Grand Rounds Pediatric Orthopedic

Dr.Mohammed Waseemuddin .MD .

Pediatric Orthopedic Surgeon

Pediatric Spinal Deformity Surgeon

Pediatric and Adult Limb Deformity

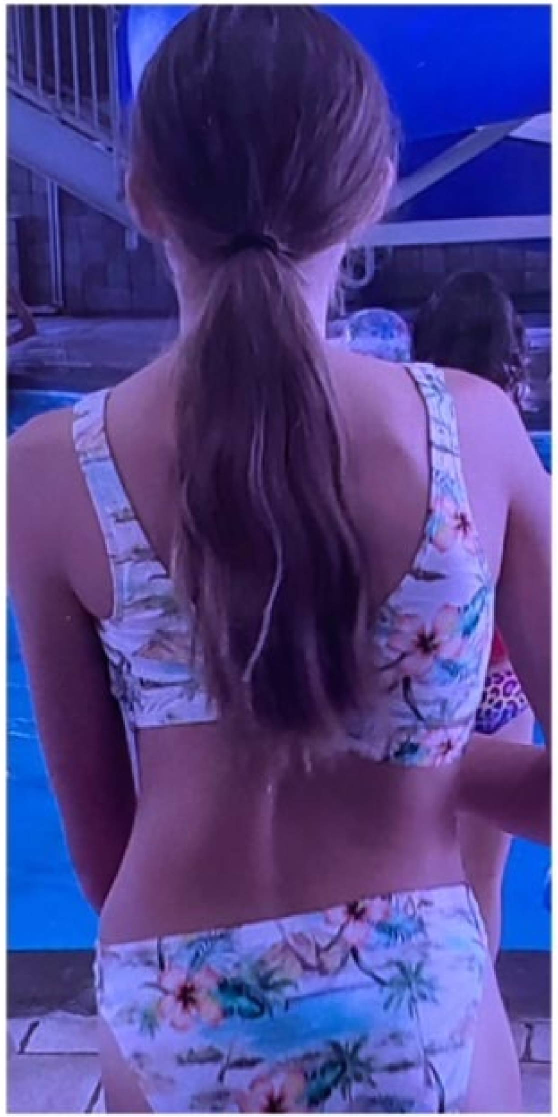
and Limb Lengthening Surgeon

Hip Preservation Surgeon

Sanford Medical Center Fargo(SMCF)

What I do ....

