Early Surgery for Early Onset Scoliosis

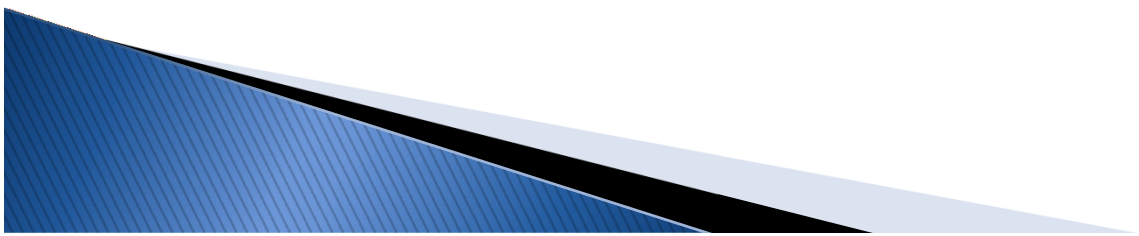
International Congress of Early Onset Scoliosis
San Diego, California
November 2013

Ron El-Hawary, MD, MSc, FRCS(C)
Halifax, Nova Scotia, Canada

Disclosures

- Consultant
  - Depuy-Synthes
  - Medtronic
  - Halifax Biomedical Inc.

- Institutional Research Support
  - Depuy-Synthes
  - Medtronic



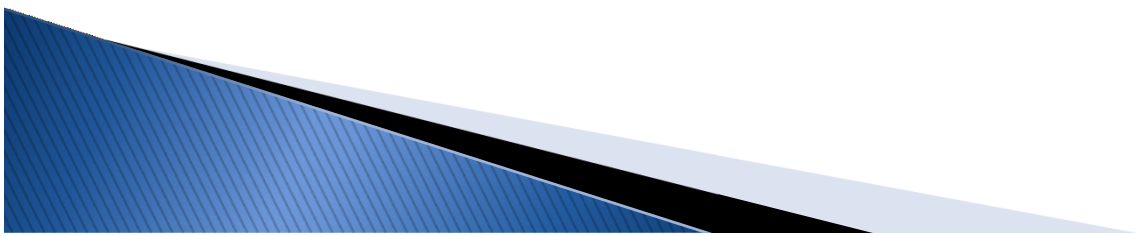
Disclosures – Former Fellow

Overview

- Early Onset Scoliosis – Early Surgery
  - Etiology of Deformity
  - Spine and Pulmonary Growth
  - The Dilemma – Early vs. Late
  - Recent Trend Towards Late Surgery
    - Casting
    - Diminishing Returns
    - Complications

Etiology of Deformity

- The thorax is the 4th dimension of the spine.
- Depending upon whether the primary problem is the **spine** or the **chest wall**, the choice of treatment may differ.

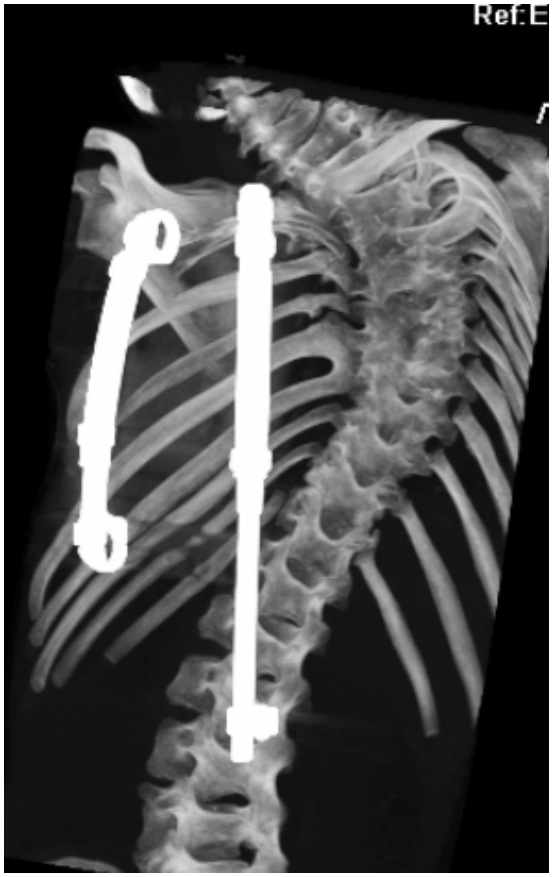


Etiology of Deformity

- Facilitate chest wall growth and potentially improve upon pulmonary development.

