

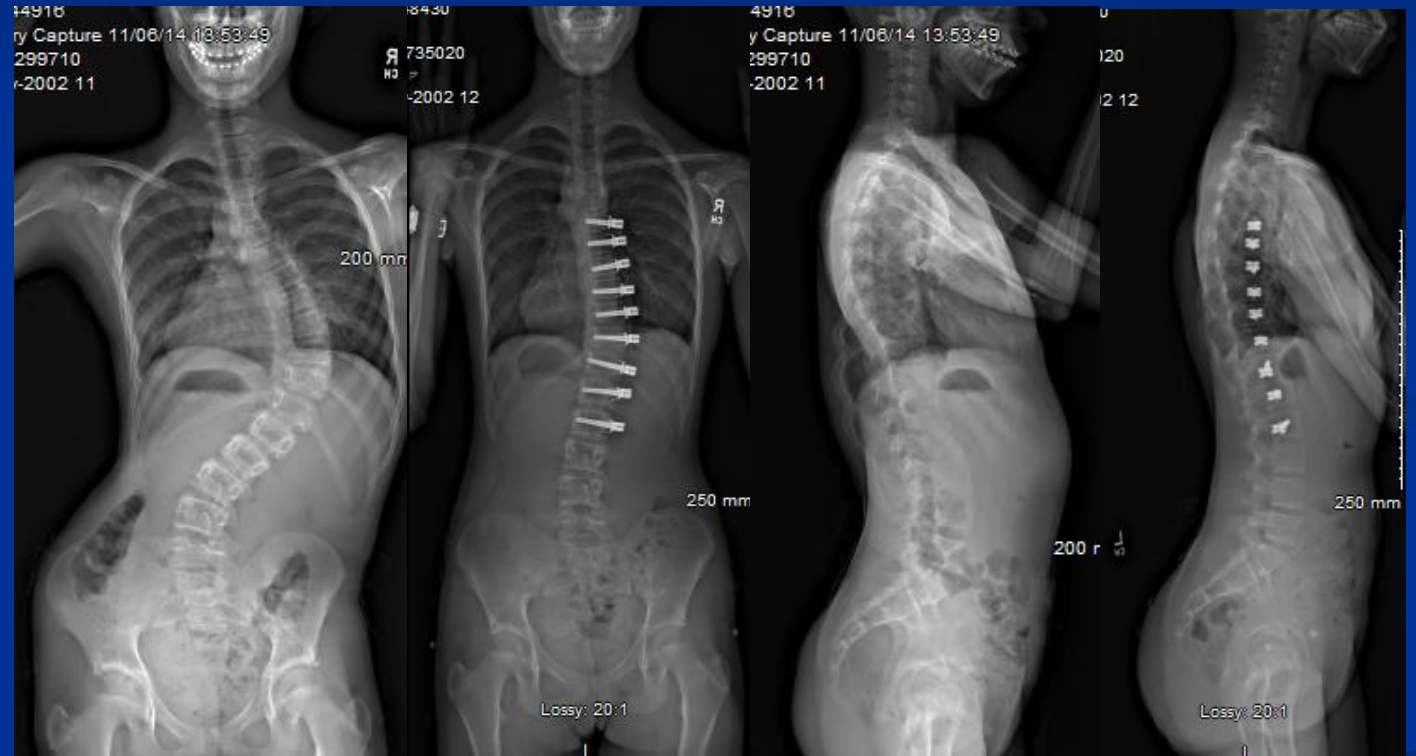
Failures of the Tethering Technique: How and Why?

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NOT FDA APPROVED DEVICE

What is Failure?

- Clinical outcome
 - Avoiding a fusion
 - HRQoL
- Radiographic
 - Improved but under what value
 - Coronal 35° ?
- Complications
 - Reoperations?
- *Need longer follow-up*



Literature

- **Animal studies: Abundant**
 - Braun *et al*: Relative vs. absolute modulation of growth in the fusionless treatment of experimental scoliosis. Spine 31:1776-82, 2006
 - Newton *et al*: Spinal growth modulation with use of a tether in an immature porcine model. JBJS 2008;90A:2695-706
- **Human: Few but increasing**
 - Crawford CH, Lenke LG: Growth modulation by means of anterior tethering resulting in progressive correction of JIS. JBJS 92A:202-9, 2010
 - Samdani *et al*: Anterior VBT for immature AIS: one-year results on the first 32 patients. Eur Spine J 2015;24:1533-9
 - Samdani *et al*: Anterior VBT for idiopathic scoliosis: 2-year results. Spine 2014;39(20):1688-93
 - Miyanji F: Results of VBT at 2 years. IMAST 2017

