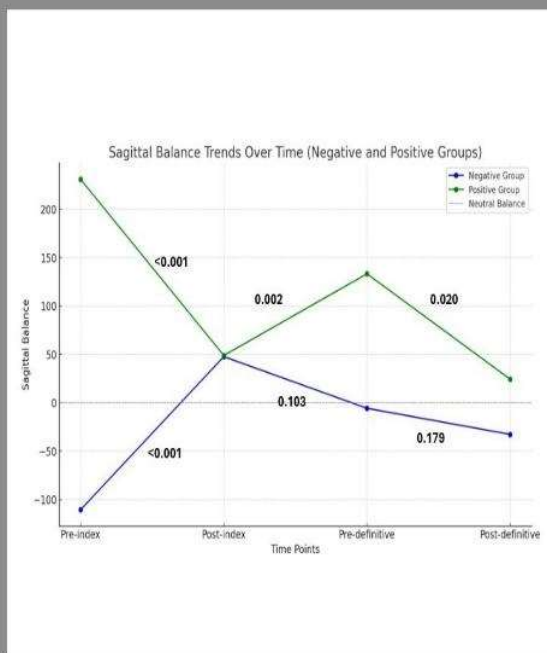
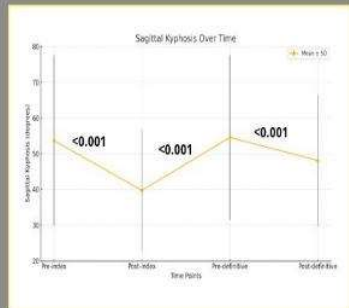
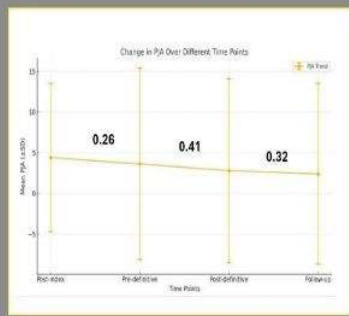
Results

420 patients (257 females), mean age 8.1 years at index implantation & 13.2 years at final follow up were included. Most common etiologies were neuromuscular (135), idiopathic (127), & syndromic (119). 234 patients were managed with TGR & 186 with MCGR. There was significant change in curvature & T1-S1 length at all time points ($p < 0.0001$). TGR had better maintenance of curvature (loss of 8° vs 12° , $p = 0.016$) & increase in length (36.8 mm vs 11.7 mm, $p = 0.001$) during lengthening. There was a significant change ($p < 0.001$) in sagittal kyphosis & LL overall, & MCGR patients ended with lower kyphosis & LL at post-definitive ($p = 0.02$). Sagittal balance move towards neutral after index & definitive. Patients with +ve balance shifted to more +ve (+84.4mm, $p = 0.002$), & those with -ve balance, to more -ve (-53.3mm, $p = 0.10$) during lengthening. No significant change in these variables from post-definitive to mean follow-up of 2.9 years. PJA decreased from post-index to follow-up ($p = 0.003$). The EOSQ-24 was not in normative range at pre-definitive & follow-up. It showed no significant change from pre-definitive to follow-up in all 3 domains except transfer (77% vs 72%, $p = 0.013$) & fatigue/energy level (75% vs 70%, 0.0008), where deterioration observed. 28% (119/420) needed UPOR, most common reason rod fracture (53), & anchor pull-out (43).

Conclusion

Sagittal balance & PJA are not changed after definitive surgery. Kyphosis & LL are reduced & MCGR patients have lower values. The EOSQ-24 are not in normative range & not impacted by definitive surgery. Restoration of "normal" sagittal alignment remains difficult with current techniques and may affect long term HRQoL.

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



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

150. Effect of Distraction-based Growth Friendly Implants on Spinopelvic Parameters and Health-Related Quality of Life after Growth-Friendly Spine Surgery in EOS Patients at a Minimum of 5 Years Follow-up

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Hypothesis

The kyphogenic effect of posterior distraction-based growth friendly instrumentation contributes to deteriorating sagittal imbalance over time.

Design

Retrospective, longitudinal observational cohort study using PSSG registry

Introduction

The kyphogenic effect of posterior distraction via either traditional growing rods (TGR) or magnetically controlled growing rods (MCGR) may contribute to deteriorating sagittal imbalance requiring correction at definitive fusion.

Methods

The PSSG database was queried for all ambulatory patients with growth friendly procedures with 5 year or pre-definitive fusion follow up radiographs. In the sagittal plane, the straight proportion of growth friendly instrumentation over the total length of instrumentation (Instrumentation Ratio, IR) was measured over serial radiographs as a surrogate for implant lengthening. Statistical analysis was performed via mixed model two-way ANOVA with instrumentation type as a grouping factor and time as a repeated factor.