Etiology of Deformity

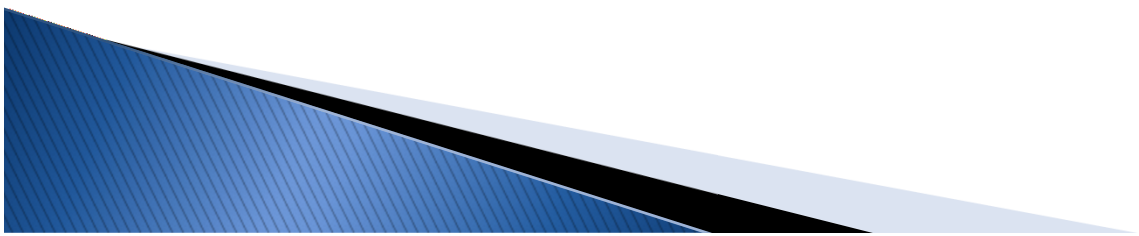
- Efforts to correct/maintain scoliosis may not be successful if rib tethers are not addressed.



Time. Nice try Ron. Charlie – your turn.

Growth

- One of the goals of treatment of EOS is the maintenance of **spine growth**.
- Spine growth is bimodal and has it's first peak from birth to 5 years of age.
- Early growth friendly surgery can capitalize on the first peak of spine height velocity.



Growth

- “Golden" period for thoracic spine and chest growth: Birth to 8 years of age.

- “Growth Modulation” – Justify treatment of thoracic deformities before the age of 5 years in order to preserve pulmonary growth.

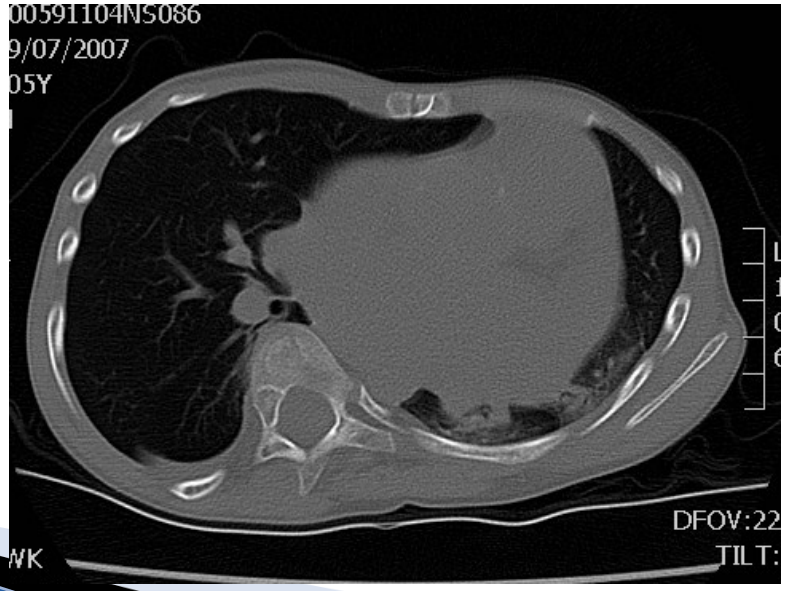
Growth

- Rib fusions (Campbell, 2003)
  - Opening wedge thoracostomy
  - Increase the thoracic volume ("parasol effect")
  - Performed prior to the end of bronchial tree development (8 years of age).
- Muscle Function?
- Compliance?

Growth

- What about the endothoracic hump?

- Will derotation with **early** growth guidance improve thoracic volume **and** diaphragm muscle function?

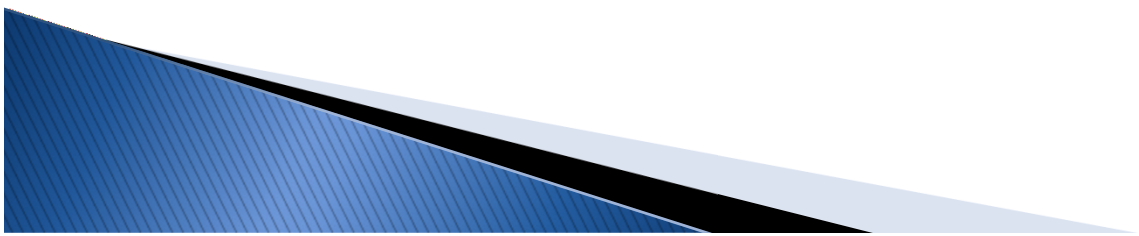


Dilemma

- By **waiting** to intervene, the chest wall deformity may become **too severe** to reverse;
- However, by intervening **too early**, growth friendly treatment may cause **spontaneous fusion**.