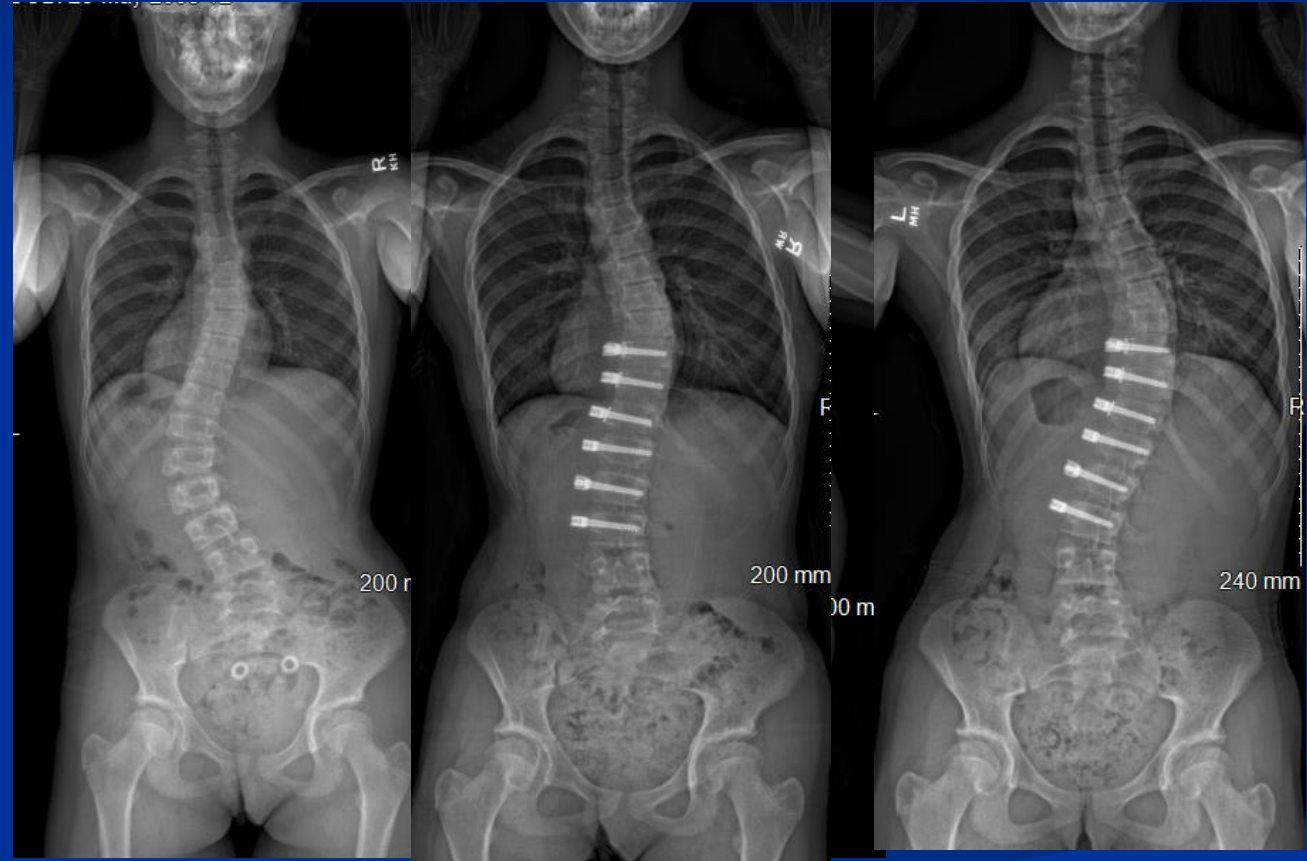
Successes and Failures Following Spinal Growth Tethering for Scoliosis: A Retrospective Look 2 to 4 Years Later

Newton et al: SRS 2016

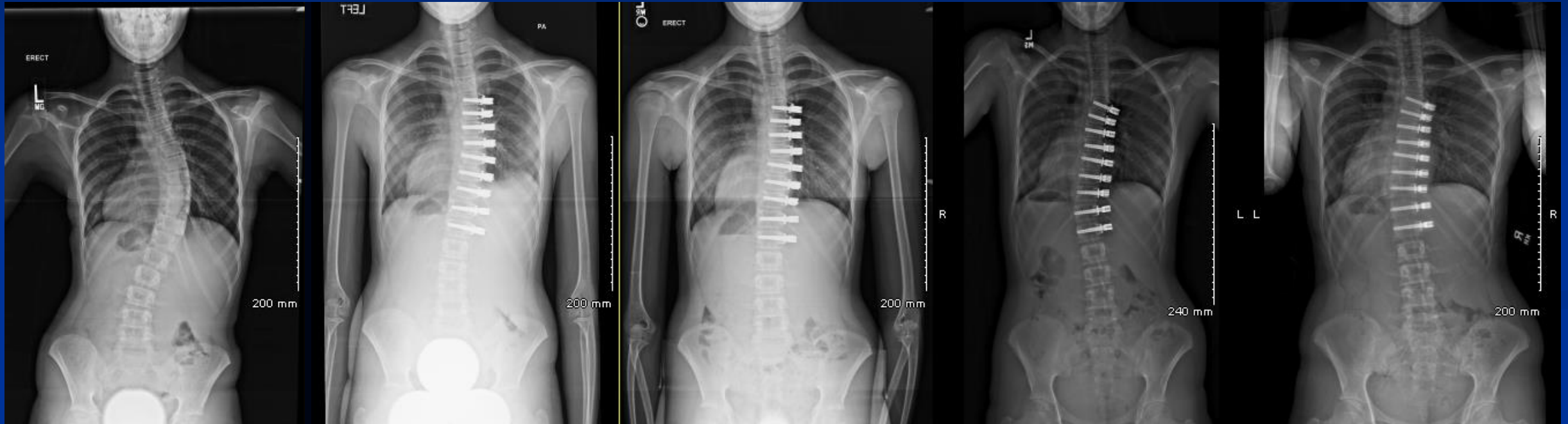
- 17 consecutive patients
 - Risser 0, mean age 11 years, mean thoracic scoliosis 52°
 - 2-4 years of follow-up
- 9/17 were considered to have a successful outcome (reduction of thoracic Cobb to < 30°)
- Good initial correction but inconsistent midterm outcomes
 - Revision surgery required for approx. 50% of patients

Reoperations

- Approximately 10-15%
 - Overcorrection
 - Younger patient, usually triradiates open
 - Technique related
 - Undercorrection
 - Curve too stiff and/or not enough growth
 - Adding on
 - Usually if tethered short of CSVL



Too Much Growth: Overcorrection



Pre-op

Immediate
post-op

1 year

2 years

2 years
after tether
cut

Curve Too Stiff



24 months

Newton Observed Failed PET Cord in 8/17 (47%)