Results

68 patients met inclusion criteria with either 5-year or pre-definitive fusion follow up radiographs. Despite interval posterior distraction (IR $p=0.004$), no significant change occurred in Pelvic Incidence (PI), Sacral Slope (SS), Pelvic Tilt (PT), Lumbar Lordosis (LL), or Thoracic Kyphosis (TK). Radiographic markers of global sagittal balance remained normalized when comparing pre-operative and 5-year or pre-definitive fusion for this cohort and did not demonstrate significant change throughout lengthening: Sagittal Vertical Axis (SVA) normalized while T4-L1 Pelvic Angle mismatch and PI:LL mismatch were unchanged. 44 of 68 had EOSQ results within 6 months of both their pre-operative and 5-year follow-up visits. Pain Discomfort decreased (76 to 65, $p=0.019$) and Parental Impact increased (70 to 77, $p=0.006$). No other statistically significant differences in domains exist over this time interval.

Conclusion

This longitudinal cohort of ambulatory patients treated with TGR or MCGR demonstrate maintenance of balanced global sagittal alignment and stable sagittal parameters. Sample size is too small to make significant conclusions regarding HRQOL in this cohort, however, evidence of deterioration of EOSQ is lacking.

	Pre-operative	5-yr / pre-definitive	p value
IR	0.39	0.43	p=0.004
PI	48.1°	50.9°	p=0.144
SS	42.1°	41.8°	p=0.866
PT	6.3°	9.3°	p=0.132
LL	53.6°	54.6°	p=0.771
TK	35.6°	31.6°	p=0.233
SVA	24.4 mm	9.6 mm	p=0.016
T4L1PA	3.8°	4.3°	p=0.407
<u>PI:LL</u>	11.1°	14.3°	p =0.136

Comparison of pre-operative and 5-year/pre-definitive fusion sagittal parameters

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

151. Long-term Outcomes in Adulthood Following Traditional Growing Rods for Early-Onset Scoliosis

Masaaki Ito, MD, PhD; Teppei Suzuki, MD, PhD; Koki Uno, MD, PhD

Hypothesis

TGR patients have poorer long-term QOL and social outcomes than AIS patients.

Design

Retrospective case series study

Introduction

Traditional growing rods (TGR) for early-onset scoliosis (EOS) impose significant burdens due to repeated surgeries. We investigated the long-term clinical and social outcomes of patients who reached adulthood following TGR.

Methods

Forty patients (20 female) who underwent TGR at our hospital between 1999 and 2012 were studied. Radiographic findings, survival, and employment status were assessed. Patient-reported outcomes (SRS-22, ODI) were compared with those of AIS patients (>10 years post-operative).

Results

The patients were categorized by etiology: congenital/structural (n=17), neuromuscular (n=6), syndromic (n=10), and idiopathic (n=7). The mean age was 7.9 years [2.7–13.4] at initial TGR surgery and 26.0 years [19.7–33.3] at final follow-up, with a mean follow-up duration of 17.9 years. During the postoperative period, four patients (10%) died (cardiovascular disease: 2, sepsis: 1, unknown: 1) at a mean age of 17.4 years [11–20.2]. Definitive fusion was performed in 36 patients. Chronological changes in mean scoliosis and thoracic kyphosis were: 85°/53° (pre-TGR), 51°/41° (post-TGR), 53°/51° (pre-definitive fusion), 40°/49° (post-definitive fusion), and 46°/53° (final follow-up). Corresponding T1-S1 lengths were 259, 298, 341, 361, and 361 mm. The mean number of lengthening procedures was 9.1, resulting in a total of 11.9 surgical interventions per patient. Complications included surgical site infections in 17 patients (43%) and unplanned surgeries in 20 patients (50%). Regarding social outcomes for survivors without intellectual disability (n=27), work status included: sedentary (n=9), light (n=8), medium (n=2), student (n=2), and unemployed (n=6). Compared to the AIS control group, the TGR group demonstrated significantly lower scores in SRS-22 domains: Function (3.88 vs. 4.30), Self-image (3.53 vs. 4.02), and Satisfaction (3.62 vs. 4.20) (all P<0.01).

Conclusion

TGR treatment entails a high surgical burden and complication rate. Adult TGR patients report significantly lower function, self-image, and satisfaction than AIS patients. Their limited employment highlights the critical need for long-term multidisciplinary support in adulthood.

Table. Comparison of SRS-22 and ODI scores between TGR and AIS groups

		TGR	AIS	P value
SRS-22	Function	3.88 ± 0.59	4.30 ± 0.45	<0.01
	Pain	4.62 ± 0.45	4.68 ± 0.39	0.59
	Self-image	3.53 ± 0.52	4.02 ± 0.54	<0.01
	Mental health	4.14 ± 0.58	4.37 ± 0.56	0.18
	Satisfaction	3.62 ± 0.63	4.20 ± 0.75	<0.01
ODI (%)		10.2 ± 11.8	7.0 ± 6.7	0.24

Compared to AIS, the TGR group had significantly lower SRS-22 Function, Self-image, and Satisfaction scores, with no differences in ODI or Pain.

