

86. Preclinical Targeting of the Osteopontin– $\alpha 5\beta 1$ Integrin Axis Reveals a Disease-Modifying Mechanism in Adolescent Idiopathic Scoliosis †

Alain Moreau, PhD; Mohamed Elbakry, PhD; Anita Franco, MS

Hypothesis

Aberrant activation of the osteopontin (OPN)– $\alpha 5\beta 1$ integrin signaling axis is a causal driver of spinal deformity progression in adolescent idiopathic scoliosis (AIS), and early inhibition of this pathway can modify disease development.

Design

Translational mechanistic study integrating human cellular systems, biological stratification, and interventional scoliosis mouse models.

Introduction

AIS progression varies widely among patients with similar curve magnitudes, indicating that biological mechanisms precede structural failure. Current treatments are mechanical and reactive, targeting deformity rather than its molecular drivers. We investigated whether the OPN– $\alpha 5\beta 1$ integrin signaling axis represents a rate-limiting, druggable mechanism governing scoliosis progression.

Methods

OPN– $\alpha 5\beta 1$ signaling was examined in primary human cells stratified by biological endophenotypes associated with AIS progression. Pathway modulation was tested using pharmacological inhibition of $\alpha 5\beta 1$ integrin engagement or upstream reduction of $\alpha 5$ integrin availability. In vivo efficacy was evaluated in validated scoliosis mouse models with longitudinal radiographic assessment of curve onset and progression.

Results

AIS segregated into reproducible biological states defined by differential sensitivity to OPN, driven by regulation of $\alpha 5\beta 1$ integrin availability rather than ligand abundance alone. Pharmacological modulation of this axis normalized downstream signaling in human osteoblasts derived from AIS patients (surgical cases). Moreover, in scoliosis mouse models, early pathway inhibition prevented completely scoliosis development compared with controls, demonstrating preclinical disease modification.

Conclusion

Our data identify the OPN– $\alpha 5\beta 1$ integrin axis as a causal, disease-modifying mechanism in AIS. Preclinical inhibition of this pathway alters scoliosis development in vivo, supporting a shift toward early, biology-based intervention strategies.

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

87. A single DNA-based polygenic risk score for adolescent idiopathic scoliosis improved by patient-derived paravertebral muscle gene-activity data. †

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Hypothesis

A single DNA-based polygenic risk score (PRS) can identify children at high risk for future adolescent idiopathic scoliosis (AIS), supporting targeted screening and follow-up.

Design

Predictive modeling study.

Introduction

AIS may progress before detection and severe curves may require spinal fusion, yet intensive surveillance for every child is impractical. We developed a genetics-only PRS, and then tested whether patient-derived paravertebral muscle single-nucleus RNA sequencing (snRNA-seq) gene-activity data prioritize biologically relevant GWAS regions and improve the model.

Methods

We meta-analyzed AIS GWAS (total $n > 440,000$; AIS cases $> 8,000$) and built genome-wide and snRNA-seq-informed region-prioritized PRS models. Performance was evaluated in an independent Japanese cohort. Risk stratification was also estimated in a simulated first-degree family-history population.

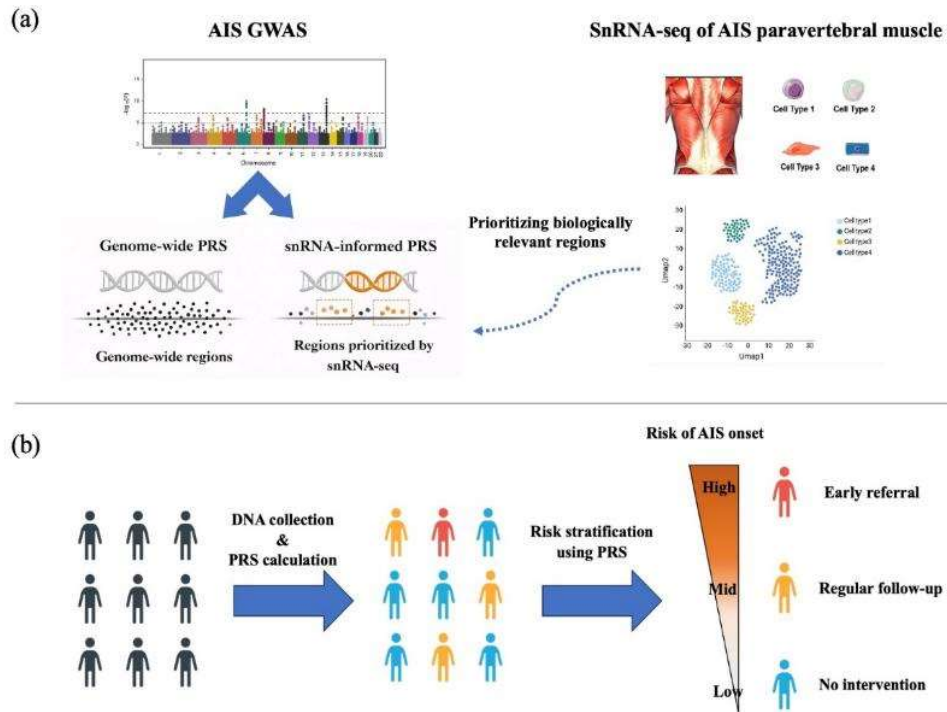
Results

The genome-wide PRS achieved an AUC of 0.723. The snRNA-seq-informed region-prioritized PRS improved the AUC to 0.761. In the Japanese cohort, individuals in the top 10% of the region-prioritized PRS had higher odds of AIS (OR 7.17; 95% CI, 6.53-7.82) compared with the population average, significantly outperforming a previously reported conventional PRS model (OR 3.36; 95% CI, 2.33-4.88; $p = 4.8 \times 10^{-5}$). In a simulated population with a family history of AIS, the predicted AIS prevalence was 53.9% in the top 10% and 67% in the top 1% PRS strata.