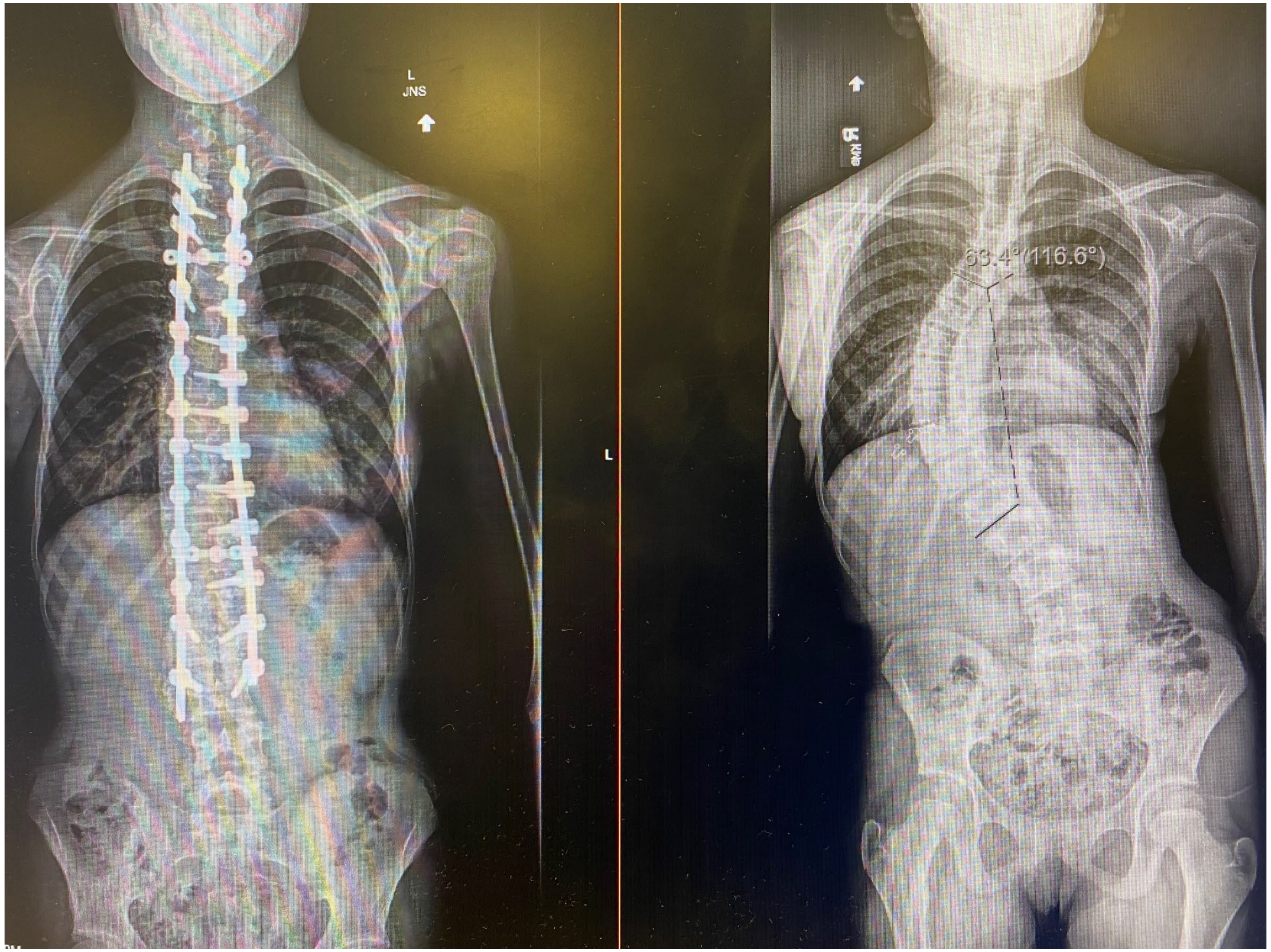
Scoliosis Corrective Procedures



Case 2

Scoliosis correction

Case 3

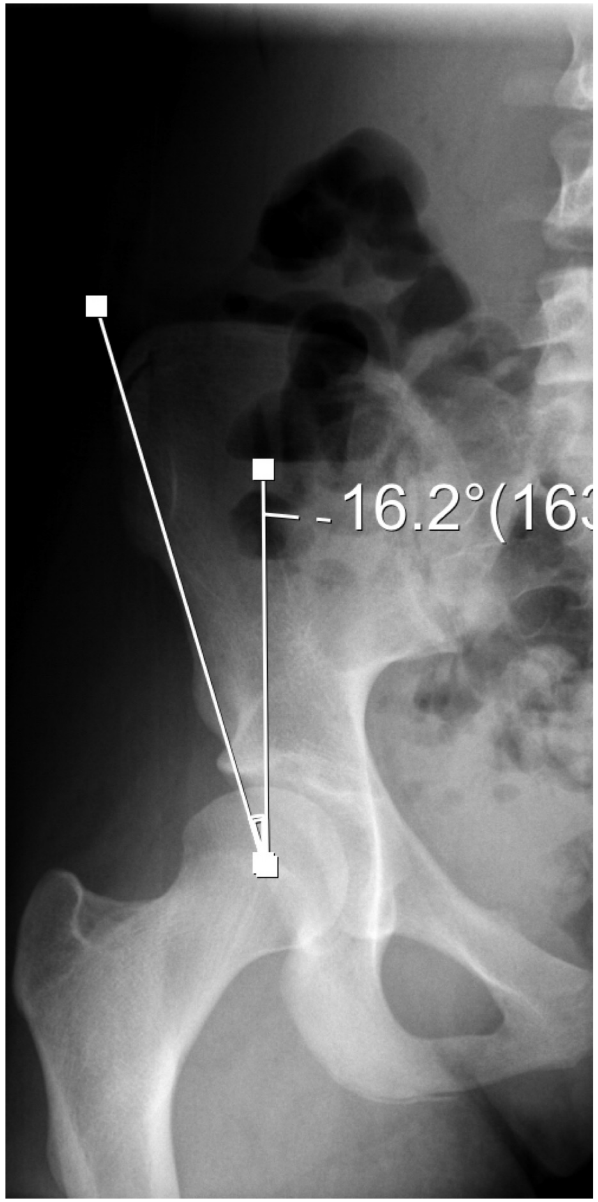


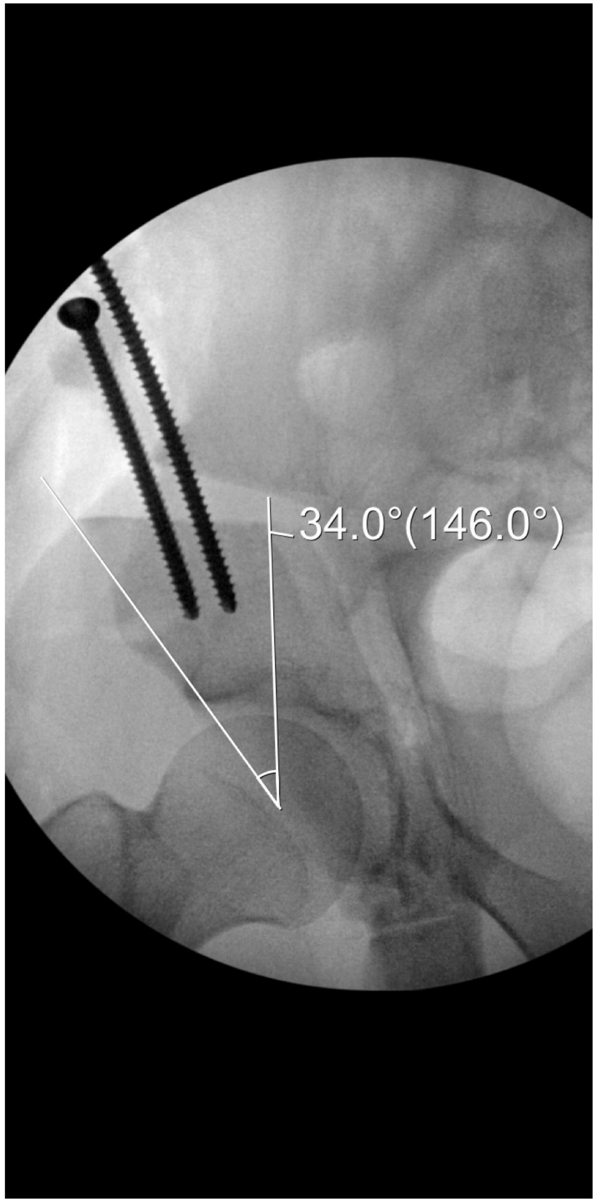
Derotation Osteotomy

Case 2

OCD Lesion of the Hip

Complex Hip reconstruction



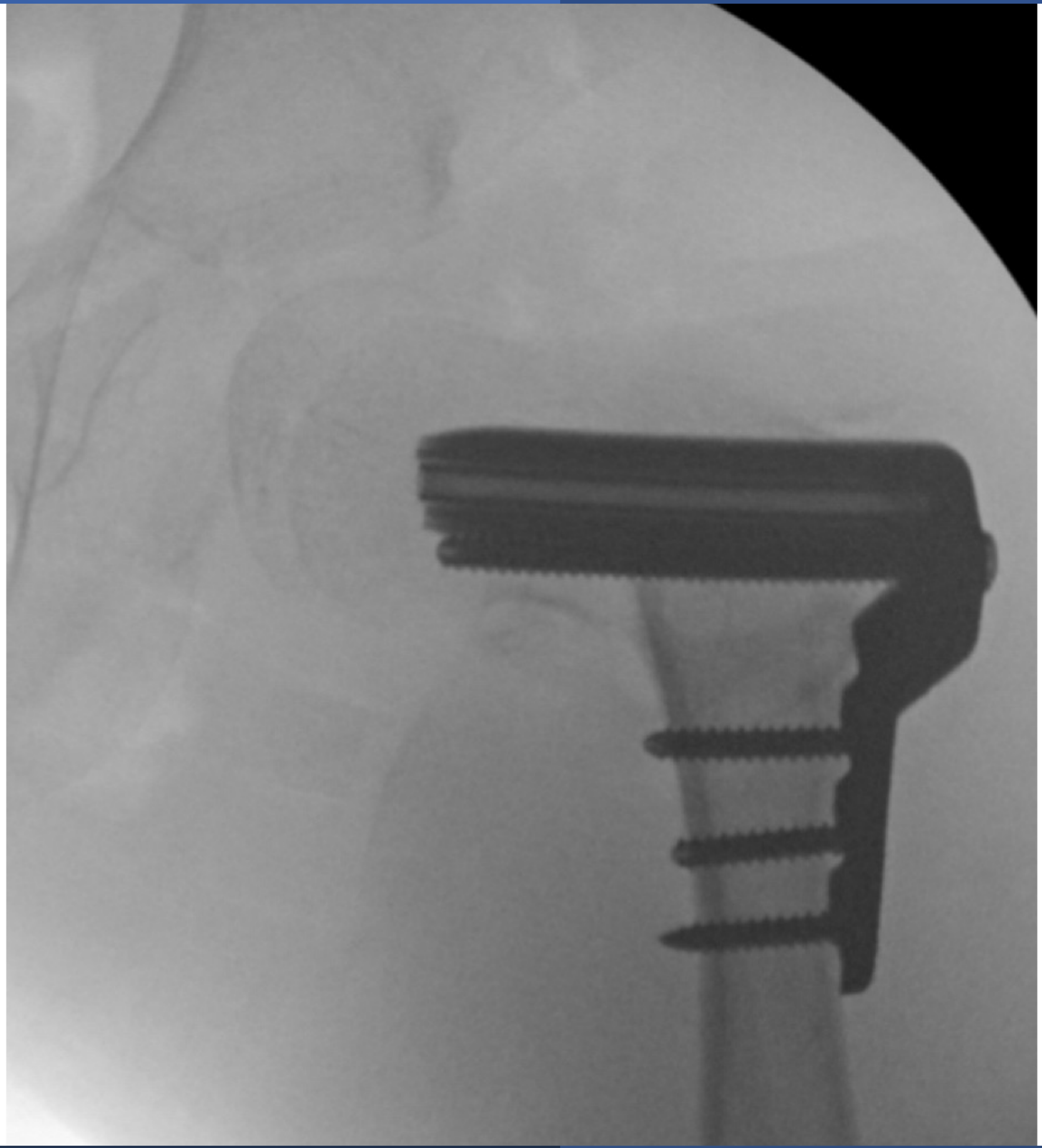


Complex trauma

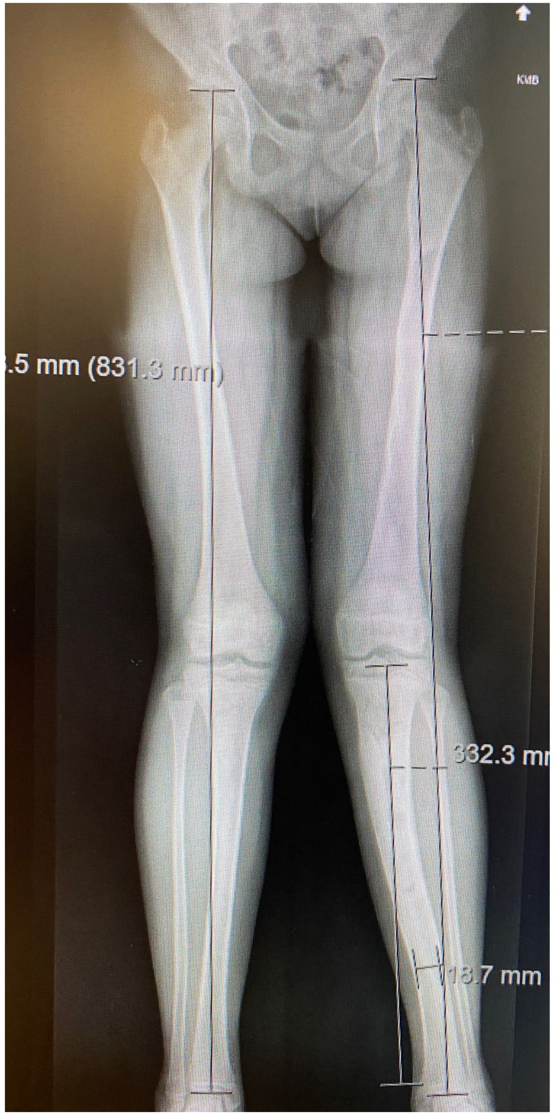
PAO...