152. Congenital Scoliosis: An Update to Its Natural History and Clinical Approach

Mihir Sharma, BS; Alexander Bhatt, MS; Jason Brenner, BS; Ashlyn Callan, MS; Priya Singh, MD; Edina Gjonbalaj, BS; Pediatric Spine Study Group; Jacob F. Schulz, MD; Leila Mehraban Alvandi, PhD; Jaime A. Gomez, MD

Hypothesis

The natural history of congenital scoliosis follows the discoveries of McMaster and Ohtsuka.

Design

Retrospective cohort analysis.

Introduction

Congenital scoliosis exhibits a variable natural history. Predictive modeling could improve care.

Methods

This multicenter study included 464 patients with congenital scoliosis with baseline and follow-up X-rays. Patients with neurological conditions were excluded. Deformities were classified using McMaster's system. The primary outcome was a Cobb angle $\geq 50^\circ$ assessed at final follow-up or at last follow-up before surgical or casting/bracing treatment. A Kaplan-Meier survival analysis was used to analyze curve progression by deformity type, deformity location, and gender. A Chi-squared Automatic Interaction Detection (CHAID) decision tree was used to find predictors of progression. A Cox regression model was used to assess independent associations between progression and baseline age, deformity type, and gender.

Results

The mean baseline and follow-up ages were 3.5 ± 3.5 years and 8.8 ± 4.7 years, respectively. Most patients underwent surgical correction (55.3%), followed by observation (40.1%) or casting/bracing (4.5%). Baseline and follow-up Cobb angles averaged $46.5^\circ \pm 18.9^\circ$ and $51.3^\circ \pm 22.9^\circ$, respectively. Kaplan-Meier analysis demonstrated that patients with unilateral unsegmented bars, with or without hemivertebra (HV), were at the highest risk of progression. Thoracic and thoracolumbar curves also showed higher progression risk, and female patients were more likely to progress. Cox regression identified higher baseline Cobb angle (OR 1.05 per degree increase, $p < 0.001$), older age at baseline (OR 1.12 per year increase, $p < 0.001$), and female sex (OR 1.38, $p = 0.024$) as independent predictors of progression. CHAID analysis through recursion identified baseline Cobb angle as the strongest predictor. Cobb $\leq 38^\circ$: Low progression risk (20.8%), especially in block vertebra, incarcerated HV, and complex anomalies (6.9%). Cobb $38-54^\circ$: Moderate progression risk (53.2%), with higher risk in patients with semisegmented HV, wedge, and unilateral unsegmented bar deformities (70.6%). Cobb $> 54^\circ$: High risk of maintenance at $> 50^\circ$ (92.2%) regardless of deformity type.

Conclusion

Baseline Cobb angles with deformity classifications are a predictors of curve progression in congenital scoliosis.

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

Greater risk of progression in small curves ($<38^\circ$)



Fully segmented



Unilateral bar



Unilateral bar and hemivertebra



Wedge

Greater risk of progression in mid-range curves ($38^\circ - 54^\circ$)



Unilateral bar and hemivertebra



Unilateral bar



Wedge



Semisegmented

Complex anomalies

Results from the CHAID Analysis.

153. The interesting morphological changes of adjacent vertebra after posterior hemivertebrectomy with unilateral short segment fusion for long-term follow-up in children

Xuhong Xue, MD, PhD; Kai Li, MD; Sheng Zhao, MD

Hypothesis

Morphological changes of adjacent vertebra after hemivertebrectomy is beneficial for scoliosis correction in pediatric congenital hemivertebra

Design

A retrospective study

Introduction

This study aimed to investigate morphological changes of adjacent vertebra and long-term efficacy of posterior hemivertebrectomy with unilateral short-segment fusion in pediatric congenital hemivertebra.

Methods

The patients with hemivertebra were included in a single spine center from Jan 2000 to Jan 2018, which were treated with posterior hemivertebrectomy with unilateral short segment fusion. The Cobb angle of main curve, TK, and SVA before surgery; immediately, 6 months, and 5 years after surgery were compared. The correction rates of the immediate postoperative and final follow-up were compared. The convex and concave heights of proximal vertebral bodies (PVB) and distal vertebral bodies (DVB) were compared before and 5 years after surgery.