Conclusion

A genetics-only PRS can meaningfully stratify future AIS onset risk, and prioritizing loci using patient-derived paravertebral muscle gene-activity data (snRNA-seq) improves predictive performance. Clinical take-home: A single genetic test may help identify patients who warrants earlier referral and closer, risk-tailored surveillance, especially in families with AIS.

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(a): Construction of genome-wide and single-nucleus RNA-seq (snRNA-seq) informed polygenic risk scores (PRSs) for adolescent idiopathic scoliosis (AIS). (b): Schematic illustration of PRS-based risk stratification for AIS onset and clinical decision-making.

88. Gut Microbiome–Derived TMAO Pathway as a Central Metabolic Driver of Biological Aging in Adult Spinal Deformity † ‡

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Hypothesis

We hypothesized that accelerated biological aging in adult spinal deformity (ASD) is driven by specific metabolic alterations and these metabolites independently contribute to biological aging beyond chronological age.

Design

Prospective multiomics study of consecutive ASD patients.

Introduction

Biological aging has emerged as a determinant of vulnerability in ASD than chronological age, yet its metabolic drivers remain unclear. This study aimed to identify metabolomic and proteomic signatures associated with biological aging.

Methods

Fasting plasma samples from 120 ASDs (age ≥ 40 years) underwent quantitative CE–MS–based metabolomic profiling (1,100 metabolites) and targeted proteomic analysis of inflammatory cytokines and adipokines. Biological age was estimated using PhenoAge. Correlation analyses, ranked metabolite profiling, and pathway enrichment were performed to identify metabolic determinants of biological aging. A composite TMAO Pathway Index was constructed using z-standardized trimethylamine N-oxide (TMAO), trimethyllysine, choline, and dimethylglycine to quantify microbiome-derived metabolic activity.

Results

Among the top metabolites associated with PhenoAge, microbiome-derived metabolites accounted for 28%, including choline ($p = 0.50$), dimethylglycine ($p = 0.50$), phenylacetylglutamine ($p = 0.49$), p-cresol sulfate ($p = 0.45$), 3-indoxylsulfuric acid ($p = 0.44$), trimethyllysine ($p = 0.43$), and TMAO ($p = 0.35$). The TMAO Pathway Index demonstrated a strong association with biological aging ($p = 0.59$, $p = 6.5 \times 10^{-7}$) and remained an independent predictor after adjustment for chrono age ($\beta = 4.6$ years per SD; 95% CI, 0.9–8.3; $p = 0.02$). IDO activity showed a moderate association with PhenoAge ($p = 0.25$) and correlated with the TMAO Pathway Index ($p = 0.34$, $p = 6.5 \times 10^{-4}$), whereas conventional systemic inflammatory indices demonstrated minimal associations. Proteomic analyses further revealed selective upregulation of pro-inflammatory cytokines and suppression of adiponectin in association with TMAO Pathway Index.

Conclusion

ASDs demonstrate a distinct metabolic aging phenotype dominated by microbiome-derived metabolites and glycation stress. The TMAO pathway emerged as the strongest metabolic driver of biological aging. These findings identify the microbiome–metabolite axis as a promising biological target to mitigate accelerated aging in ASD.

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Metabolite	rho	p value	Pathway
Gluconic acid	0.61	2.73E-07	Glucose oxidation
N-(1-Deoxy-1-fructosyl)leucine	0.57	2.09E-05	Glucose / Glycation
N-Acetylgalactosamine	0.58	3.33E-05	Glucose / Glycation
N-Acetylglucosamine			
N-Acetylmannosamine			
N,N-Dimethylglycine	0.50	5.09E-05	Microbiome / TMAO axis
Choline	0.50	5.61E-05	Microbiome / TMAO axis
Phe	0.47	1.43E-04	Amino acids (aromatic)
N2-Phenylacetylglutamine	0.49	1.93E-04	Microbiome / TMAO axis
Isocitric acid	0.46	1.93E-04	TCA cycle
N-(1-Deoxy-1-fructosyl)valine	0.50	3.67E-04	Glucose / Glycation
p-Cresol sulfate	0.45	3.78E-04	Microbiome / TMAO axis
Ile	0.44	4.15E-04	Amino acids (BCAA)
Cystine	0.44	4.57E-04	Redox / antioxidant
3-Indoxylsulfuric acid	0.44	5.12E-04	Microbiome / TMAO axis
Val	0.43	6.18E-04	Amino acids (BCAA)
Ornithine	0.40	1.41E-03	Urea cycle
2-Deoxyribonic acid-1	0.50	1.68E-03	Nucleotide / DNA turnover
Alloisoleucine	0.40	1.75E-03	Amino acids (BCAA)
N-Acetylgalactosamine 4-sulfate	0.61	1.84E-03	Glucose / Glycation
N6,N6,N6-Trimethyllysine	0.43	2.90E-03	Microbiome / TMAO axis
Gluconolactone	0.41	3.15E-03	Glucose oxidation
SDMA	0.37	3.43E-03	Arginine / NO pathway
Malic acid	0.37	3.63E-03	TCA cycle
Taurine	-0.37	3.71E-03	Redox / antioxidant
Fructosyllysine	0.61	4.50E-03	Glucose / Glycation
Trimethylamine N-oxide	0.35	5.90E-03	Microbiome / TMAO axis