Trend Towards Late Surgery

- Casting Resurgence
- Diminishing Returns
- Complications
- “Delay Tactic” / “Window of Opportunity”



Growth as a corrective force in the early treatment of progressive infantile scoliosis

- Prospective study of 136 children with progressive infantile scoliosis
- 94 patients referred & treated early, scoliosis resolved with casting
- 42 patients referred late, casting could reduce but not reverse the deformity

Mehta, JBJS, 87B, 2005

Casting

- Effects on Pulmonary Development?

Courtesy J. d'Astous

Casting

- Effects on Pulmonary Development?

Serial Casting as a Delay Tactic in the Treatment of Moderate-to-Severe Early-onset Scoliosis

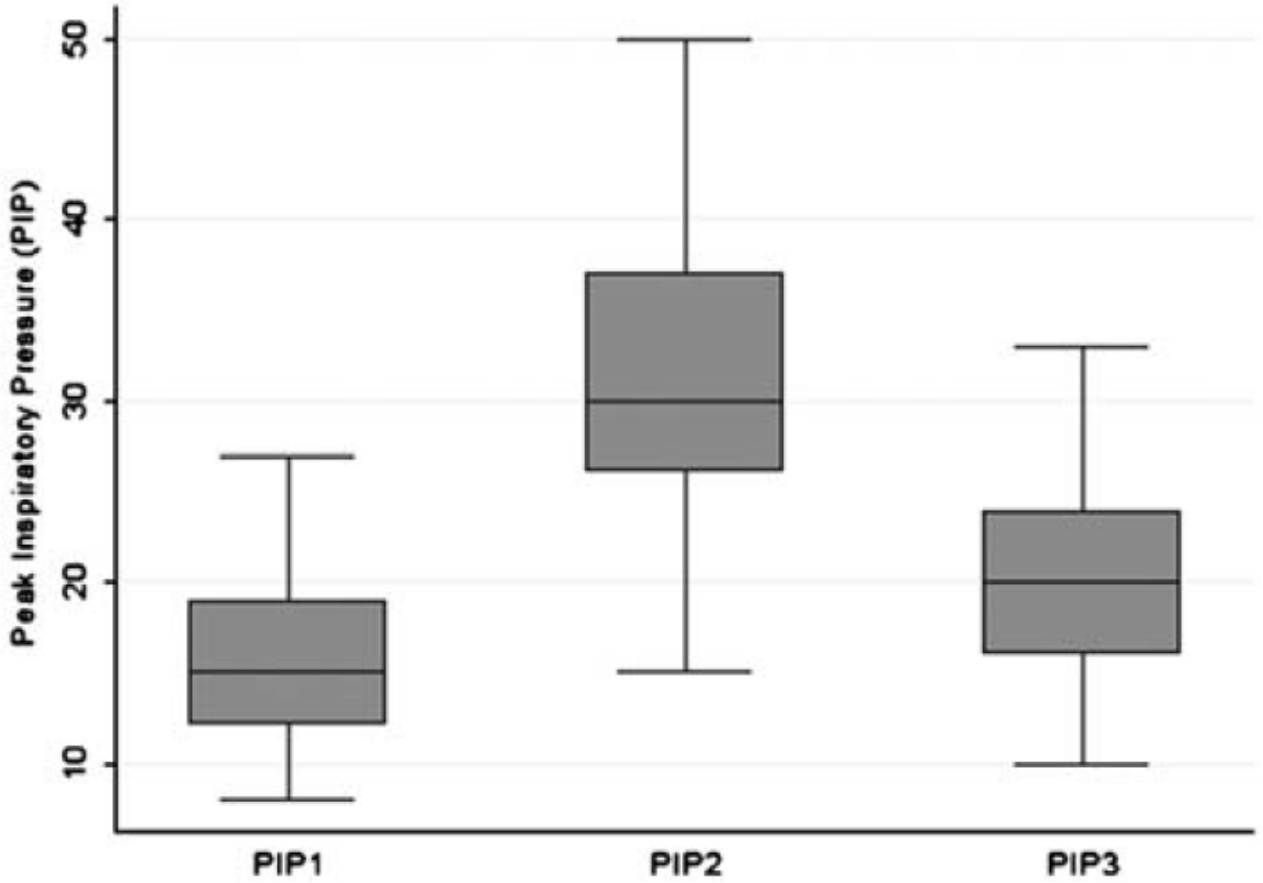
Nicholas D. Fletcher, MD, Anna McClung, BSN, RN,† Karl E. Rathjen, MD,† Jaime R. Denning, MD,‡ Richard Browne, PhD,† and Charles E. Johnston III, MD†*

- Effects on Pulmonary Development?
  - "Finally, the effects of casting on pulmonary function were not measured but certainly present an area for future study."