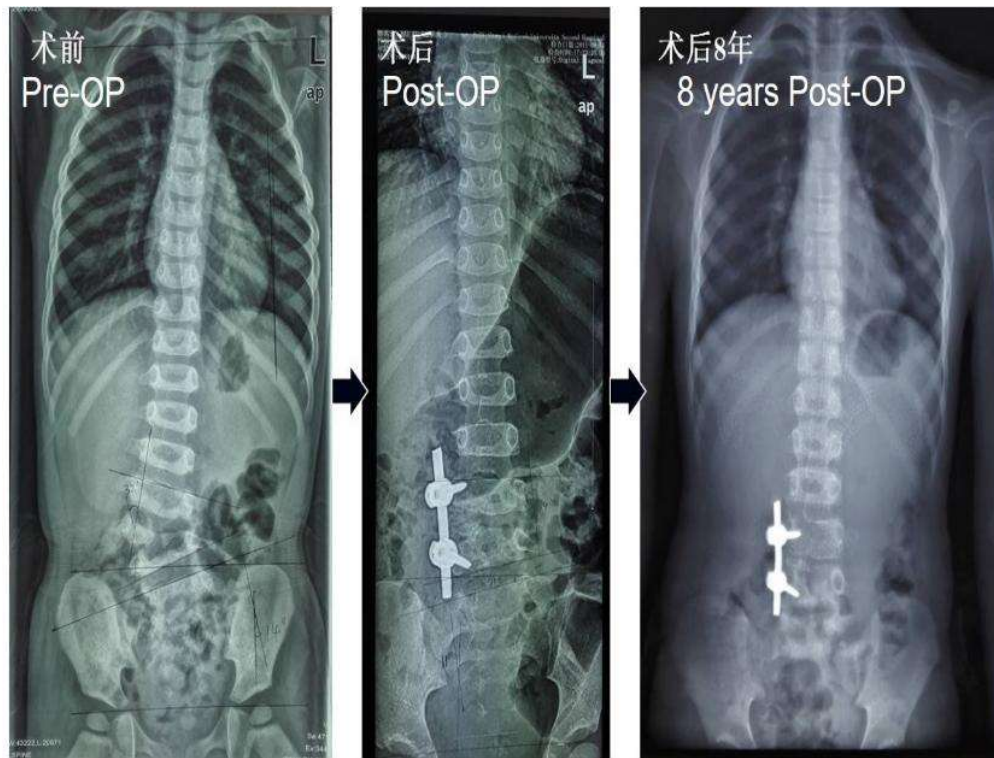
Results

In total, 26 patients were included undergoing posterior hemivertebrectomy, consisted of 12 males and 14 females, average aged 2-10 (5.4 ± 2.9) years. All patients were followed up for 60-82 (68.8 ± 8.1) months. The operation time ranged from 84 min to 174 (120.0 ± 24.0) min. The bleeding loss was 75-130 (100.0 ± 16.1) ml. The correction rate was $66.3\% \pm 18.4\%$. The preoperative, immediate postoperative and 5-year postoperative Cobb angles of main curve were $36.3^\circ \pm 11.4^\circ$, $12.3^\circ \pm 7.4^\circ$ and $12.6^\circ \pm 7.4^\circ$, respectively. The differences were statistically significant ($P < 0.05$). The convex height, concave height of the PVB and DVB showed an increasing trend from 1 year to 5 years after surgery compared with the preoperative. The differences were statistically significant ($P < 0.001$). The total growth rates of the PVB and DVB in concave side at 5 years after surgery were $106.4\% \pm 89.3\%$ and $96.9\% \pm 74.1\%$, respectively; the total growth rates of convex side were $91.0\% \pm 93.5\%$ and $96.2\% \pm 101.3\%$, respectively; the BLPD total growth rates were $37.0\% \pm 47.7\%$ and $40.4\% \pm 70.3\%$, respectively.

Conclusion

The posterior hemivertebra resection with unilateral short segment fusion for the treatment of congenital hemivertebra in pediatric patients can achieve satisfactory results at long-term follow-up. The morphological changes of adjacent vertebra is interesting: from cuneiform or irregularly shaped into a square.

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



Demo case

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

154. Three Year Results of a Randomized Controlled Trial Comparing Two Novel Distraction-Based Devices for Neuromuscular Early Onset Scoliosis

Justin V. Lemans, MD, PhD; Casper S. Tabeling, MD; Hilde W. Stempels; Agnita Stadhouders, MD; Jeroen Renkens, MD; Lotfi Miladi, MD; Tom P. Schlosser, MD, PhD; René M. Castelein, MD, PhD; Moyo C. Kruijt, MD, PhD

Hypothesis

The One-Way Self-Expanding Rod (OWSER) and the Spring Distraction System (SDS) have similar outcomes at 3 year follow-up when treating Neuromuscular Early Onset Scoliosis (NM EOS) patients.

Design

Randomized controlled trial

Introduction

Current surgical management of NM EOS in skeletally immature patients often relies on serial distractions, imposing substantial burdens on patients and healthcare systems. To address this limitation, two novel growth-friendly implants that do not require in-hospital lengthenings were introduced: the One-Way Self-Expanding Rod (OWSER) and the Spring Distraction System (SDS) (Figure 1). This multicenter, RCT investigates and compares the efficacy and safety of these two "growth-friendly" systems.

Methods

Non-ambulatory, NM EOS patients indicated for surgical treatment were enrolled at three Dutch academic spine centers. Based on a power analysis to detect a 5° difference in loss of correction, 30 patients were randomized, blinded and treated with either the OWSER or SDS. Both groups were compared with respect to the radiographic and clinical outcomes at three years of follow-up, including curve correction, spinal growth, complications and UPRORs.