Top 25 Metabolites Associated with PhenoAge

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89. Genetic Study of 100 Idiopathic Early-Onset Scoliosis Families Provides New Hypotheses to Explain its Pathogenesis †

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Hypothesis

We hypothesized that idiopathic early-onset scoliosis (iEOS) has an underlying genetic basis and that systematic genetic analysis can identify candidate genes and pathways contributing to disease risk.

Design

Multi-center cohort study

Introduction

Combining exome sequencing (ES) and inheritance mapping has been effective for discovering the genetic mutations that cause certain forms of early-onset scoliosis. However, the “idiopathic” group has remained enigmatic. The purpose of this study was to define the biologic causes of iEOS by genetic studies in a cohort of 100 well-characterized iEOS patients and their parents.

Methods

Children >3 years, their parents, and other affected relatives were recruited from nine U.S. pediatric orthopaedic centers. Informed consent, blood/saliva, and clinical information documenting their diagnoses was obtained. ES and microarray genotyping were performed, and standard quality controls applied. Single nucleotide variants (SNVs) were identified from the data, annotated by frequency in the general population, and by predicted functional impact. Only variants with frequencies < 0.1% in the population and that fit with the presumed inheritance pattern (autosomal dominant, autosomal recessive, or de-novo) in the family were considered for further analyses.

Results

Of the 100 iEOS families, 90 were ultimately evaluated. A total of 350 genes were identified as candidates by SNV analysis, 14 of which were detected in more than one family. Notably, two of the 14 genes, DNAH6 and DNAH10, encode dynein heavy chains, components of primary cilia that enable cells to sense their environment. Of the remaining 12 genes, 4 (HSPG2, OBSCN, TTN, SYNE1) are muscle related genes. Pathway analysis of the 350 candidate genes showed significant strong association with a muscle structure and motor function-related pathway ($p=6.5 \times 10^{-10}$).

Conclusion

Initial evaluation of our iEOS cohort suggests that it is genetically heterogeneous. Recurrent variants in DNAH6 and DNAH10 implicate cilia dysfunction in some cases of iEOS, a mechanism we are currently testing in patient cells. Pathway analyses suggest that genetic changes affecting muscle function may contribute to disease susceptibility in many cases of iEOS. Further studies are warranted to understand how disturbances in cilia and muscle function specifically affect the growth and coordinated functioning of the spine in young patients.

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

90. Surgical vs Nonsurgical Treatment in Patients Living with Adolescent Idiopathic Scoliosis (AIS): A Target Trial Emulation with 30 Years of Follow-up § ‡

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Hypothesis

At the 30-year follow-up (30yFU), adolescents with moderate (40-60°) curves who underwent surgery will have a better quality of life (HRQoL) than those treated nonsurgically

Design

Target Trial Emulation (TTE) (Hernán&Robins, Am J Epidemiol 2016) reproduces the elements of an ideal hypothetical clinical trial protocol using observational real-world data

Introduction

Surgery for AIS improves HRQoL at the 2 and 5-year follow-ups. However, some patients with moderate curves may choose nonsurgical treatment

Methods

Multicenter observational study (13 centers, 9 countries, 3 continents) of AIS patients with baseline Cobb $\geq 40^\circ$, treated during adolescence (ages 10-18), ≥ 20 years of follow-up, who accepted the invitation to participate. The primary outcome was EQ-5D-5L at the 30yFU. Secondary outcomes included SRS-22, SF-36, ODI, NRS, and Cobb angle. We created comparable surgical (S) vs nonsurgical (NS) groups from the 563 eligible patients by adjusting for baseline confounding factors using inverse probability weighting (IPW). The TTE controlled for confounding and censoring due to loss to follow-up, having a well-defined time zero for eligibility (t_0), a 1-year grace period for compliance with treatment assignment, and a follow-up of 30 $\pm$ 5 years. Standardized mean difference (SMD) effectiveness estimates were obtained using weighted ordinary least squares regression models