J Pediatr Orthop • Volume 32, Number 7, October/November 2012

Casting for Infantile Scoliosis: The Pitfall of Increased Peak Inspiratory Pressure

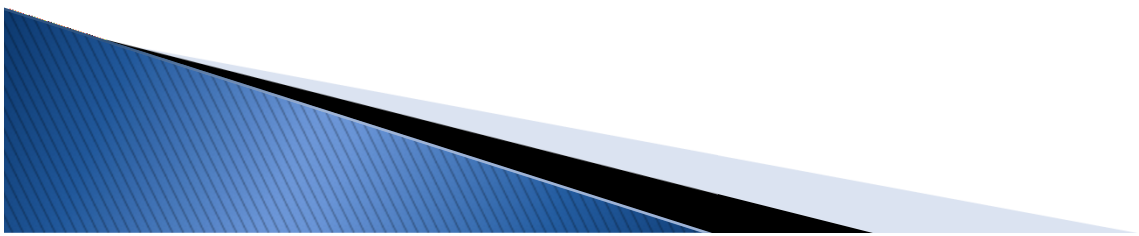
Arjun A. Dhawale, MD, Suken A. Shah, MD,* Samantha Reichard,*
Laurens Holmes Jr, DrPH, PhD,* Robert Brislin, DO,†
Kenneth Rogers, PhD, ATC,* and William G. Mackenzie, MD, FRCSC**



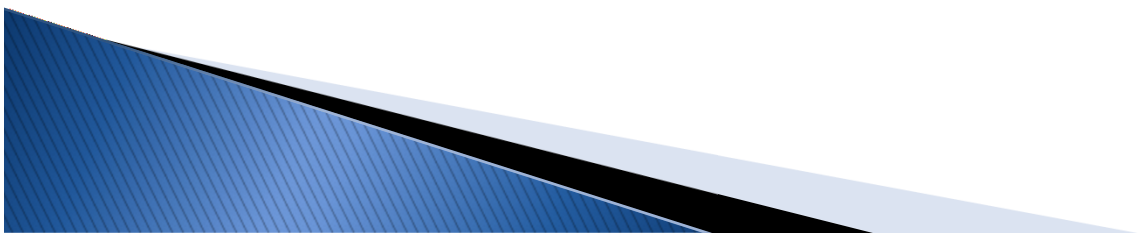
J Pediatr Orthop • Volume 33, Number 1, January/February 2013

Casting

- Effects on Pulmonary Development?
  - Currently unknown.