- 2 confirmed at reoperation
- 6 suspected based on change in screw angulation

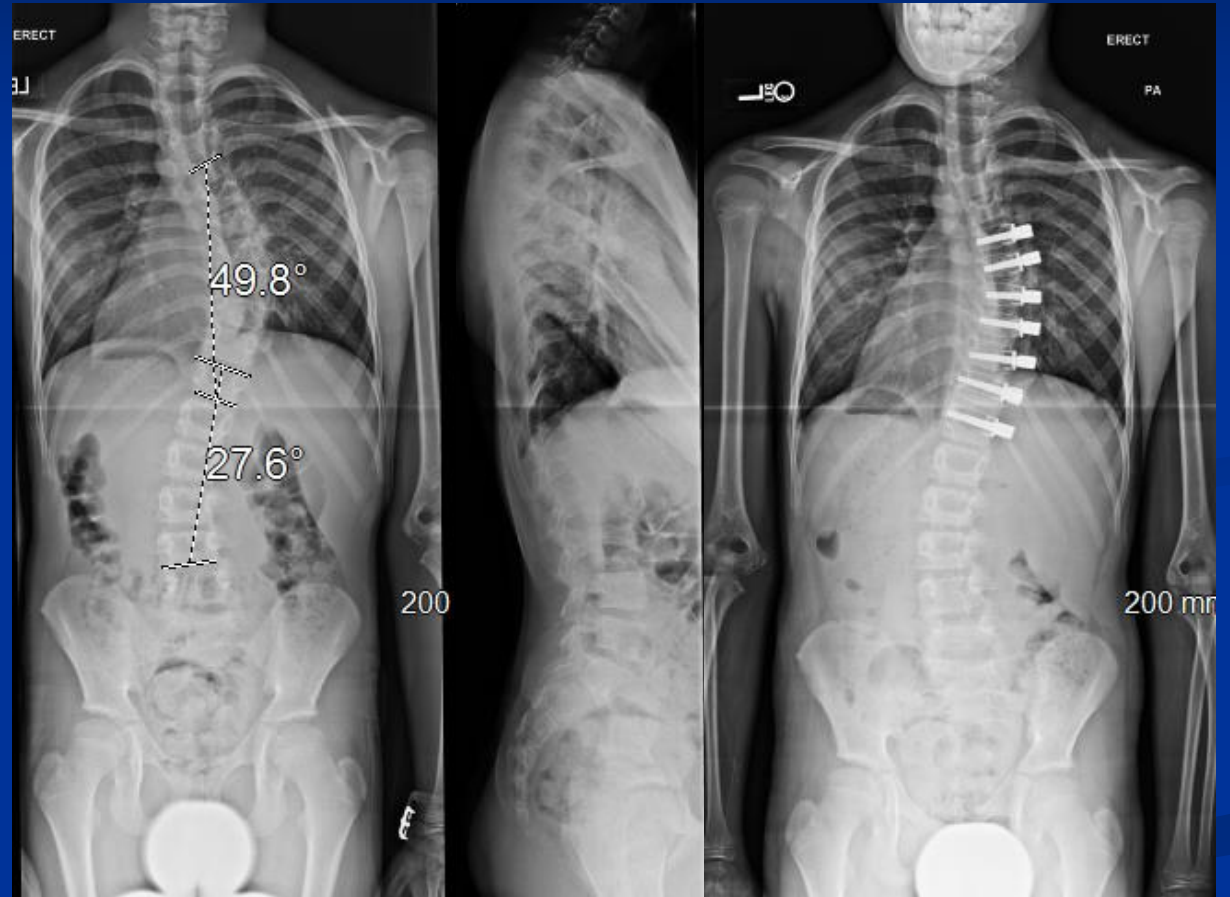


Not All Broken Tethers Are Failures

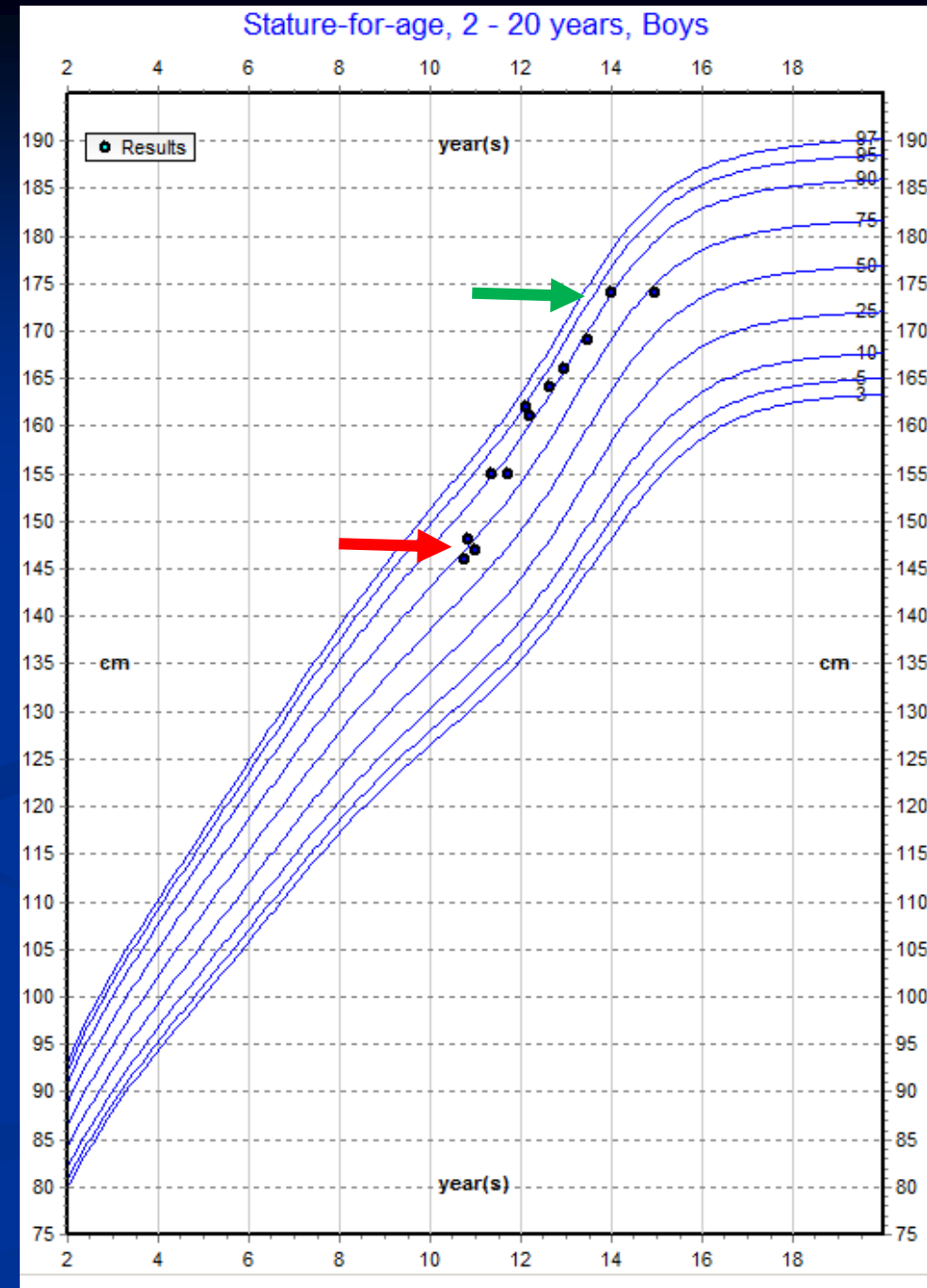


Patient R.L.

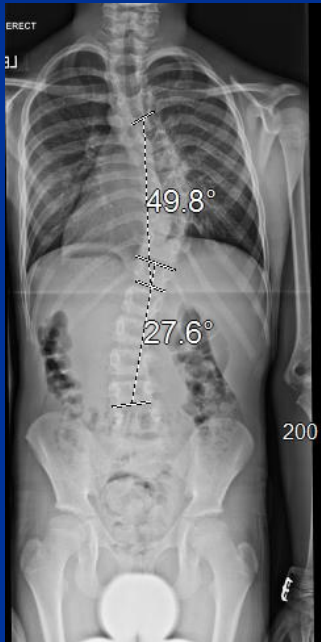
- 12-year-old boy with AIS
 - Risser 0, triradiates open, Sanders 3
 - 49° right thoracic curve
 - Bends to 28°
 - Inclinator 12°



- Age at surgery 12 years
Height 145 cm
- Current age 16 years
 - Height 175 cm
- Grows 30 cm = 13.6 inches



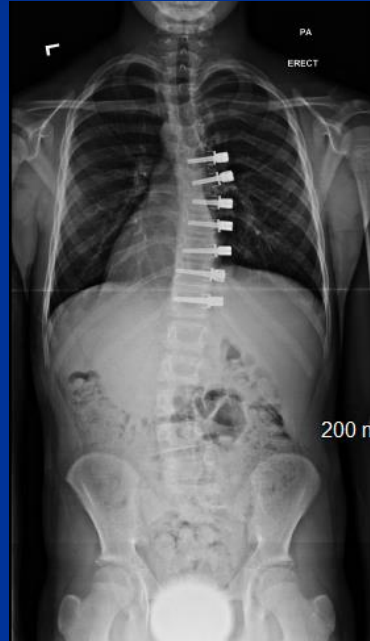
Patient R.L.