Results

Thirty patients (mean age 9.0 years; 20 boys) with a variety of NM disorders were included. One OWSER patient died after two years of follow-up. Two SDS patients died within the first postoperative year and were replaced. All deaths were caused due to underlying disease and unrelated to the treatment. Main coronal curve correction was -34° (-47%) in OWSER and -40° (-52%) in SDS and was maintained similarly. Pelvic obliquity improved after surgery (OWSER -60%; SDS -70%) and was maintained in both groups. T1-S1 growth during follow-up was physiological for both devices, but slightly higher for OWSER (+13%) as compared to SDS (+12%). The OWSER group had 6 implant-related complications and 6 UPRORs (0.14/patient/year). In the SDS group, there were 3 implant-related complications and 3 UPRORs (0.07/patient/year).

Conclusion

Both the OWSER and SDS achieved approximately 50% main curve correction which was maintained during three years of follow-up. Spinal growth was physiological, with greater T1-S1 growth for OWSER. Complication- and UPROR rate was favourable for both systems.

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

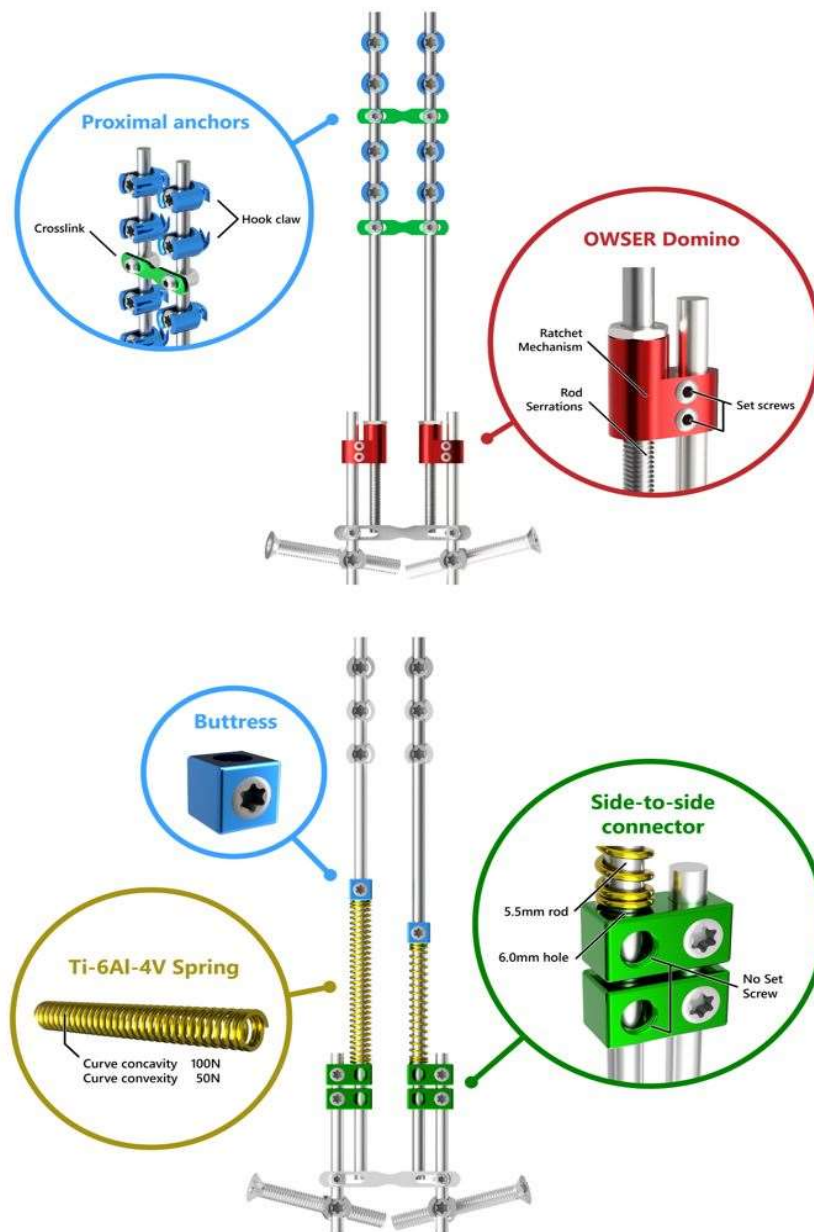


Figure 1: Schematic overview of the OWSER (top) and SDS (bottom) implant

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

155. Spinopelvic Alignment Parameters using the T4L1PA Hip Axis Predicts PJK and Reoperation in Scheuermann's Kyphosis Correction

Brandon A. Ramo, MD; Jesse P. Robinette, MD; Anna McClung-Booth, BSN; Matthew Siebert, MD;
Megan Johnson, MD

Hypothesis

Surgical intervention for Scheuermann's Kyphosis (SK) achieves radiographic correction but carries substantial complication risk, which can be minimized by achieving normal spinopelvic parameters

Design

Retrospective, single center cohort

Introduction

Scheuermann's kyphosis presents a unique surgical challenge in pediatric spinal deformity because restoration of normal sagittal parameters within the region of kyphosis alone or over-correction of kyphosis has been associated with risk of junctional failures. In adults, sagittal plane imbalance based on patient-specific T4L1PA hip axis predicts junctional/mechanical failures. We sought to apply these concepts to predict failure in pediatric patients with SK undergoing deformity correction.