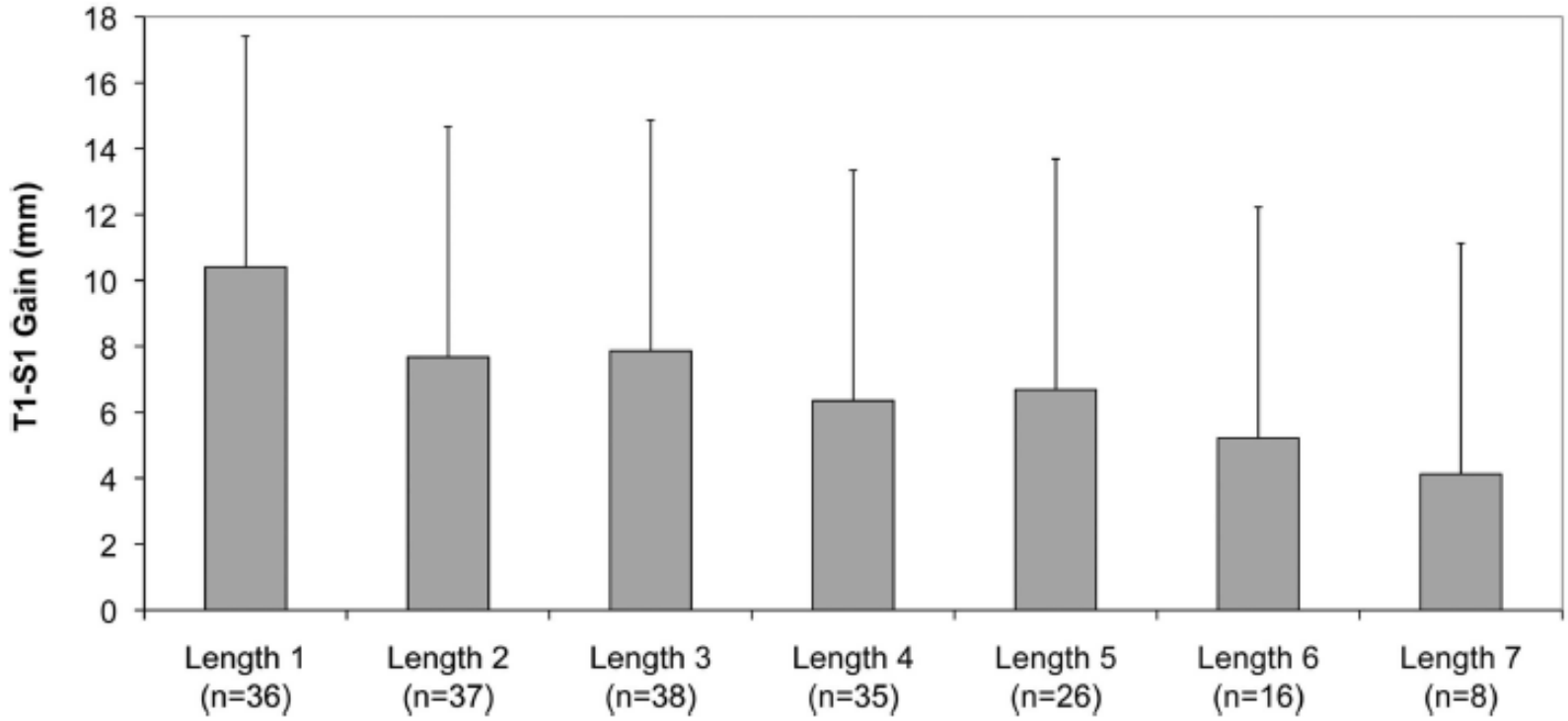
Diminishing Returns



Lengthening of Dual Growing Rods and the Law of Diminishing Returns

Wudbhav N. Sankar, MD, David L. Skaggs, MD, Muharrem Yazici, MD, Charles E. Johnston II, MD, Suken A. Shah, MD, Pooya Javidan, MD, Rishi V. Kadakia, BS, Thomas F. Day, MD, and Behrooz A. Akbarnia, MD

- ICEOS 2009 – Best Paper Award



SPINE Volume 36, Number 10, pp 806–809

Growing-Rod Graduates: Lessons Learned from Ninety-nine Patients Who Completed Lengthening

John M. Flynn, MD, Lauren A. Tomlinson, BS, Jeff Pawelek, BS, George H. Thompson, MD, Richard McCarthy, MD, Behrooz A. Akbarnia, MD, and the Growing Spine Study Group

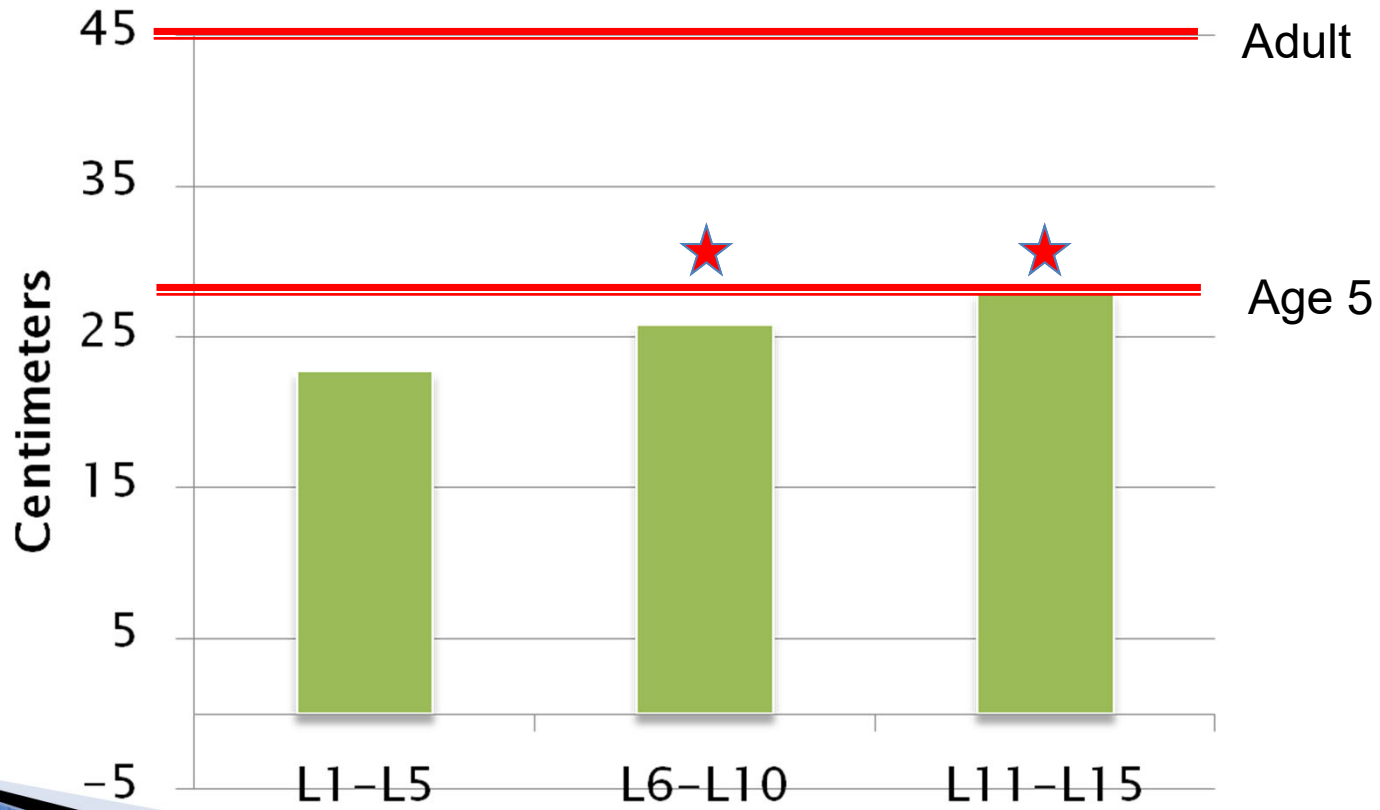
- Of 58 operative reports made at final fusion that contained comments on spinal flexibility:
  - 19% - Mobile
  - 19% - Decreased Flexibility
  - **62% - Completely stiff**
  - 24% - Osteotomies
  - 8% - Thoracoplasty.