Age 12



Age 13



Age 14



Age 15



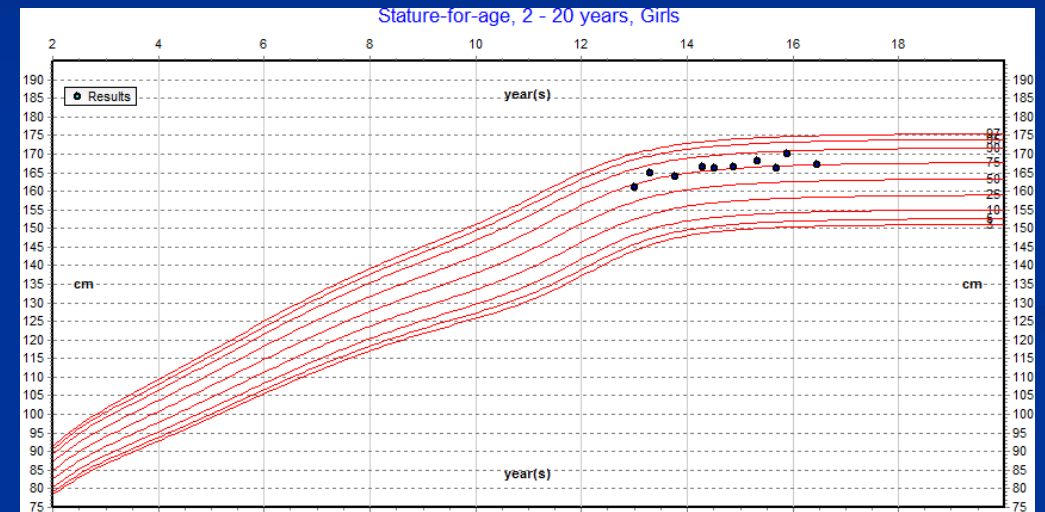
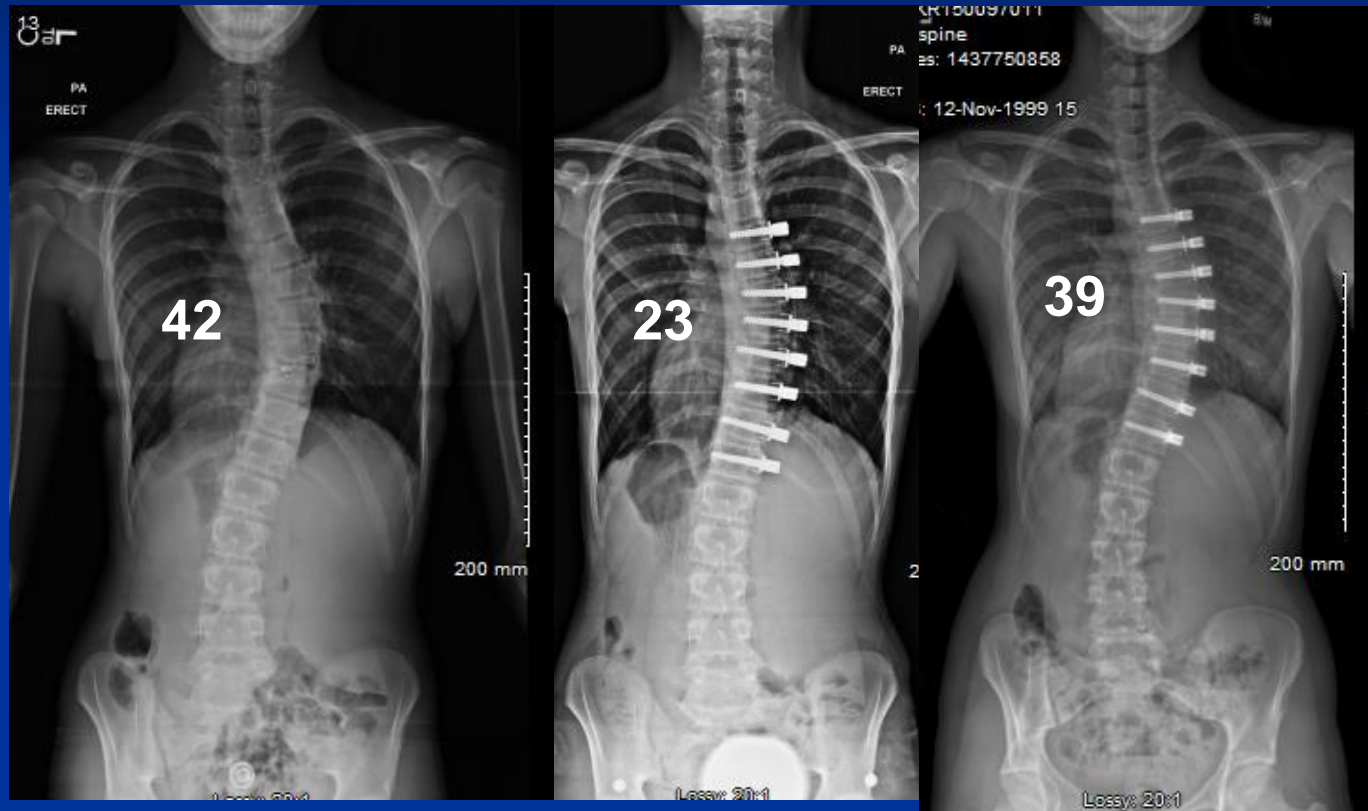
Age 16



WHO Not to Tether

- Patient too skeletally immature
- Family
 - Do they understand all options?
 - Not FDA approved
 - No long-term data
 - Expectations
 - Residual deformity
- Not enough growth

Did Not Grow Enough?



The First 100 Consecutive Anterior Vertebral Body Tethering Procedures for Immature Adolescent Idiopathic Scoliosis at a Single Institution: Outcomes and Complications in the Early Postoperative Period

Joshua M. Pahys MD, Amer F. Samdani MD,
Patrick J. Cahill MD, Robert Ames MD, Vishal Khatri MD,
Joseph Kimball MD, Harsh Grewal MD, Glenn Pelletier MD,
Randal R. Betz MD