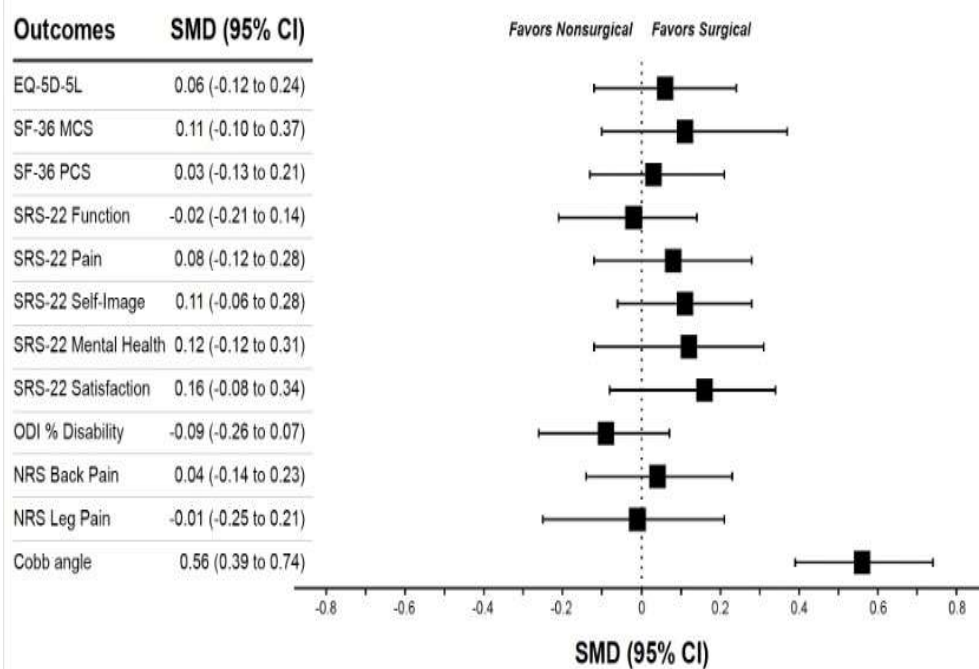
Results

483 patients (S=328, NS=155). After cloning and IPW adjustment, baseline characteristics were: age 14.3 $\pm$ 1.9 years; 90% female; Cobb 52.6 $\pm$ 11°. At the 30yFU, the SMD for the EQ-5D-5L was small [0.06 (95%CI:-0.12 to 0.24)] in favor of surgery, ruling out minimal clinically important effects (<MCID). SMDs for secondary outcome measures also tended to favor surgery but did not reach clinically important effects. SMDs were greater in mental health dimensions [SRS-22-Satisfaction (0.16); SRS-22-Mental Health (0.12); SRS-22-Self-Image (0.11), and SF-36MCS (0.11)] than in physical dimensions (function, disability, pain). Only the Cobb angle showed a moderate SMD (0.56; 95%CI: 0.39 to 0.74), reaching clinical importance

Conclusion

At the 30yFU, patients with moderate AIS fused during adolescence showed improved Cobb angle compared to those treated conservatively. While fusion does not significantly impair pain and function at this timepoint, estimates for HRQoL rule out clinically meaningful effects

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

91. Does Early Administration of Disease Modifying Therapy (DMT) Prevent Early Onset Scoliosis (EOS) in Spinal Muscular Atrophy (SMA) §

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Hypothesis

Early DMT initiation reduces the risk of developing EOS compared with late initiation, and the reduction magnitude varies by SMN2 copy number and symptom status at birth.

Design

Multicenter retrospective cohort study of consecutive SMA patients (≤ 1 y/o).

Introduction

Early DMT improves survival and motor function but the impact on mitigating EOS remains unclear. The study aimed to examine the effect of age at DMT initiation on developing EOS and investigate roles of SMN2 gene number and symptom status at birth.

Methods

Patients were categorized into early-DMT (≤ 6 wk) vs late-DMT (> 6 wk). EOS ($\geq 10^\circ$) was diagnosed on surveillance spine X-ray. Cox regressions evaluated associations between age of DMT initiation and EOS diagnosis, stratified by SMN2 number (< 3 vs. ≥ 3), and $\pm$ symptoms at birth.