J Bone Joint Surg Am. 2013;95:1745-50

The Effect of Rib-Based Distraction Surgery on Spine Growth

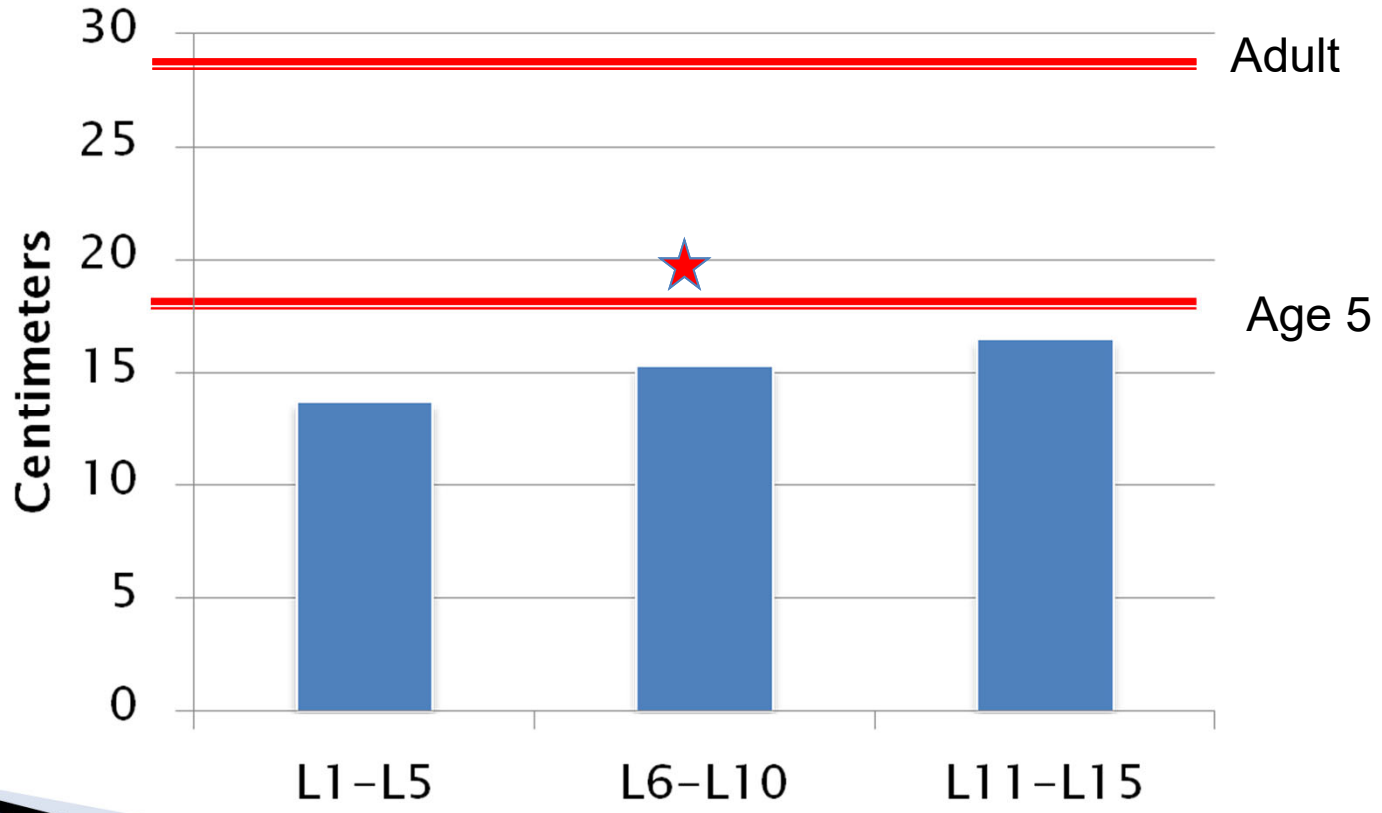
Chest Wall & Spine Deformity Study Group