Shriners Hospital for Children, Philadelphia, PA, USA

- **Complications:**

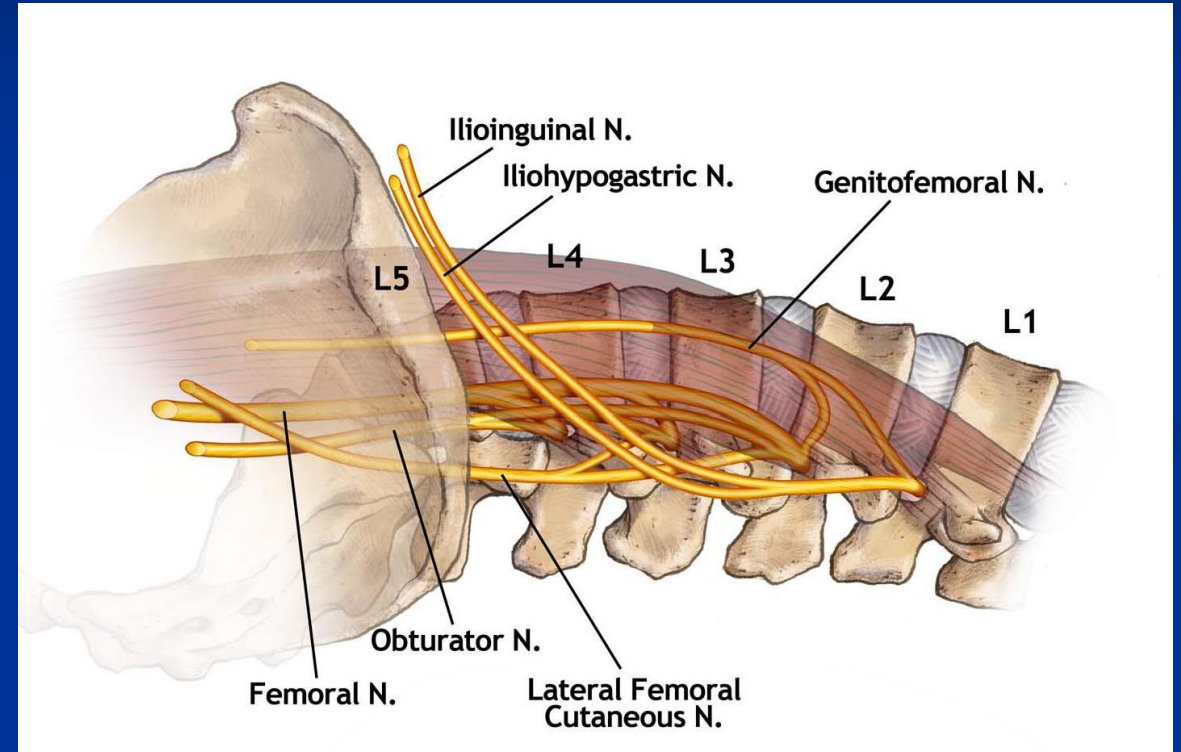
- 5% with transient thigh pain/numbness
- 2% converted to open procedure
- 1% prolonged atelectasis
- 1% unresolved intercostal neuralgia
- No neurologic deficits

- **Conclusion:**

- 49% initial coronal Cobb correction
- 33% initial rib prominence reduction
- Progressively faster operative times and lower EBL
- No major, few minor complications

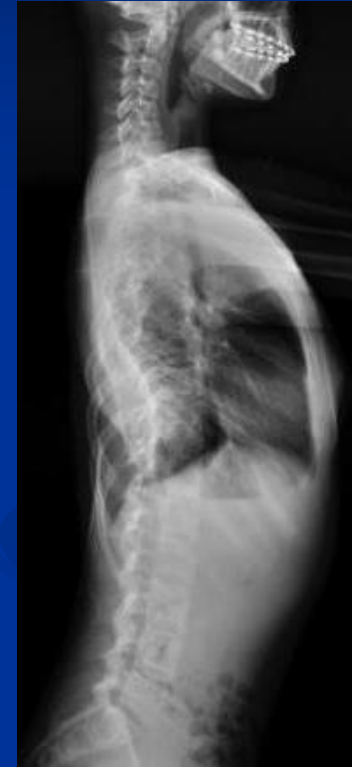
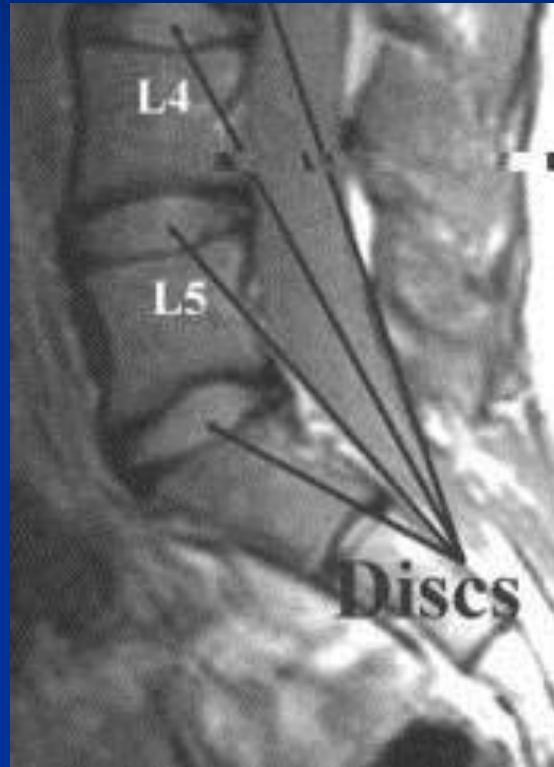
Complications

- Lumbosacral plexus
 - Posteriorly placed screws
 - Peel psoas back
- Three chest tube reinsertions
 - Delayed effusions
 - Now leave chest tube in two days
- One infection
 - Salmonella
- One patient excessive blood loss
 - Lumbar tether
 - Aortic branch



WHY Consider Anterior Growth Modulation?

- Adjacent level degeneration later
- Maybe better sagittal compensation
- Hypothetically, mobile spine better than fused spine