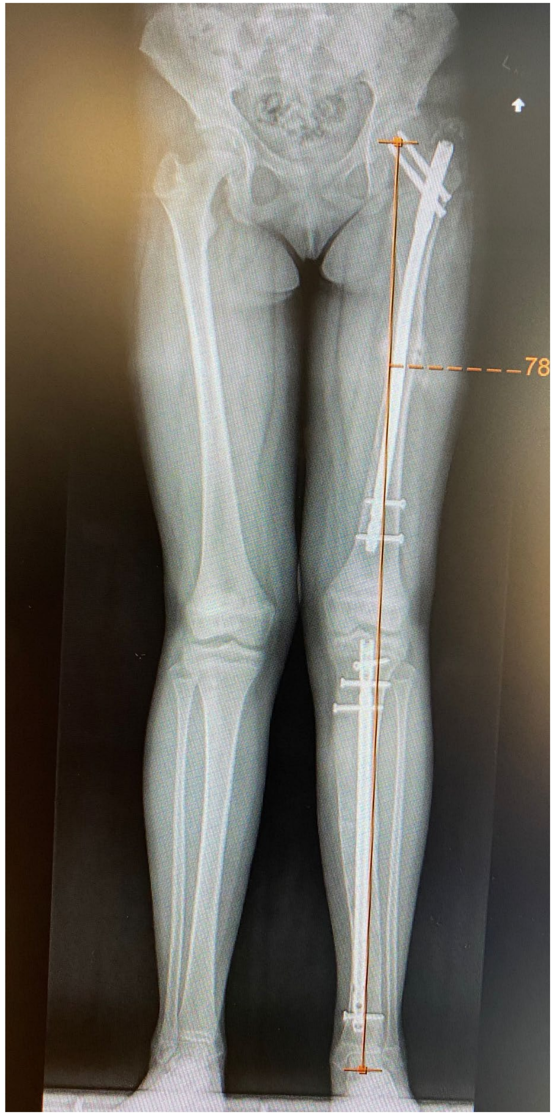

L


KMB

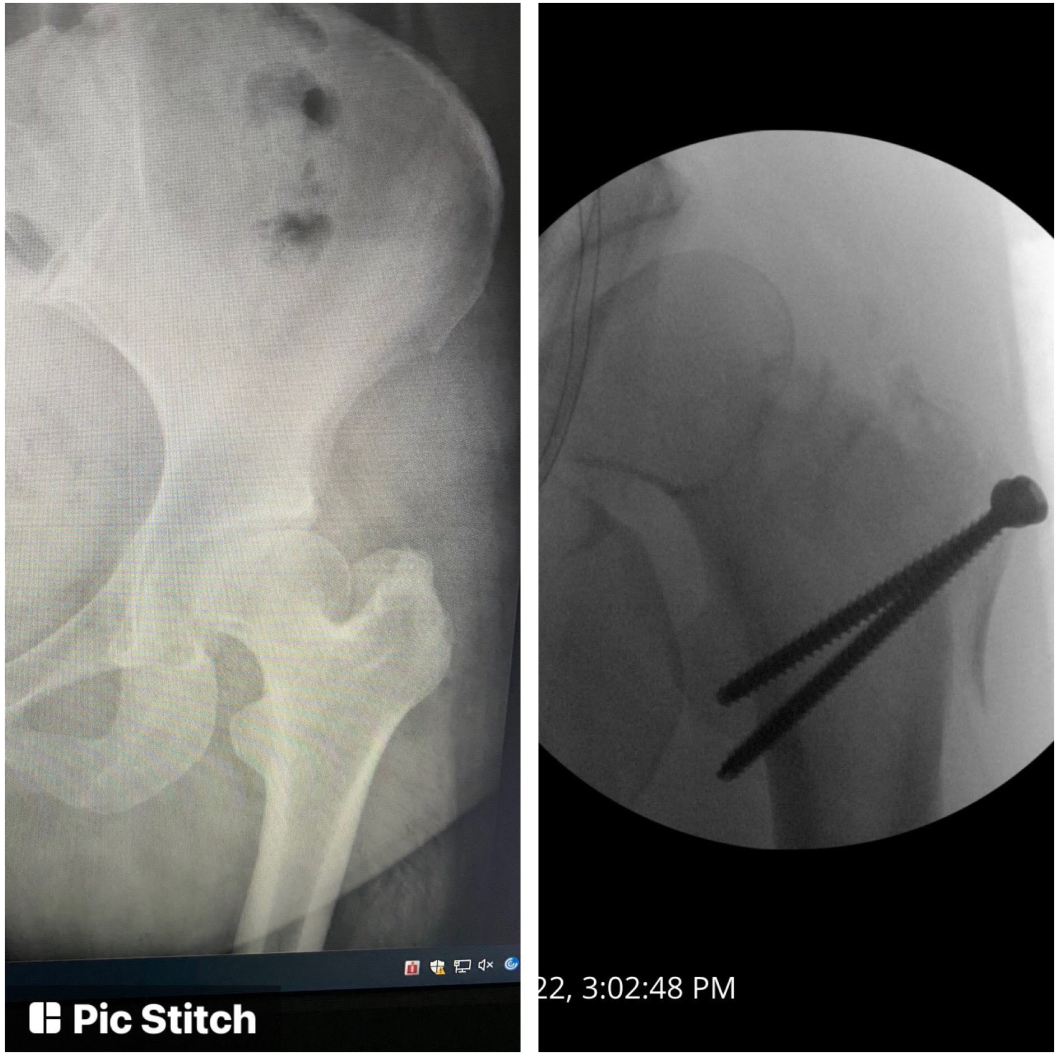

L


Deformity Correction



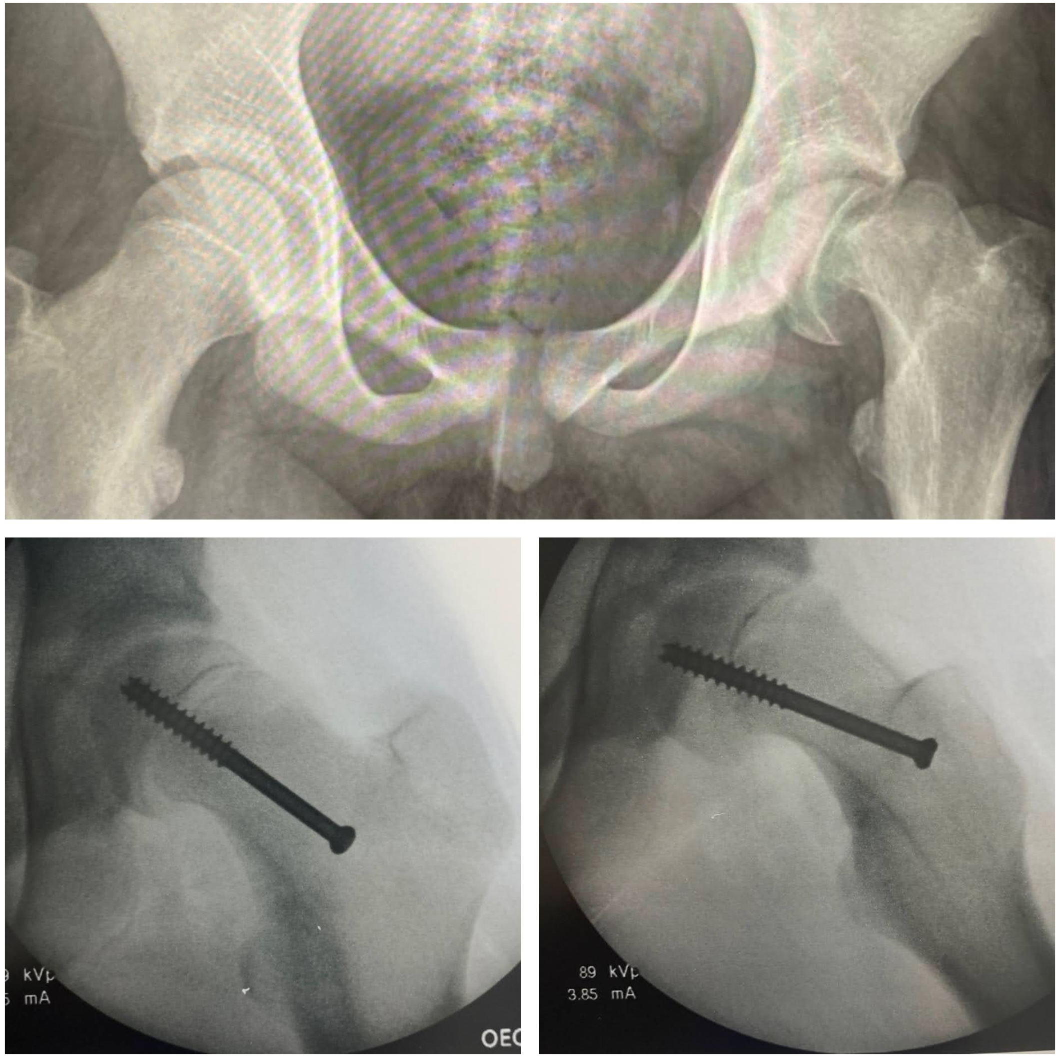


FAI…

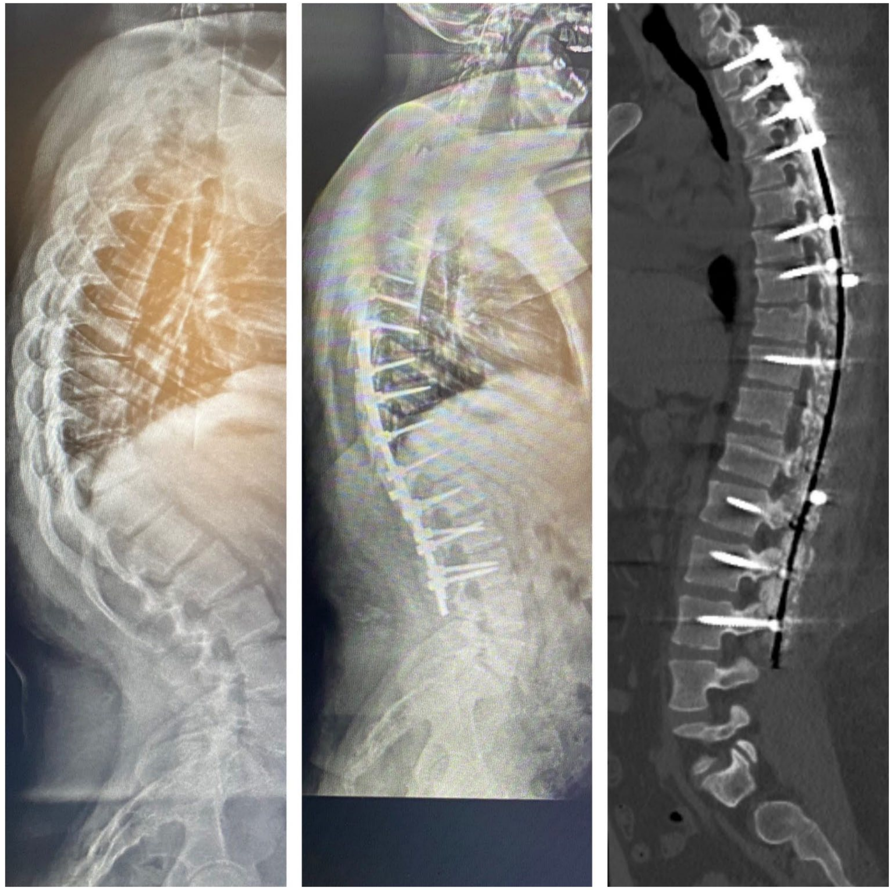


Tumor excision

Slipped capital femoral epiphysis



Kyphosis corrective procedure.



Scoliosis Classification

Main Class and Subtype	Demographic and Clinical Characteristics
Idiopathic	
Infantile	Occurs in the first 3 years of life; male preponderance; levoscoliosis is more common than dextroscoliosis
Juvenile	Occurs at age 4–10 years; female preponderance; dextroscoliosis is more common than levoscoliosis
Adolescent	Occurs at age 10–18 years; female preponderance; dextroscoliosis is more common than levoscoliosis
Congenital	
Osteogenic	Wedge-shaped vertebrae, hemivertebrae, fused vertebrae, unilateral bar
Neuropathic	Tethered cord, syringomyelia, Chiari malformation, (myelo)meningocele, diastematomyelia
Developmental	
Skeletal dysplasia	Achondroplasia
Skeletal dysostosis	Neurofibromatosis, osteogenesis imperfecta
Neuromuscular	
Neuropathic (acquired)	Cerebral palsy, spinocerebellar degeneration, poliomyelitis
Myopathic	Muscular dystrophy of various types (eg, Duchenne dystrophy)
Tumor-associated	
Osseous	Osteoid osteoma, osteoblastoma
Extraosseous	Extramedullary (eg, neurofibroma) or intramedullary (eg, astrocytoma) tumor

Curve Type