- ICEOS 2012 – Best Paper Award - Nominee



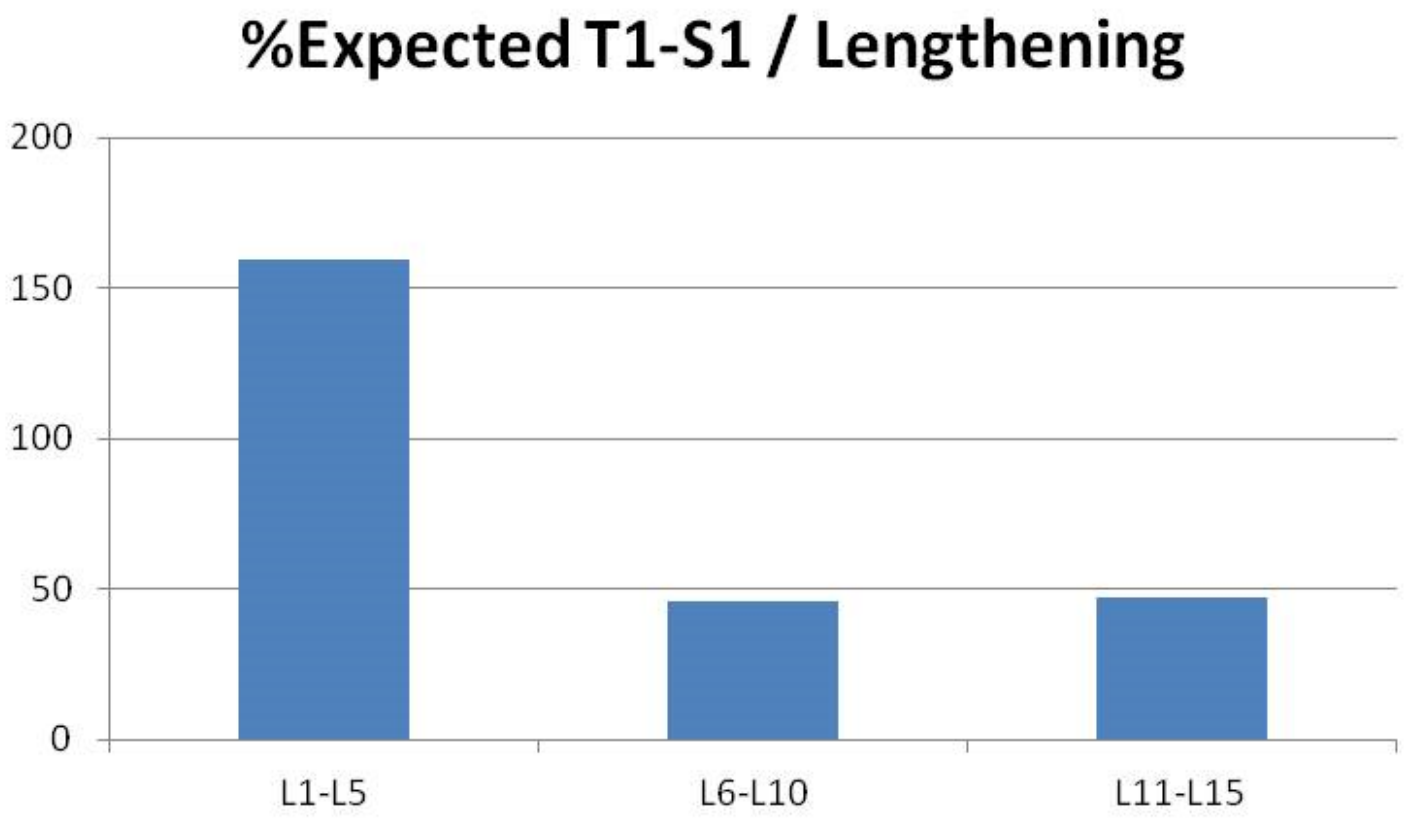
The Effect of Rib-Based Distraction Surgery on Spine Growth