Look at improvement in cervical lordosis

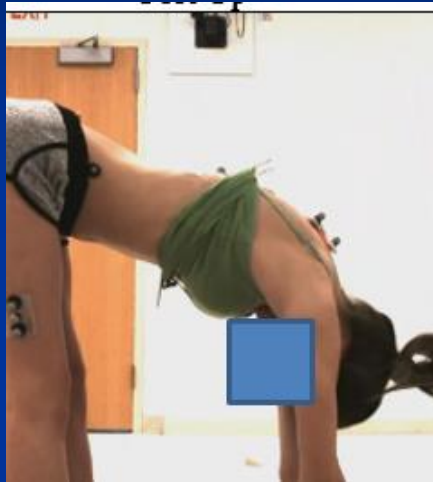
Trunk Motion Pre- / Post-op

PSF

Pre-op



6m post-op



VBT

Pre-op



6m post-op



Thoracic PSF vs. VBT

12 year old T2-T11

Preoperative
54 degrees



6 months post-op

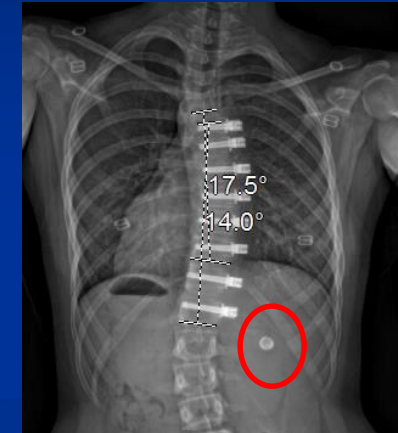


13 year old T5-T12 Tethering

Preoperative
48 degrees



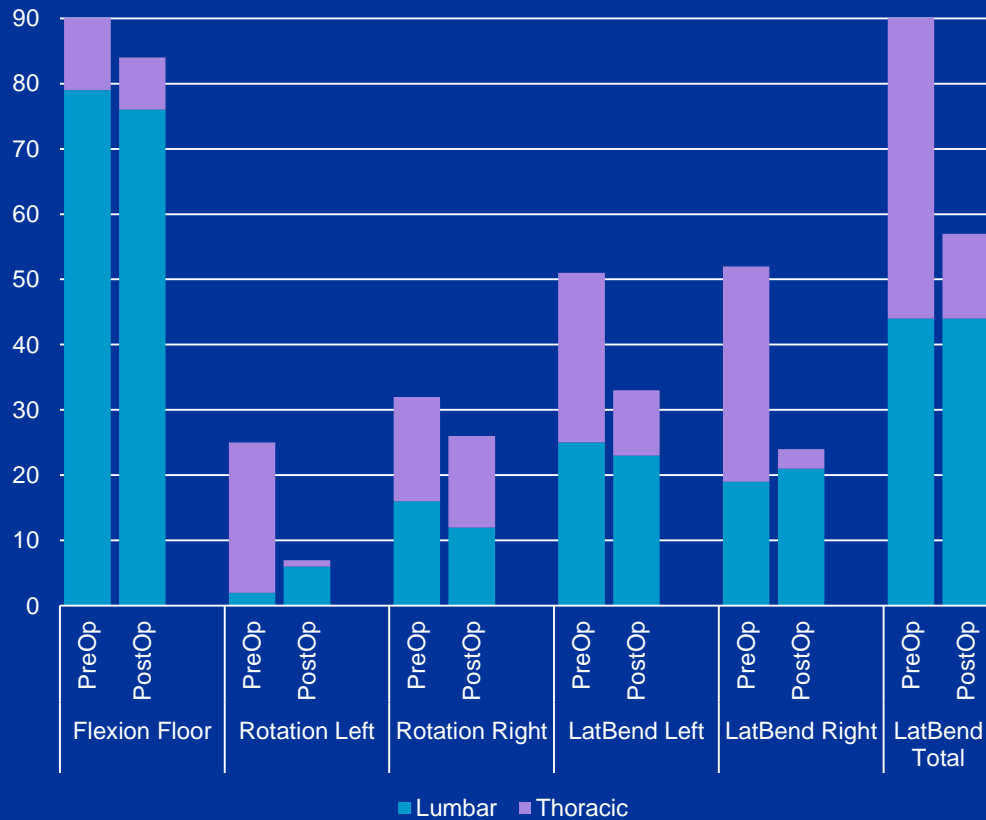
6 months post-op



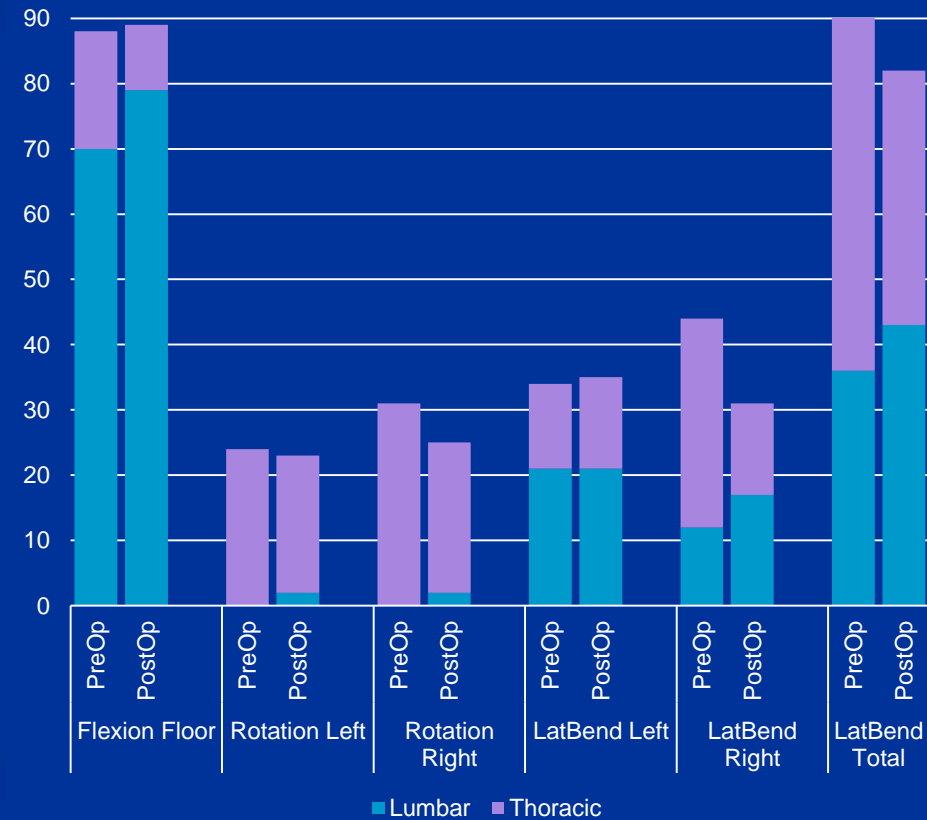
Thoracic Fusion vs. Tether

Trunk Motion Analysis

Pre/post Fusion T2-T11



Pre/post Tethering T5-12



Thoracolumbar Fusion vs. Tether

Preoperative