Type	Proximal Thoracic	Main Thoracic	Thoracolumbar / Lumbar	Curve Type
1	Non-Structural	Structural (Major*)	Non-Structural	Main Thoracic (MT)
2	Structural	Structural (Major*)	Non-Structural	Double Thoracic (DT)
3	Non-Structural	Structural (Major*)	Structural	Double Major (DM)
4	Structural	Structural (Major*)	Structural	Triple Major (TM)
5	Non-Structural	Non-Structural	Structural (Major*)	Thoracolumbar / Lumbar (TL/L)
6	Non-Structural	Structural	Structural (Major*)	Thoracolumbar / Lumbar - Main Thoracic (TL/L - MT)

*Major = Largest Cobb Measurement, always structural
Minor = all other curves with structural criteria applied

STRUCTURAL CRITERIA
(Minor Curves)

Proximal Thoracic: - Side Bending Cobb ≥ 25°
- T2 - T5 Kyphosis ≥ +20°

Main Thoracic: - Side Bending Cobb ≥ 25°
- T10 - L2 Kyphosis ≥ +20°

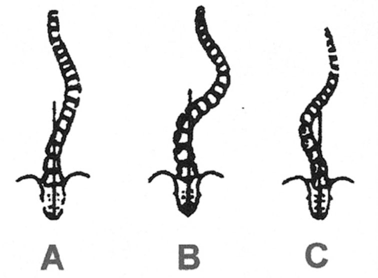
Thoracolumbar / Lumbar: - Side Bending Cobb ≥ 25°
- T10 - L2 Kyphosis ≥ +20°

LOCATION OF APEX
(SRS definition)

CURVE	APEX
THORACIC	T2 - T11-12 DISC
THORACOLUMBAR	T12 - L1
LUMBAR	L1-2 DISC - L4

Modifiers

Lumbar Spine Modifier	CSVL to Lumbar Apex
A	CSVL Between Pedicles
B	CSVL Touches Apical Body(ies)
C	CSVL Completely Medial



Thoracic Sagittal Profile T5 - T12	
- (Hypo)	< 10°
N (Normal)	10°- 40°
+ (Hyper)	> 40°

Curve Type (1-6) + Lumbar Spine Modifier (A, B, or C) + Thoracic Sagittal Modifier (-, N, or +)