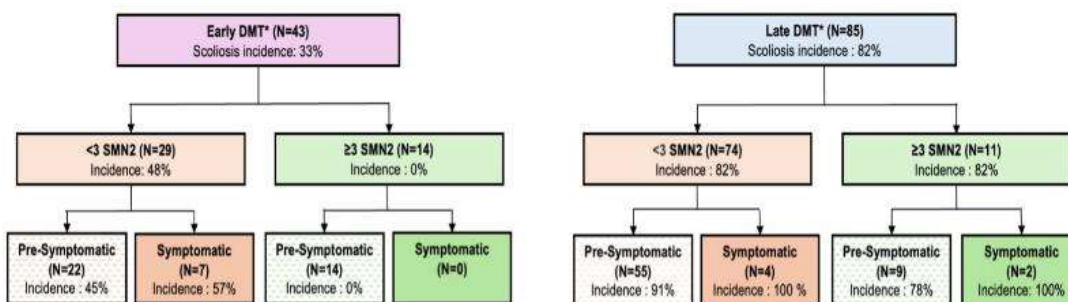
Results

Of 128 infants (34% early-DMT; 66% late-DMT), 84 (66%) developed EOS @ 2.2 ± 1.5 yrs. 72% of infants with < 3 SMN2 developed EOS vs 36% with ≥ 3 SMN2 ($p < 0.001$). EOS was observed in 77% of symptomatic and 67% of pre-symptomatic infants ($p = 0.546$). The type of DMT administered appeared to affect EOS ($p = 0.010$), but when adjusted for age of DMT initiation, DMT type was not associated with EOS risk (hazard ratio (HR)=1.15, $p = 0.500$). Age at DMT initiation significantly influenced risk ($p < 0.001$): EOS occurred in 33% of infants treated early vs. 82% treated late (Fig. 1a). DMT initiation > 6 wk did not lessen EOS risk regardless of subsequent timing. Stratified analyses demonstrated that the effect of DMT timing on EOS varied by SMN2 number and symptom status: • < 3 SMN2 infants with early-DMT = 48% EOS; with late-DMT = 82% EOS ($p < 0.001$); • ≥ 3 SMN2 infants with early-DMT = 0% EOS; with late-DMT = 82% EOS ($p < 0.001$); •pre-symptomatic infants with < 3 SMN2 + early-DMT reduced EOS risk by 54% (HR=0.46, $p = 0.033$, Fig. 1b); •pre-symptomatic infants with ≥ 3 SMN2 + early-DMT eliminated risk (HR=0, Fig 1c); •No significant associations were observed among symptomatic infants, regardless of SMN2 number (Fig 1d&e).

Conclusion

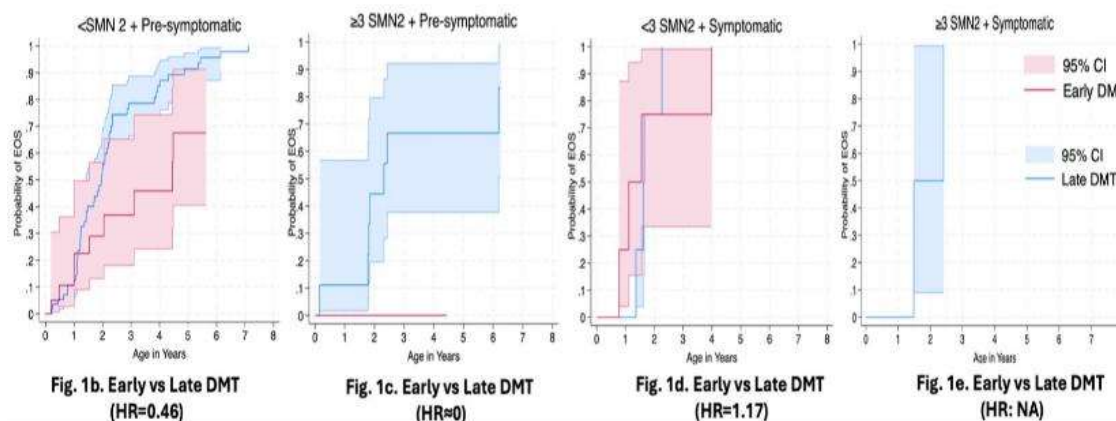
The effect of DMT to mitigate EOS is influenced by the age of administration, SMN2 number, and symptom status at birth. Among infants with < 3 SMN2, most developed EOS by age 4, but risk was partially (~30%) moderated if DMT was initiated before age 6 wk. This study indicates that early, routine spine surveillance should be performed on high-risk children with < 3 SMN2 who were treated > 6 wk.

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



* DMT Type: nusinersen, onasemnogene abeparvovec, risdiplam

Fig. 1a. Incidence of EOS diagnosis in patients who administered DMT within the first year of their lives



92. Tranexamic Acid Dosing in Deformity Spine Surgery: A 3-Year Prospective Randomized Comparison of Low-Dose versus High-Dose Regimens §

Sharif A. Jonayed, MBBS, MS

Hypothesis

A high-dose tranexamic acid (TXA) regimen provides superior reduction in perioperative blood loss and transfusion requirements compared to a low-dose regimen in adult spinal deformity surgery, without increasing the incidence of thromboembolic or neurological complications .

Design

Single-center, prospective, double-blind randomized controlled trial conducted from January 2019 to December 2023, with a minimum follow-up of 2 years (mean 36 months).

Introduction

While tranexamic acid is a standard antifibrinolytic agent in spinal deformity surgery, the optimal dosing strategy remains undefined. This study compares the safety and efficacy of two distinct TXA dosing protocols—low-dose versus high-dose—in reducing blood loss and improving perioperative outcomes, with longitudinal assessment of complications and functional recovery .

Methods

Ninety-six patients undergoing posterior spinal fusion for adult spinal deformity were randomized into two groups. The low-dose group received a loading dose of 10 mg/kg followed by a maintenance infusion of 1 mg/kg/hr. The high-dose group received a loading dose of 50 mg/kg followed by a maintenance infusion of 5 mg/kg/hr. Primary outcomes were intraoperative and total perioperative blood loss, transfusion volume, and transfusion rate. Secondary outcomes included operative time, postoperative hemoglobin, thromboembolic events, neurological status, and SRS-22r scores. Follow-up was conducted at 6, 12, 24, and 36 months.

Results

The high-dose group had significantly lower intraoperative blood loss (795 ± 138 mL vs. 1185 ± 194 mL; $p < 0.001$) and total blood loss (1195 ± 215 mL vs. 1720 ± 290 mL; $p < 0.001$). Transfusion rates were 22% in the high-dose group versus 48% in the low-dose group ($p = 0.008$). Thromboembolic complications were rare and comparable between groups (1 vs. 2 events; $p = 0.56$). No differences were observed in neurological outcomes or surgical site infection. At final follow-up (minimum 2 years), SRS-22r scores improved equally in both groups, with no late complications attributable to TXA dosing.