Methods

Radiographic spinopelvic parameters (pelvic incidence, L1PA, T4PA, C2PA) were measured preoperatively, immediately postop and at final follow-up. Outcomes were PJK, defined as proximal junctional angle $>15^\circ$, DJK, and revision surgery for PJK or DJK. Spinopelvic parameters of T4-L1PA mismatch and L1PA mismatch from ideal state ($L1PA=0.5PI-19\pm2$) were correlated to outcomes using multivariable non-linear (cubic spine) logistical regression. Fisher's exact test was also used to compare between groups.

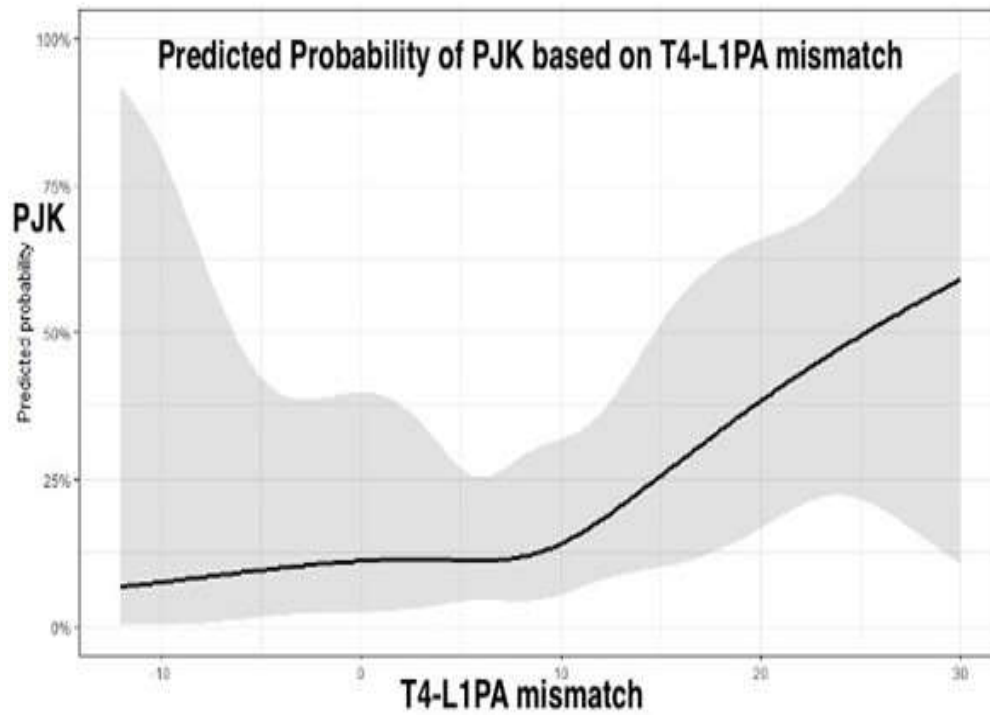
Results

77 SK patients (55M, 22F), mean 16.4 ± 2.1 years, mean kyphosis $87.3\pm9^\circ$, min 2y follow-up, underwent deformity correction. 18 patients (23%) experienced radiographic PJK (n=15) or DJK (n=3). All-cause reoperation was 7/77 (9.1%). 2 PJK and 2 DJK patients had reoperations for sagittal problems (5.2% of total cohort). Having PJK or DJK led to increased risk of reoperation vs. not: 4/18 (22.2%) vs 3/59 (5.1%), $p=0.048$. The 15 patients with PJK had similar L1PA postop but significantly different T4PA (5.35 vs. 0.06° , $p=0.023$) than those 62 without PJK, leading to higher rates of T4-L1PA mismatch. Logistic regression identified that T4-L1PA mismatch was the single significant predictor of PJK as an outcome (estimate = -2.449 Std Error 0.555 , $p<0.0001$).

Conclusion

Spinopelvic alignment parameters using the T4L1PA hip axis seem to predict poor outcomes related to PJK and mechanical failure in the Scheuermann's Kyphosis population. Pediatric deformity surgeons should consider spinopelvic alignment goals pre- and intraoperatively to avoid junctional problems and mechanical failure.

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



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

156. Aiming to Stop More Proximally When Determining Distal Fusion Level According to Stable Sagittal Vertebra in Scheuermann's Kyphosis. Comparison of Two X-ray Methods Lateral Traction Under General Anesthesia vs Standing Full-spine Lateral X-ray

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Hypothesis

Lateral Traction X-ray Under General Anesthesia (L-TrUGA) helps to stop proximally in selection of distal fusion level and save more distal mobile segments in Scheuermann's kyphosis

Design

Retrospective

Introduction

Over the past 15-20 years, selection of the distal fusion level in SK has been based on the stable sagittal vertebra (SSV) identified on standing lateral x-ray (S-LX) described by Lenke. The aim of study is to evaluate whether distal fusion level selection based on SSV on the lateral-TrUGA allows a more proximal stopping level with preservation of additional distal mobile segments and to assess the incidence of distal junctional kyphosis.