65 & 75 degrees



6 months post-op



Preoperative
55 & 40 degrees

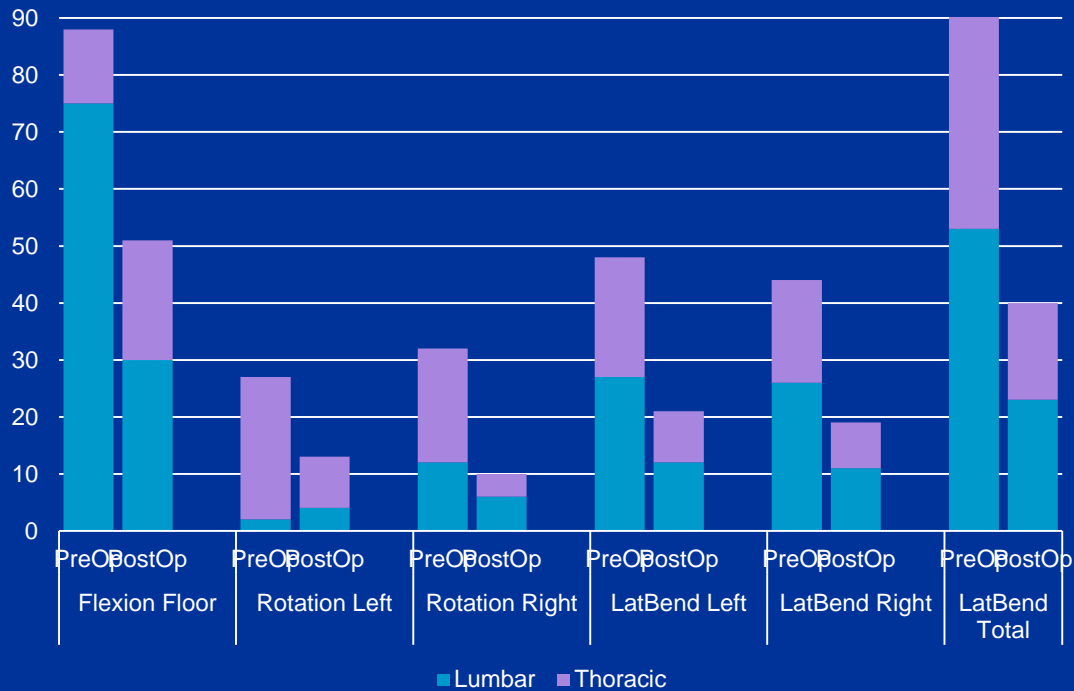


6 months post-op
23 & 23 degrees

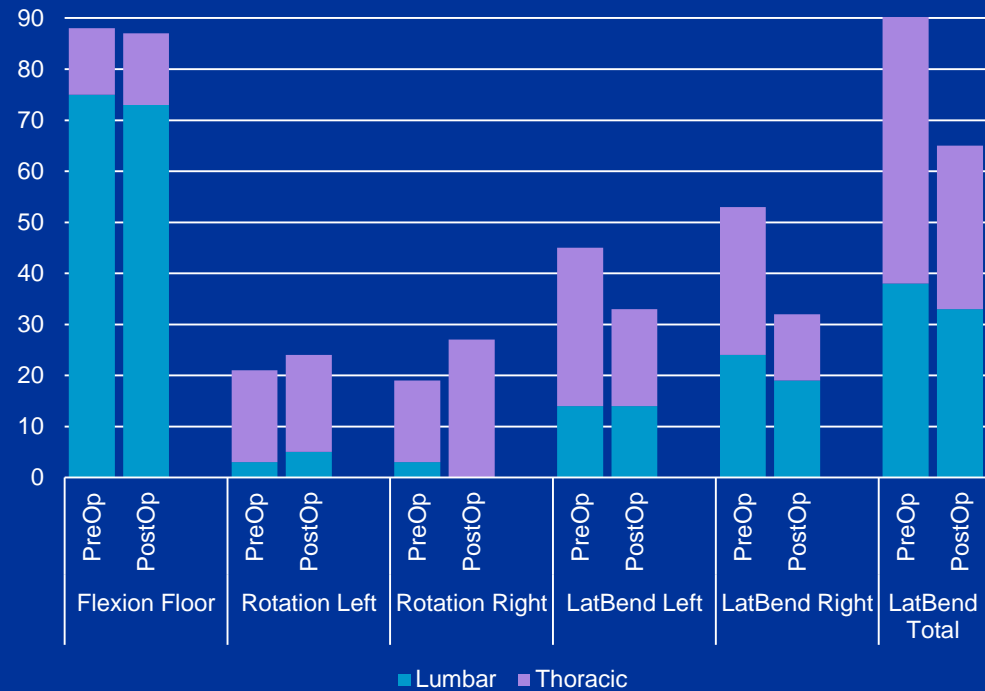


Fusion vs. Tethering Trunk Motion Analysis

Pre/post Fusion T5-L4



Pre/post Tethering T5-L4



Conclusions

- Failures of tethering most commonly occur in mature patients and in those with stiff curves
- Reoperation rate is higher than with fusion, but perhaps not all should be considered failures
- Cord breakage common and will lead to loss of correction if segment has not modulated
- Promising technique with evolving indications