Conclusion

In spinal deformity surgery, a high-dose TXA regimen is significantly more effective than a low-dose regimen in reducing blood loss and transfusion needs, without increasing thromboembolic risk . This regimen offers a safe and efficacious strategy for enhancing perioperative management in complex spinal reconstructions.

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

93. Casting and Bracing as a Bridging Strategy to Delay Surgery in Young Children with Thoracolumbar and Lumbar Formation-Failure Congenital Scoliosis

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Hypothesis

In children with thoracolumbar or lumbar formation-failure congenital scoliosis, conservative management with bracing and/or serial casting reduces yearly curve progression compared with observation alone.

Design

Multi-center retrospective cohort study

Introduction

In congenital scoliosis, surgical timing is influenced by vertebral anomaly morphology or level, yet early surgery carries higher complication and reoperation risk. This study aimed to evaluate whether conservative therapy improves curve control in thoracolumbar or lumbar formation-failure congenital scoliosis.

Methods

Patients (≤ 6 yrs old) with congenital scoliosis, major coronal curve of $\geq 25^\circ$, and ≥ 1 formation-failure anomalies in the thoracolumbar or lumbar region were included. Conservative treatment consisted of serial casting followed by bracing or bracing alone (Fig. 1a–e). Treatment choice was determined by a combination of patient age, curve magnitude and family preference. Successful curve control was defined as a yearly curve progression of $\leq 0^\circ$. All patients were followed until definitive surgical treatment.

Results

65 consecutive patients (29 males, 36 females) with a mean baseline major coronal curve of 38° and a mean follow-up of 3.6 yrs were included. Patients were categorized into a treatment group (52%) and an observation group (48%). Compared to observation, the treatment cohort was older at baseline (3.3 vs 2.1 y/o, $p=0.001$), had a larger baseline curve (42° vs 33° , $p<0.0001$), and had a longer duration of follow-up (4.3 vs 2.9 yrs, $p=0.015$). The treatment cohort had significantly higher success (82% vs 13%, $p<0.0001$) and better curve control ($-1.2^\circ/\text{yr}$ vs $3.5^\circ/\text{yr}$ progression, $p<0.0001$) than the observation. These associations did not vary by baseline age or major coronal curve magnitude, indicating no effect modification by these factors. After adjustment for baseline age and major coronal curve, treated patients were 6 times more likely to achieve successful curve control than those under observation (risk ratio = 6.04; $p<0.0001$). Curve-type was not associated with treatment allocation or outcome.

Conclusion

Bracing and/or serial casting effectively controlled curve progression for a mean duration of 4.3 yrs, supporting its role as a bridging strategy to delay surgery and potentially reduce the risk of complications and reoperation in very young children with congenital scoliosis.

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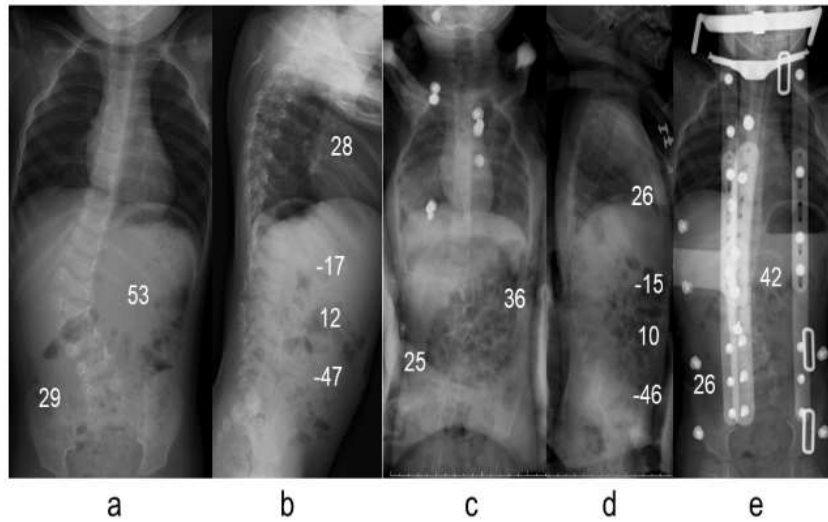


Figure 1. Female (1 year 9 months) with congenital scoliosis due to vertebral formation failure. (a,b) Baseline radiographs. (c,d) Radiographs at initial cast application. (e) Radiograph during Milwaukee brace wear.

94. Non-Operative Treatment for Adult Spinal Deformity: Long Term Results of a Biopsychosocial Intervention – a Prospective Cohort Study With a Mean Follow-Up of 8 Years §

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Marinus de Kleuver, MD, PhD; Miranda L. Van Hooff, PhD

Hypothesis

Symptomatic Adult Spinal Deformity (ASD) patients improve after a two week biopsychosocial intervention and these beneficial results are maintained at a minimum of 5-year follow-up.

Design

Prospective cohort study

Introduction

The prevalence and societal burden of disease of adult spinal deformity (ASD) is increasing. Currently, no evidence based non-operative treatment exists for ASD patients with chronic low back pain (CLBP) and reduced quality of life (QoL).