Methods

50 pts (34M,16F) underwent posterior spinal fusion for SK. Curves were classified as thoracic (T-SK; apex above T10) in 38 pts and thoracolumbar (TL-SK; apex at T10 or below) in 12 pts. Fusion was stopped at SSV identified on L-TrUGA in all pts. Sagittal parameters and DJK were evaluated on preop, postop and final f/up EOS lateral images. Clinical outcomes were assessed using SRS-22r.

Results

Mean age was 18 yrs (15–32), mean f/up was 8,65 yrs (2-18). In T-SK group, TK improved from 76.8° to 49.9°, LL improved from 67.2° to 47.7°, resulting in PI–LL mismatch of 8°. In TL- SK group, TK improved from 76.0° to 46.0°, LL from 63.0° to 32.0°, with a PI–LL mismatch of 11°. Corrections were maintained at final f/up in all pts. In 28 of 50 pts (56%), L-TrUGA identified more proximal SSV than S-LX, preserving one or more additional mobile segments. The greatest segment preservation was observed in T-SK, with 40% of pts gaining at least one level, followed by TL-SK in 33%. L-TrUGA saved 2 distal mobile segments in 8% of pts. None of pts developed DJK during f/up. Only 1 patient (2%) in T-SK group required revision for pseudarthrosis. SRS-22r scores improved significantly from 3.62 to 4.52.

Conclusion

In this 50 pts cohort, distal fusion level selection based on stable sagittal vertebra on lateral-TrUGA preserved one or more additional distal mobile segments in 56% of pts when compared with standing full-spine x-rays. The absence of distal junctional kyphosis indicates that distal fusion can be safely stopped more proximally when lateral-TrUGA is used for decision making compared with standing x-ray in Scheuermann's Kyphosis

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

157. Operative Treatment for Scheuermann Kyphosis: A Comparison of Outcomes Between Adult and Adolescent Patients

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Hypothesis

Adults with Scheuermann kyphosis present with more severe baseline deformity, achieve lower rates of thoracic kyphosis normalization, and experience higher pathologic junctional failure than adolescents despite similar fusion lengths.

Design

Multicenter, Multi-study group retrospective comparative cohort study

Introduction

No large-scale studies have directly compared Scheuermann kyphosis (SK) pathology and surgical outcomes by age. Age-dependent differences may guide optimal treatment.

Methods

Adolescent and adult SK patients undergoing posterior spinal fusion were identified from two prospective multicenter spinal-deformity registries. Demographics, perioperative outcomes, complications, radiographic alignment, reciprocal sagittal changes, occurrence of proximal junctional kyphosis and failure (PJK, PJF), and Scoliosis Research Society-22 (SRS-22) scores were compared. Continuous variables were compared with t-tests and Hedges' g; categorical variables with Fisher's exact tests.