Classification (e.g.1B+):____________

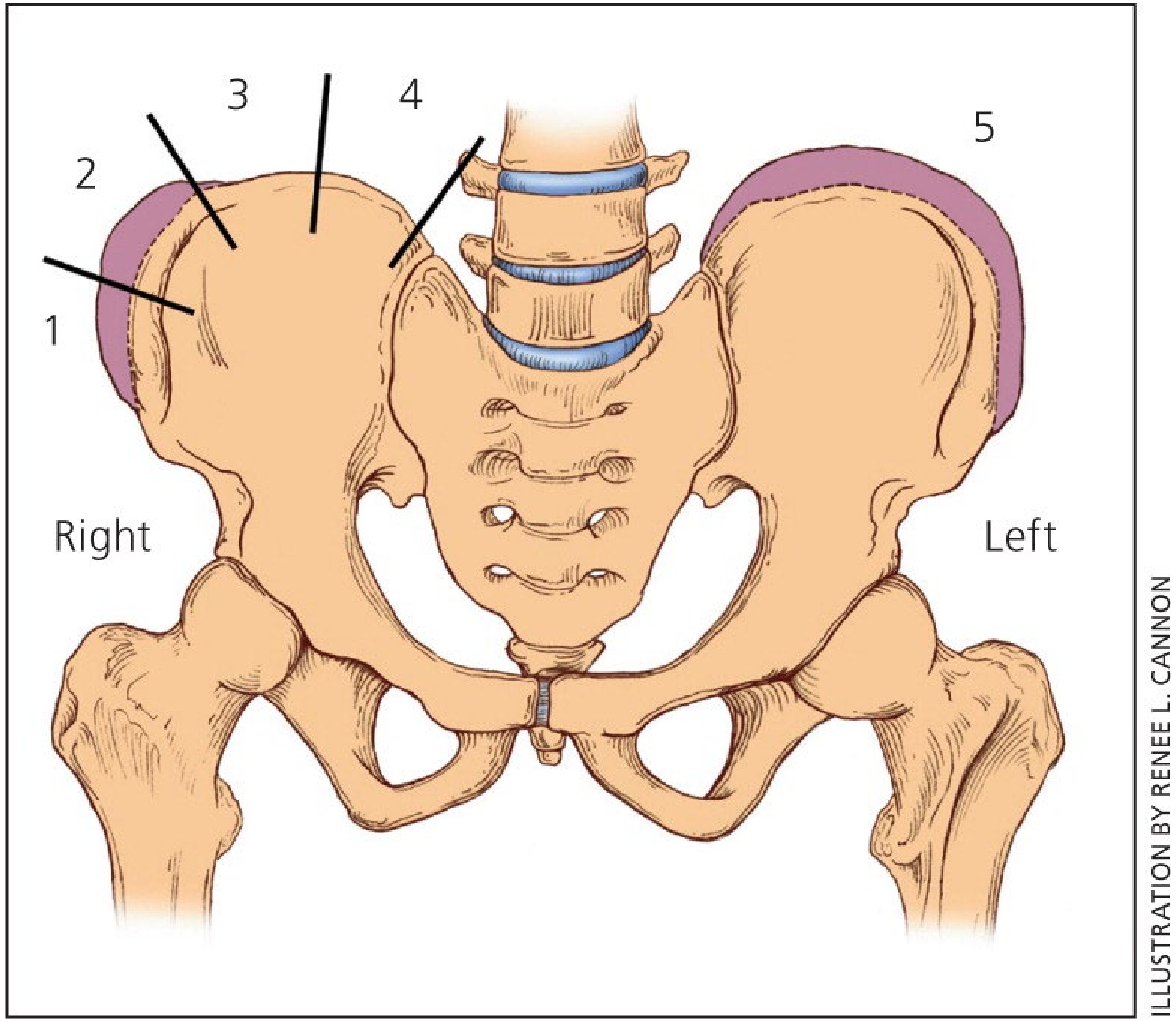
Management

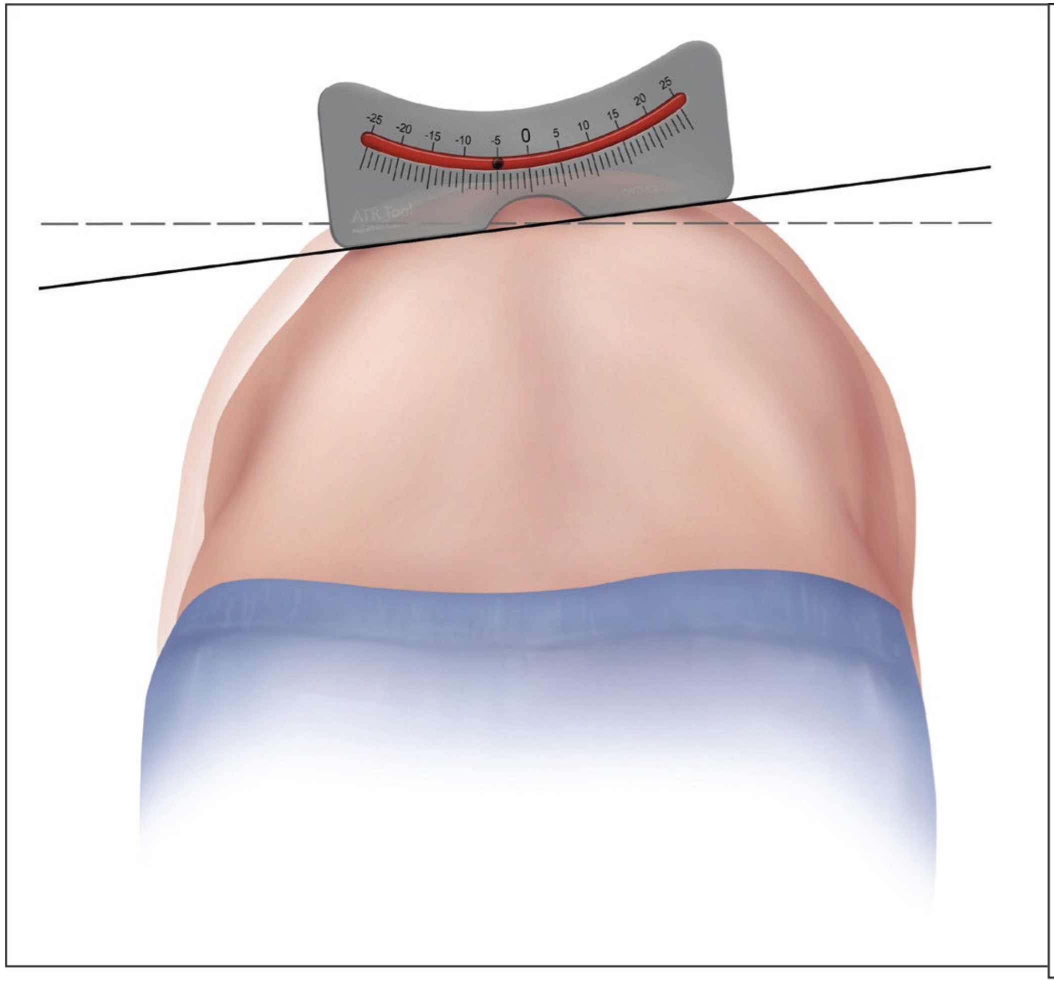
Table 3. Treatment and Referral Guidelines for Patients with Scoliosis

Cobb angle (degrees)	*Risser grade*	*Radiography/referral*	*Treatment*
10 to 19	0 to 1	Radiography every six months, no referral	Observe
10 to 19	2 to 4	Radiography every six months, no referral	Observe
20 to 29	0 to 1	Radiography every six months, referral	Brace after 25 degrees
20 to 29	2 to 4	Radiography every six months, referral	Observe or brace*
29 to 40	0 to 1	Referral	Brace
29 to 40	2 to 4	Referral	Brace
> 40	0 to 4	Referral	Surgery†