Methods

A prospective cohort study of a biopsychosocial intervention cohort (n=69) with a minimum of 5-year follow-up. Inclusion criteria: age ≥ 18 , no surgical indication, coronal Cobb angle $>10^\circ$, idiopathic (AdIS) or degenerative (de novo) scoliosis (DN), one-year follow-up data. Primary outcome: functional status (ODIv2.1a). Secondary outcomes: pain intensity (NPRS) and QoL (SF36-PCS, SF36-MCS). Clinical relevance: minimal important clinical change (MCIC; improvement in ODI ≥ 10 points), patient acceptable symptom state (PASS; ODI ≤ 22).

Results

Demographics: median age 55 (IQR 15) years, 77% female, median Cobb angle 20° (IQR 13), 29% AdIS – 71% DN, mean follow-up time 8.3 years (100 [SD 22] months). Lost to follow-up 31 patients. There was a significant time effect on functional status ($F(4,272)=13.40$, $p<.001$, $\eta^2=.17$). Mean baseline ODI improved significantly from 37.4 (SD 11.0) to 30.3 (SD 13.5) post-treatment and this effect was maintained at 8.3-years follow-up with a mean ODI of 28.8 (SD 15.2). Clinical relevance in terms of functional status: 48% of the patients reached an MCIC and 41% reached a PASS (ODI ≤ 22) at 8.3-years follow-up. All secondary outcomes, except SF36-MCS, followed a similar pattern of maintained improvement at 8.3-years follow-up. The proportion of patients using opioids decreased significantly from baseline (32%) to 8.3-years follow-up (16%) (McNemar's exact test, $p=.013$).

Conclusion

This is the first study to show significant and clinically relevant improvement in symptomatic ASD patients in terms of functional status, pain and quality of life after a biopsychosocial intervention and this improvement is maintained at a minimum of 5-year follow-up. Results on healthcare consumption and work status will be available at the time of the Meeting.

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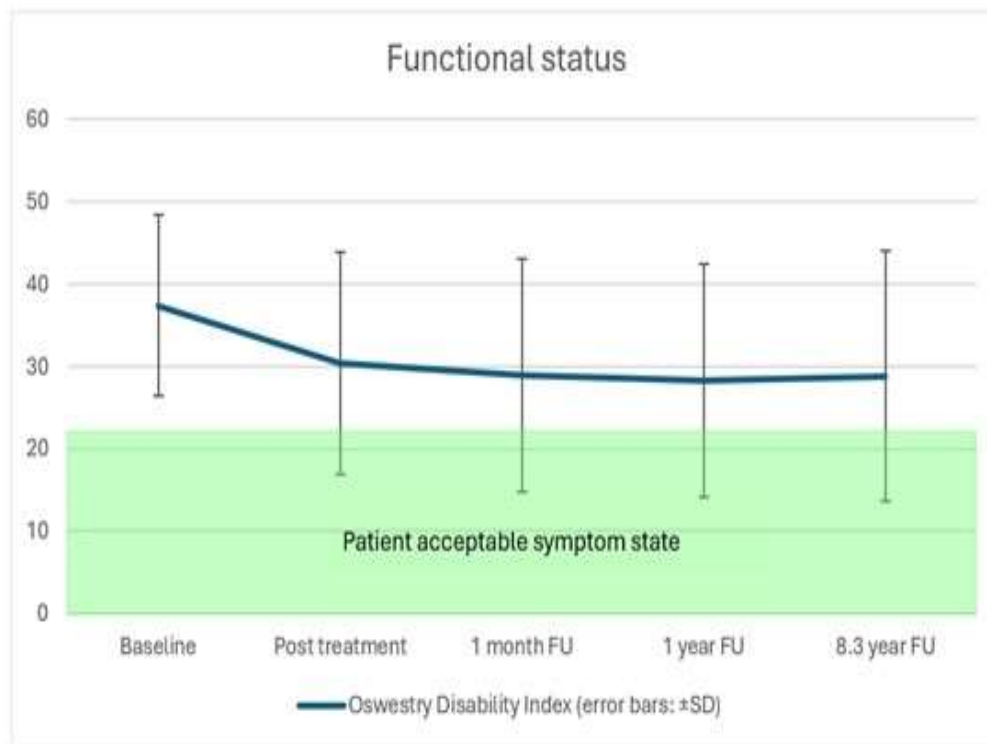


Figure 1. Mean (SD) functional status of 69 ASD patients in a biopsychosocial intervention cohort over time

95. Ten-Year Natural History and Clinical Impact of Distal Adding-on After Posterior Spinal Fusion for Lenke 1A/2A Adolescent Idiopathic Scoliosis §

Masayuki Ohashi, MD, PhD; Kei Watanabe, MD, PhD; Toru Hirano, MD, PhD; Kazuhiro Hasegawa, MD, PhD; Hideki Tashi, MD; Keitaro Minato, MD, PhD; Yohei Shibuya, MD; Masayuki Sato, MD; Mio Kubota, MD, PhD; Hiroyuki Kawashima, MD, PhD

Hypothesis

Distal adding-on (DA) after posterior spinal fusion (PSF) for Lenke 1A/2A curves progresses over time and negatively impacts clinical outcomes at 10-year follow-up.

Design

A retrospective cohort study

Introduction

Distal adding-on (DA) is a well-recognized radiographic phenomenon following PSF for AIS. However, prior studies with short-term follow-up have failed to demonstrate meaningful effects on HRQOL, raising controversy regarding whether DA represents a true postoperative complication or a benign radiographic finding. This study aimed to clarify the long-term postoperative course and clinical significance of DA over a 10-year follow-up in patients with Lenke 1A/2A curves.