Results

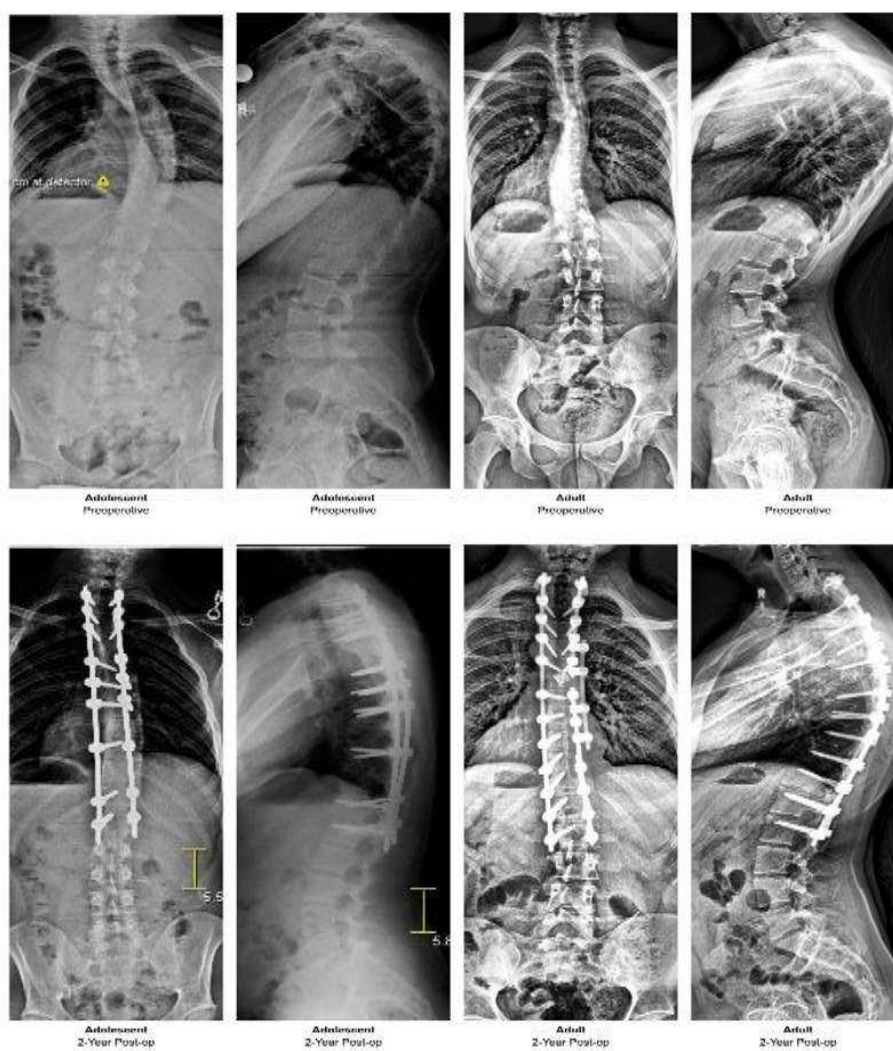
A total of 158 patients were included (97 adolescents, 61 adults). Adolescent patients had less severe preoperative thoracic kyphosis (TK; 74.7° vs 87.4°, $p<0.001$) and higher baseline SRS-22 total scores (3.60 vs 2.90, $p<0.001$). Levels fused were similar (12.8 vs 13.3, $p=0.187$), with less pelvic fixation (0% vs 8.2%, $p=0.008$), shorter operative time (337 vs 402 min, $p=0.005$), and lower ICU admission (36.9% vs 59.3%, $p=0.011$) in adolescent patients. Adolescent patients achieved greater TK correction (28.6° vs 18.4°; Hedges' $g=0.71$; $p<0.001$), more frequent TK normalization (20-50°) (64.9% vs 7.8%, $p<0.001$), and lower residual TK >70° (1.0% vs 45.1%, $p<0.001$); with less change in PI-LL (+8.9° vs +15.1°, $p=0.001$). Normative PJK (3.1% vs 17.5%, $p=0.005$) and PJF (2.1% vs 21.1%, $p<0.001$) were markedly lower in adolescent patients. Both groups improved on SRS-22; adolescents had higher follow-up total (4.29 vs 3.92, $p=0.005$) and pain (4.21 vs 3.70, $p=0.003$) scores.

Conclusion

Adolescent and adult SK represent distinct surgical phenotypes. Adolescent patients achieve greater correction and substantially lower pathologic junctional failure than adults despite similar fusion lengths, supporting age-specific surgical planning, junctional protection in adults, and consideration of earlier intervention when clinically indicated.

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Figure 1. Representative adolescent and adult Scheuermann kyphosis cases



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158. Surgical Treatment of Post-tuberculosis Kyphosis with Ossification of Ligamentum Flavum: Identification of the Primary Causes of Neurological Deficits.

Jiahao Zhang, MD; Jiale Zhu, MS; Yan Zeng, MD

Hypothesis

In patients with post-tuberculosis kyphosis (PTK), ossification of the ligamentum flavum (OLF) at adjacent segments is not an incidental finding. Its occurrence is likely associated with biomechanical alterations in the ligament induced by the local kyphotic deformity. Accurate preoperative identification of the neural compression is essential for PTK patients complicated with OLF.

Design

A retrospective comparative study.

Introduction

PTK is a severe sequela of spinal tuberculosis, often leads to progressive angular deformity and neurological deficits, primarily attributed to direct spinal cord compression at the kyphotic apex. However, emerging evidence indicates that in some patients, neurological impairment is mainly caused by secondary OLF and spinal stenosis at segments adjacent to the primary deformity. The presence of OLF complicates surgical planning, as the primary cause of neural compression must be accurately identified to choose between extensive corrective osteotomy or more localized decompression.

Methods

We retrospectively collected 100 PTK patients underwent surgeries from two centers between 2015 and 2025, including 17 PTK patients complicated by OLF. The 17 Patients were divided into three groups based on preoperative imaging: Group A1 (n=8) underwent posterior vertebral column resection (PVCR) with simultaneous OLF resection; Group A2 (n=6) underwent PVCR alone; Group B (n=3) underwent simple posterior decompression and OLF resection. Neurological function was assessed using ASIA impairment scale and modified JOA scores.

Results

All groups showed neurological improvement at the final follow-up. Group B showed a distinct advantage in reduced surgical trauma, with significantly shorter operative time (138.0 ± 35.6 min) and less estimated blood loss (286.7 ± 201.33 ml) compared to Groups A1 and A2 ($p < 0.05$).

Conclusion

The incidence of OLF in PTK patients is 17%, and OLF is a significant independent cause of neurological deficits in PTK patients. Precise preoperative identification of the primary compressive causes is essential for surgical planning. For patients with OLF as the dominant cause of compression, simple posterior decompression and OLF resection is a safe and effective, less invasive alternative to complex PVCR, resulting in excellent neurological recovery with significantly reduced surgical trauma.