**—Risser grade 4 probably warrants only observation.*

Risser Staging





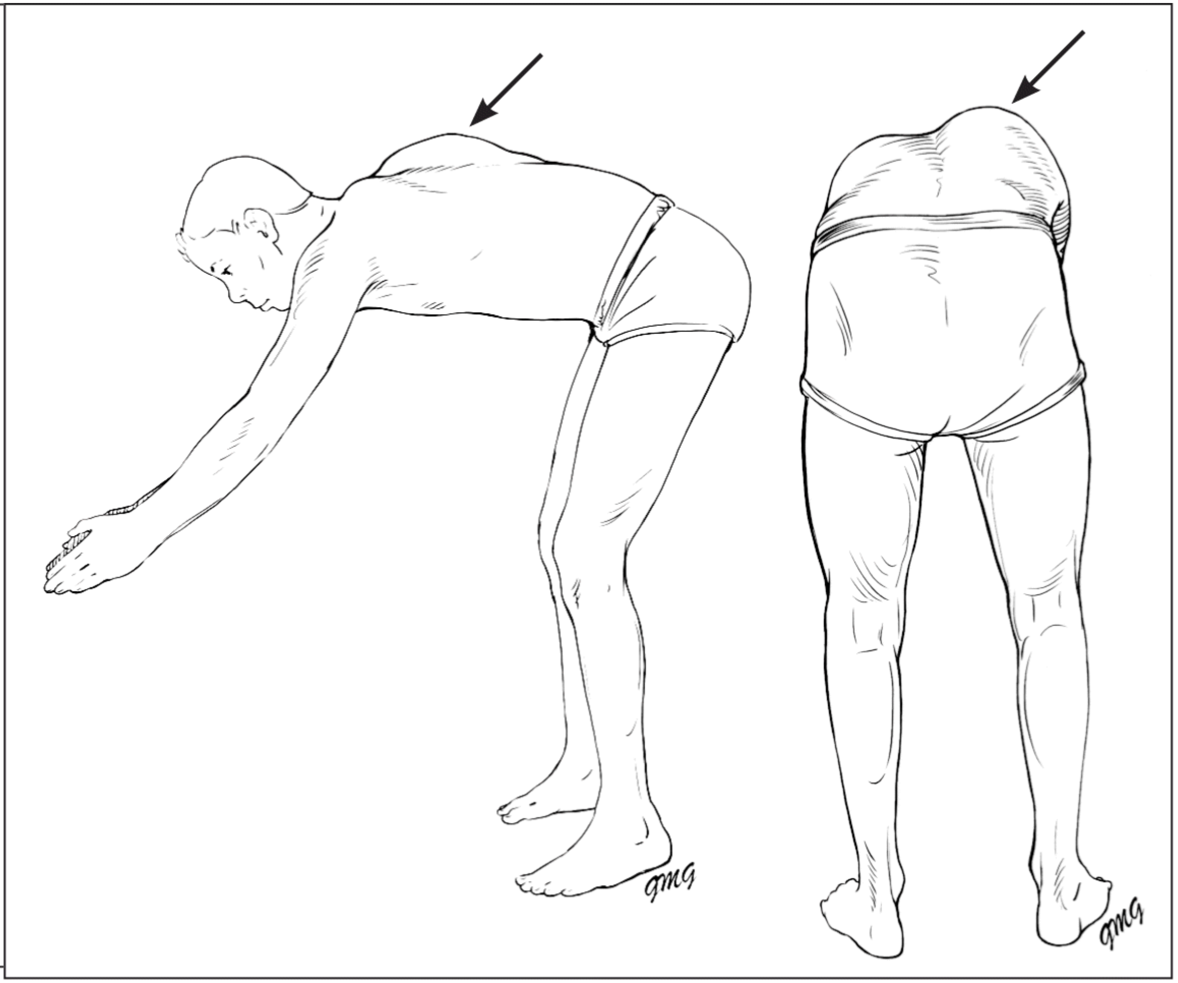


ILLUSTRATION BY GILBERT M. GARDNER

Management

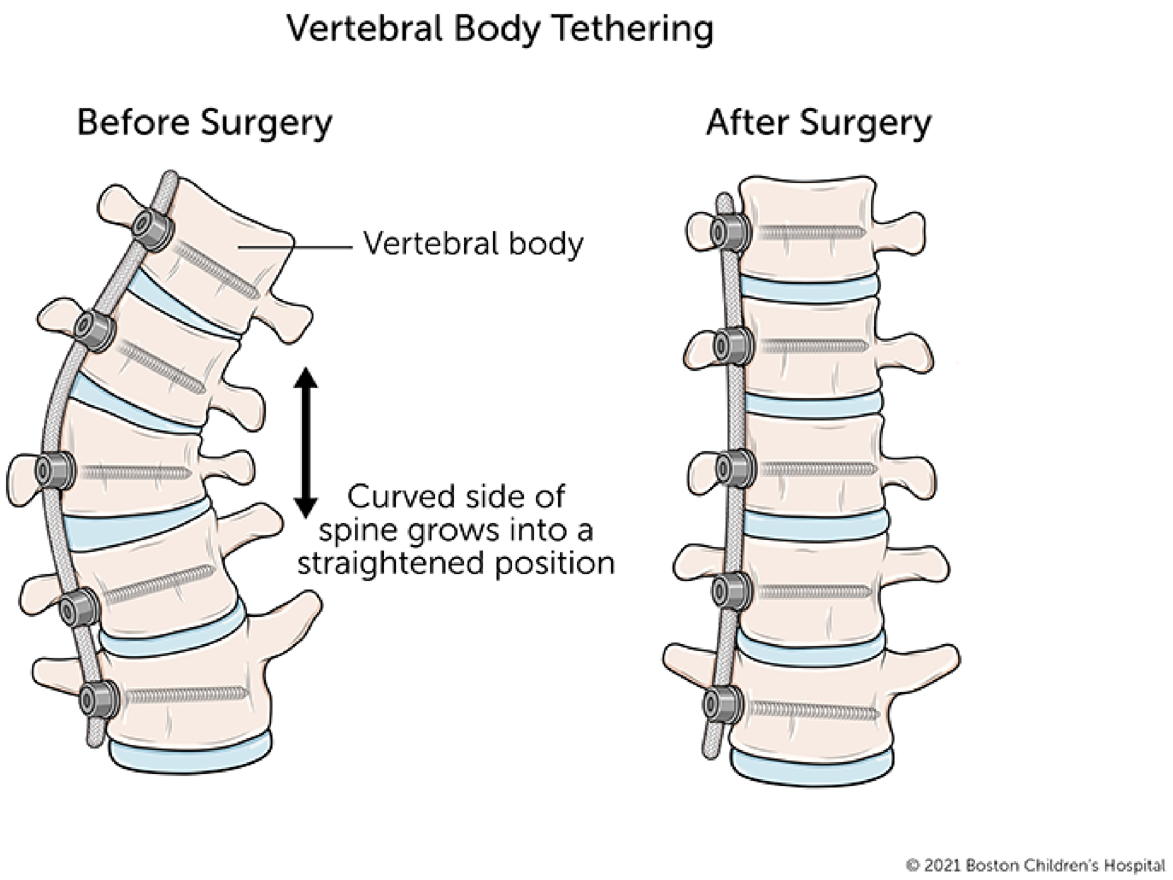
-Observation

-Bracing

-Growing Rods/ Magec rods

-Posterior spinal fusion

VBT


Vertebral Body Tethering
Before Surgery
After Surgery
Vertebral body
Curved side of
spine grows into a
straightened position
© 2021 Boston Children's Hospital

VBT

The ideal candidate for vertebral body tethering will be an individual who is older than 10 years of age but who has not yet reached spinal maturity. The degree of spinal curvature should be advanced and fall within a range of 35-65 degrees of curvature.

Would it work for older kids ?

No , the child needs to be in the growing phase for VBT to work

Complications / reoperation rate compared to spinal fusion

15-20 % reoperation rate compared to PSF . PSF has 3% reoperation rate .

Contd..

Curve correction in VBT vs PSF

96% curve correction in PSF vs 77 % with VBT at 3m .

Is there a long term data about effectiveness of VBT :

No.

How much motion am I saving with VBT

- It depends on the position if the curve

If the curve is all thoracic then VBT doesn’t saves you much motion .

If the curve is in the lumbar spine which is the mobile segment short term data shows VBT preserves more motion in the lumbar spine.

Trunk Range of Motion and Patient Outcomes After Anterior Vertebral Body Tethering Versus Posterior Spinal Fusion

Comparison Using Computerized 3D Motion Capture Technology

Joshua M. Pahys, MD Amer F. Samdani, MD Steven W. Hwang, MD Spencer Warshauer, MS
John P. Gaughan, MS, PhD, MBA Ross S. Chafetz, PT, DPT, PhD

Abstract

Background: Anterior vertebral body tethering (AVBT) for adolescent idiopathic scoliosis (AIS) is postulated to preserve motion compared with traditional posterior spinal fusion (PSF), but few studies exist to date. We used a validated computerized 3D model to compare trunk motion between patients treated with PSF and AVBT, and analyzed trunk motion in relation to the lowest instrumented vertebra (LIV).

Methods: This was a single-center retrospective review of a consecutive series of skeletally immature patients with AIS who underwent motion analysis prior to PSF (n = 47) or AVBT (n = 65) and 2 years postoperatively. Patients were divided into 4 groups on the basis of the LIV (≤L1, L2, L3, L4). Computerized 3D kinematic evaluations included thoracic and lumbar flexion, extension, side-bending, and rotation. Patient outcomes were assessed using the Scoliosis Research Society (SRS)-22 questionnaire.

Results: The LIV was ≤L1 in 48 patients treated with AVBT and 23 treated with PSF, L2 in 4 AVBT and 8 PSF patients, L3 in 10 AVBT and 8 PSF patients, and L4 in 3 AVBT and 8 PSF patients. PSF patients had a significant loss of motion in all 4 directions at 2 years postoperatively (e.g., flexion loss was 11° for ≤L1 to 30° for L4; $p < 0.001$). This equated to a 7° loss of trunk flexion per additional LIV level included in the fusion. AVBT patients only demonstrated loss of flexion and side-bending at 2 years postoperatively (e.g., flexion loss of 11° for L1 to 17° for L4; $p < 0.001$). Preoperative curve size and flexibility did not have any significant impact on differences in trunk motion between AVBT and PSF. SRS-22 scores were predominantly similar for AVBT versus PSF preoperatively and at 2 years postoperatively.