Methods

Patients with Lenke 1A or 2A curves who underwent PSF and completed 10-year follow-up were included. DA was defined as either (1) a $\geq 5^\circ$ increase in the Cobb angle of the main thoracic (MT) curve with distal curve extension, or (2) a $\geq 5^\circ$ increase in disc wedge angle (DWA) below the lowest instrumented vertebra (LIV), compared with immediate postoperative (IPO) erect radiographs.

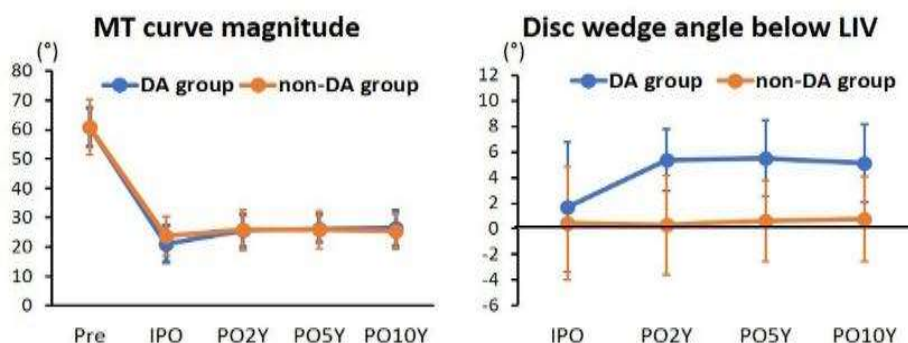
Results

Forty-one patients (34 females; Lenke type 1/2 = 21/20) were included, with a follow-up rate of 74.5%. Mean age was 15.2 years at surgery and 25.2 years at final follow-up. DA occurred in 10 patients (24.4%): 8 at PO2Y, 1 at PO5Y, and 1 at PO10Y. In the DA group, the MT curve magnitude and DWA below LIV significantly increased from IPO (median Cobb 20° , DWA 0.5°) to PO2Y (25° and 5°), and remained stable thereafter through PO10Y (25° and 4.5°) (Figure). Demographic factors, Lenke type, Risser grade at surgery, number of fused segments, and pre- and postoperative curve magnitudes as well as correction rates did not differ between the DA and non-DA groups. DWA was significantly greater in the DA group from PO2Y onward ($p < 0.01$), despite no difference at IPO ($p = 0.6$). SRS-22 scores were comparable between groups up to PO5Y; however, at PO10Y, the DA group demonstrated a significantly lower pain score (4.2 vs 4.6, $p = 0.02$) and a trend toward a lower total score (4.1 vs 4.5, $p = 0.08$) (Table).

Conclusion

Although DA did not consistently progress beyond 2 years postoperatively, it was associated with a significantly worse SRS-22 pain score at 10-year follow-up. These findings indicate that DA should not be considered a benign radiographic finding and could be clinically relevant 10 years after PSF.

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



SRS-22r	Preop	PO2Y	PO5Y	PO10Y
Pain				
DA group	4.5 (4.2-4.8)	4.4 (4.1-5.0)	4.4 (4.3-4.4)	4.2 (3.9-4.6)
non-DA group	4.8 (4.6-5.0)	5.0 (4.3-5.0)	4.6 (4.4-5.0)	4.6 (4.3-4.9)
p-value	0.1	0.3	0.07	0.02*
Self-image				
DA group	2.8 (2.4-3.1)	3.7 (3.4-4.3)	3.9 (3.7-4)	3.8 (3.4-4.1)
non-DA group	2.8 (2.4-3.2)	4.2 (3.4-4.7)	4.0 (3.4-4.2)	4.0 (3.4-4.9)
p-value	0.8	0.4	0.7	0.2
Function				
DA group	5.0 (4.4-5)	4.6 (4.3-4.8)	4.8 (4.4-4.8)	4.7 (4.6-5.0)
non-DA group	4.8 (4.6-5)	4.8 (4.6-5.0)	4.8 (4.8-5)	4.8 (4.6-5.0)
p-value	0.8	0.2	0.2	0.5
Mental health				
DA group	4.4 (4.0-4.8)	4.5 (4.3-5)	4.6 (4.2-4.9)	4.3 (3.9-4.6)
non-DA group	4.6 (3.8-5)	4.8 (4.1-5)	4.6 (4.2-5)	4.4 (4-4.8)
p-value	0.7	0.9	0.7	0.5
Satisfaction				
DA group	—	4.5 (4.0-4.9)	4.0 (4.0-4.5)	4.0 (3.6-4.9)
non-DA group	—	4.0 (4.0-4.8)	4.5 (3.6-4.9)	4.5 (4.2-4.6)
p-value	—	0.6	0.6	0.4
Total				
DA group	4.0 (3.9-4.1)	4.4 (4.0-4.6)	4.3 (4.1-4.5)	4.1 (4.0-4.3)
non-DA group	4.1 (3.9-4.3)	4.5 (4.3-4.7)	4.5 (4.2-4.7)	4.5 (4.2-4.6)
p-value	0.3	0.4	0.3	0.08

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