Conclusions: Patients treated with AVBT experienced predominantly less motion loss compared with PSF patients at 2 years postoperatively. Patients treated with PSF demonstrated loss of motion in all planes that increased with each additional LIV from ≤L1 to L4, with 7° loss of flexion per additional LIV. However, the differences in total trunk motions were relatively modest for PSF and AVBT with an LIV of ≤L1. Preoperative curve magnitude and flexibility had no significant impact on trunk motion in either group. SRS-22 scores were similar for both groups at 2 years postoperatively.

Level of Evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Vertebral body tethering compared to posterior spinal fusion for skeletally immature adolescent idiopathic scoliosis patients: preliminary results from a matched case-control study

Smitha E Mathew [1], J Blade Hargiss [2], Todd A Milbrandt [1], Anthony A Stans [1], William J Shaughnessy [1], A Noelle Larson [3]

Affiliations + expand

PMID: 35610543 DOI: 10.1007/s43390-022-00519-3

Abstract

Purpose: Direct comparisons between vertebral body tethering (VBT) and posterior spinal fusion (PSF for adolescent idiopathic scoliosis (AIS) are limited. We aimed to evaluate 2-year results of VBT and PSF to report comparative outcomes.

Methods: 26 prospectively enrolled VBT patients were matched 1:1 by age, gender, Risser sign and major curve magnitude with PSF patients. At a minimum 2-year follow-up, surgical results and radiographic outcomes were reviewed.

Results: Operative time, anesthesia time, blood loss, and length of stay were significantly lower in the VBT group (< 0.001, p = 0.003, p < 0.001, p < 0.001, respectively). The major curve at 2 years was corrected by 46% in the VBT group vs. 66% in the PSF (p = 0.0004). Success following VBT, defined as no fusion surgery and Cobb angle < 35° at the 2-year follow-up, was seen in 20 VBT patients (77%) (p = 0.0003) and correlated with mean Cobb angle of < 35° on 3-month imaging. 12 VBT patients (46%) showed curve improvement over time, and those patients had significantly lower mean Cobb angle on the 3-month radiograph than non-modulators (23° vs 31°, p = 0.014). At 2 years, cord breakage occurred in five patients (19%). By 2 years, three VBT patients developed complications (2 pleural effusion and 1 overcorrection needing return to OR). In contrast to PSF, growth continued at T1-T12 (mean 13 mm) and over the instrumented levels (mean 10 mm) following VBT, compared to no growth over instrumented segments in the fusion cohort (p = 0.011, p = 0.0001).

Conclusion: In Sanders stages 3 and 4 patients treated in the USA, Cobb angle < 35° on 3-month imaging was associated with success at the 2-year follow-up. Curve correction was superior in the PSI group with 96% achieving curve correction to < 35° vs. 77% of the VBT patients. Cord breakage was noted in 19% of VBT patients at the 2-year follow-up. Three patients developed complications in both the VBT and PSF cohorts.

Level of evidence: Level II (prospective study with matched retrospective comparison group).

Complications, Reoperations, and Mid-Term Outcomes Following Anterior Vertebral Body Tethering Versus Posterior Spinal Fusion: A Meta-Analysis

Max Shin [1], Gabriel R Arguelles [1], Patrick J Cahill [2], John M Flynn [2], Keith D Baldwin [2], Jason B Anari [1]

Affiliations + expand

PMID: 34179678 PMCID: PMC8225360 DOI: 10.2106/JBJS.OA.21.00002

Abstract

Background: Anterior vertebral body tethering (AVBT) is a growth-modulation technique theorized to correct adolescent idiopathic scoliosis (AIS) without the postoperative stiffness imposed by posterior spinal fusion. However, data are limited to small series examining short-term outcomes. To assess AVBT's potential as a viable alternative to posterior spinal fusion (PSF), a comprehensive comparison is warranted. The purpose of this meta-analysis was to compare postoperative outcomes between patients with AIS undergoing PSF and AVBT. Our primary objective was to compare complication and reoperation rates at available follow-up times. Secondary objectives included comparing mid-term Scoliosis Research Society (SRS)-22 scores, and coronal and sagittal-plane Cobb angle corrections.

Methods: We performed a systematic review of outcome studies following AVBT and/or PSF procedures. The inclusion criteria included the following: AVBT and/or PSF procedures; Lenke 1 or 2 curves; an age of 10 to 18 years for >90% of the patient population; <10% non-AIS scoliosis etiology; and follow-up of ≥1 year. A single-arm, random-effects meta-analysis was performed. Deformity corrections, complication and reoperation rates, and postoperative SRS-22 scores were recorded.

Results: Ten AVBT studies (211 patients) and 14 PSF studies (1,069 patients) were included. The mean follow-up durations were similar for both groups. Pooled complication rates were 26% for AVBT versus 2% for PSF, and reoperation rates were 14.1% for AVBT versus 0.6% for PSF with nonoverlapping confidence intervals (CIs). The pooled reoperation rate among studies with follow-up times of ≥36 months was 24.7% in AVBT versus 1.8% in PSF. Deformity correction, clinical outcomes, and mid-term SRS-22 scores were similar.

Conclusions: Our study showed greater rates of complications and reoperations with AVBT compared with PSF. Reoperation rates were significantly greater in AVBT studies with longer follow-up (≥36 months). Deformity correction, clinical outcomes, and mid-term SRS-22 scores were similar. While a potential fusionless treatment for AIS merits excitement, clinicians should consider AVBT with caution. Future long-term randomized prospective studies are needed.

Level of evidence: Therapeutic Level III. See Instructions for Authors for a complete description of levels of evidence.

Vertebral body tethering for non-idiopathic scoliosis: initial results from a multicenter retrospective study

Abstract

Purpose

Vertebral body tethering (VBT) has been described for patients with idiopathic scoliosis. Results of the technique for non-idiopathic scoliosis have not yet been reported.

Methods

An international multicenter registry was retrospectively queried for non-idiopathic scoliosis patients who underwent VBT with minimum 2-year follow-up. Success at 2 years was defined as Cobb angle < 35 degrees and no fusion surgery.

Results

Of the 251 patients treated with VBT, 20 had non-idiopathic scoliosis and minimum 2-year follow-up. Mean age at surgery was 12.4 years (range 10 to 17 years). Mean major Cobb angle at enrollment was 56 degrees. Of those, 18 patients had a major thoracic curve and two had a major lumbar curve. Of the 20 patients, nine met criteria for success (45%). Eight of the 20 patients had poor outcomes (four fusions, four with curve > 50 degrees). Success was associated with smaller preoperative Cobb angle (50 vs. 62 degrees, $p = 0.01$) and smaller Cobb angle on initial postop imaging (28 degrees vs. 46 degrees, $p = 0.0007$). All patients with Cobb angle < 35 degrees on 1st postop imaging had a successful result, with the exception of one patient who overcorrected and required fusion. Syndromic vs. neuromuscular patients had a higher likelihood of success (5 of 7, 71%, 2 of 10, 20%, $p = 0.03$).

Conclusion

Selected non-idiopathic scoliosis can be successfully treated with VBT, but failure rates are high and were associated with large curves, inadequate intraoperative correction and neuromuscular diagnosis. Achieving a Cobb angle less than 35 degrees on 1st standing radiograph was associated with a successful outcome which was achieved in 45% of patients.

Growing Rods / Magec

-curves > 50° in small children with significant growth remaining

-allows continued spinal growth over unfused segments

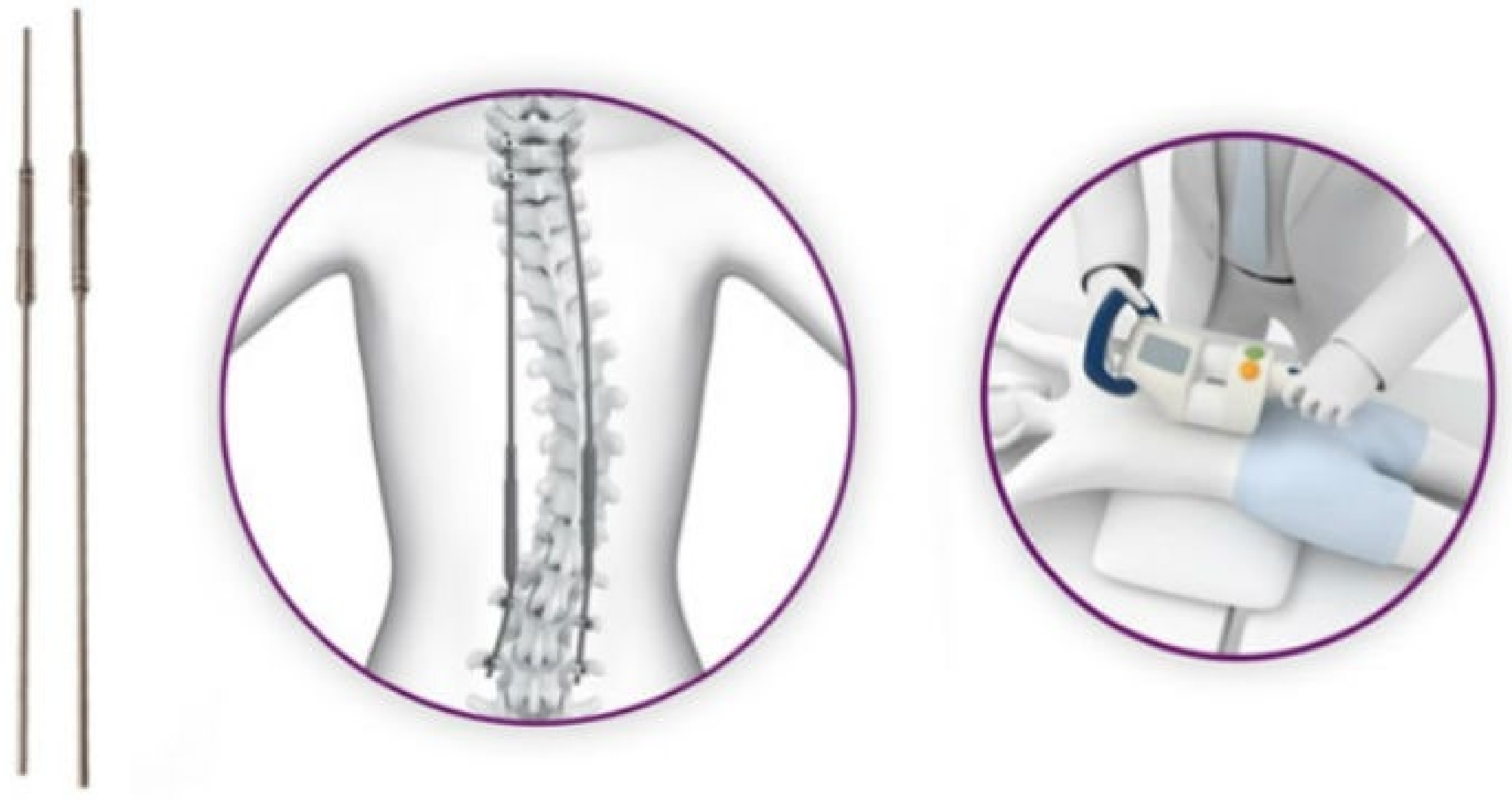
-definitive PSF performed when the child has grown and is closer skeletal maturity

-Minimum age to do PSF ?

10Y or ideally wait till the triradiates close.

TGR (Traditional Growing Rods)

Magec Rods



Traditional versus magnetically controlled growing rods in early onset scoliosis surgical treatment

Farid Samadov, Hacı Mustafa Ozdemir, Mehmet Ali Talmac, Samet Erinc, Suleyman Cakirturk & Bertan Cengiz

European Spine Journal **32**, 889–898 (2023) | Cite this article

Abstract

Purpose

Growing rod surgeries are common methods in the treatment of early onset scoliosis. Magnetic growing rod (MGR) surgery, in particular, has become more widespread in the last 10 years. The aim of this study was to compare the effects of traditional and magnetically controlled growing rod techniques on efficacy, safety, spinal growth, and lung development.

Methods

A retrospective analysis was made of 24 TGR and 17 MGR patients. Inclusion criteria were patients aged < 10 years, curvature > 40° or a progression of > 10° in the 4–6 month follow-up for curves between 25 and 40°.

Results

There were 9 males and 15 females in the TGR cohort and 7 males and 10 females in the MGR cohort. The mean age at first surgery was 6.1 years and 7.1 years, respectively. Major curve Cobb angles of TGR were preop. 51.5°, postop. 21.4° and 18.1° at the final follow-up. In the MGR cohort, these values were 60.4°, 41.8°, and 36.4°, respectively. The mean T1-S1 lengthening velocity was calculated as 1.12 cm/year (0.9318 mm/month) in the TGR group and 1.27 cm/year (1.0571 mm/month) in the MGR group. In the TGR cohort, a total of 99 procedures were performed as 24 initial surgeries and 75 additional procedures (5 lengthening during unplanned surgery due to complications; 4 revision, 1 debridement). In the MRG cohort, a total of 25 surgical procedures were performed as 17 initial surgeries and 7 additional procedures (3 debridements, 5 revisions).

Conclusion

The results of this study showed that the TGR system provided better correction in the coronal plane and was superior in kyphosis restoration than the MGR system. Both methods were successful in lengthening, but complication rates were slightly higher in the MGR cohort. The most common complication was the pullout of the proximal anchors, and this was more common in the MGR. Both TGR and MGR were found to be effective treatments. Lengthening without surgery is a significant advantage of the MGR system, but it has a high revision rate, and Cobb angle correction was found to be less effective than with TGR.

Traditional Growing Rods Versus Magnetically Controlled Growing Rods for the Surgical Treatment of Early-Onset Scoliosis: A Case-Matched 2-Year Study

Behrooz A. Akbarnia MD, Jeff B. Pawelek BS, Kenneth M. C. Cheung MD, Gokhan Demirkiran MD, Hazem Elsebaie FRCS, MD, John B. Emans MD, Charles E. Johnston MD, Gregory M. Mundis MD, Hilali Noordeen FRCS, David L. Skaggs MD, MMM, Paul D. Sponseller MD, MBA, George H. Thompson MD, Burt Yaszay MD, Muharrem Yazici MD & Growing Spine Study Group

Spine Deformity 2, 493–497 (2014) | Cite this article

Abstract

Introduction

Traditional growing rod (TGR) surgery is a treatment technique commonly used for progressive early-onset scoliosis. Studies have shown that repeated TGR lengthenings can significantly increase the risk of complications. Magnetically controlled growing rods (MCGR) are currently available outside of the United States and early results have been promising. The purpose of this study was to compare the effectiveness of MCGR versus TGR for the treatment of early-onset scoliosis.

Methods

Magnetically controlled growing rod patients were selected based on the following criteria: aged less than 10 years, major curve greater than 30°, thoracic height less than 22 cm, no previous spine surgery, and minimum 2-year follow-up. A total of 17 MCGR patients met the inclusion criteria, 12 of whom had complete data available for analysis. Each MCGR patient was matched with a TGR patient by etiology, gender, single versus dual rods, preoperative age, and preoperative major curve.

Results

Magnetically controlled growing rod patients had a mean age of 6.8 years and mean follow-up of 2.5 years. Mean follow-up was greater for TGR patients by 1.6 years. Major curve correction was similar between MCGR and TGR patients throughout treatment. The MCGR patients experienced an average of 8.1 mm/year increase in T1 –S1 during the lengthening period, compared with 9.7 mm/year for TGR patients ($p = .73$). There was a mean increase in Tl–T12 of 1.5 mm/year for MCGR patients and 2.3 mm/year for TGR patients ($p = .83$). The TGR patients had 73 open surgeries, 56 of which were lengthenings. The MCGR patients had 16 open surgeries and 137 noninvasive lengthenings. Three TGR patients underwent 5 unplanned revision surgeries whereas 3 MCGR patients underwent 4 unplanned revisions.

Conclusions

Major curve correction was similar between MCGR and TGR patients throughout treatment. Annual T1–S1 andT1–12 growth was also similar between groups. The MCGR patients had 57 fewer surgical procedures than TGR patients. Incidence of unplanned surgical revisions as a result of complications was similar between groups.

TGR vs MAGEC

-Both are spine lengthening procedures

-More planned return to the OR with TGR vs MAGEC

-MAGEC does not work well in kids with high BMI

-No kyphosis achieved with MAGEC

-MAGEC is more EXPENSIVE

-MAGEC is a great tool in neuromuscular patients with high risk for anesthesia .

-More correction and lengthening is achieved with TGR

-More unplanned visits to the OR with MAGEC

Revision of TGR or MAGEC to Definitive fusion

-Needs to revised to a definitive fixation as it is less rigid.

-Might be able accept TGR or Magec as a definitive fixation who are at high risk for anesthetic complications but the family needs to be informed that the implants can fail and might need to be revised to a definitive fixation.


Thank you…