Chest Wall & Spine Deformity Study Group



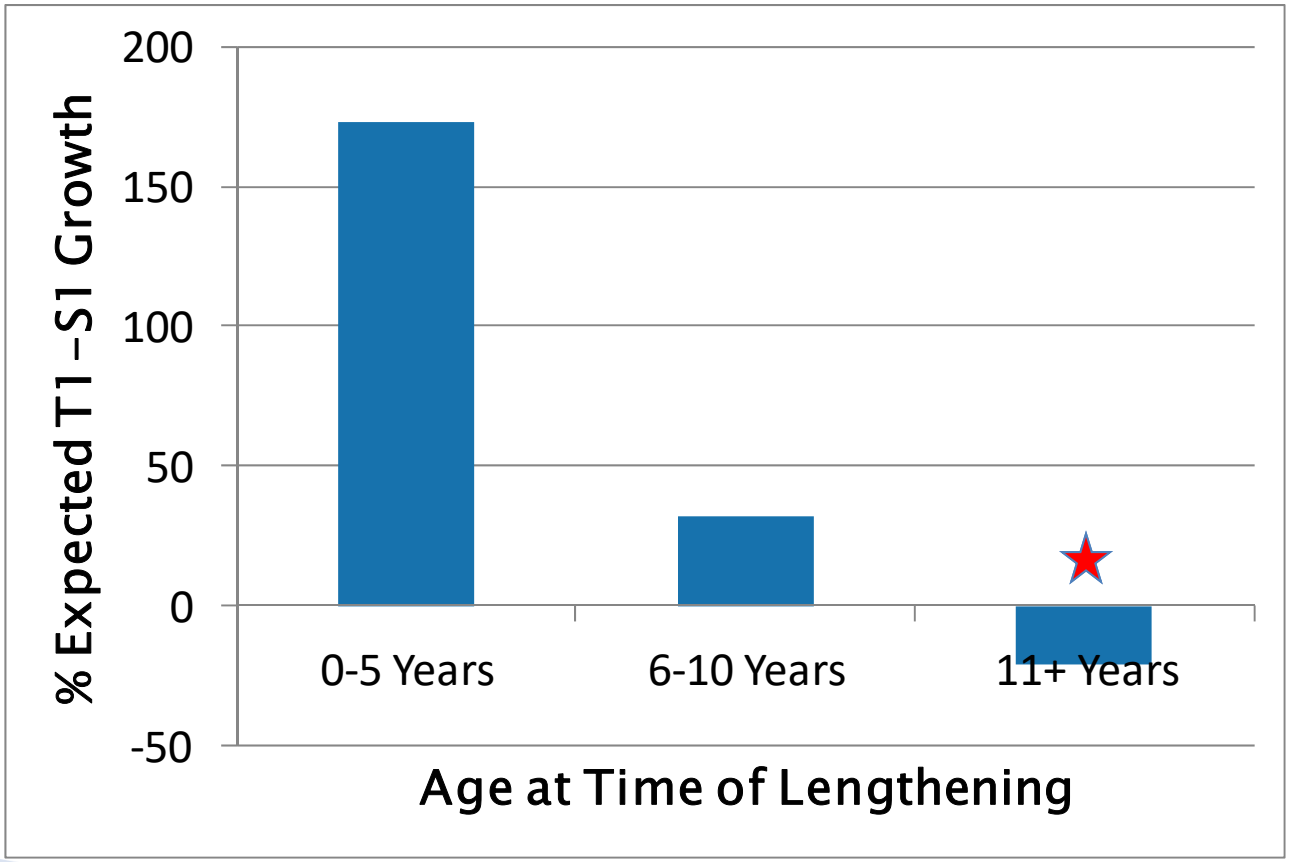
The Effect of Rib-Based Distraction Surgery on Spine Growth

Chest Wall & Spine Deformity Study Group



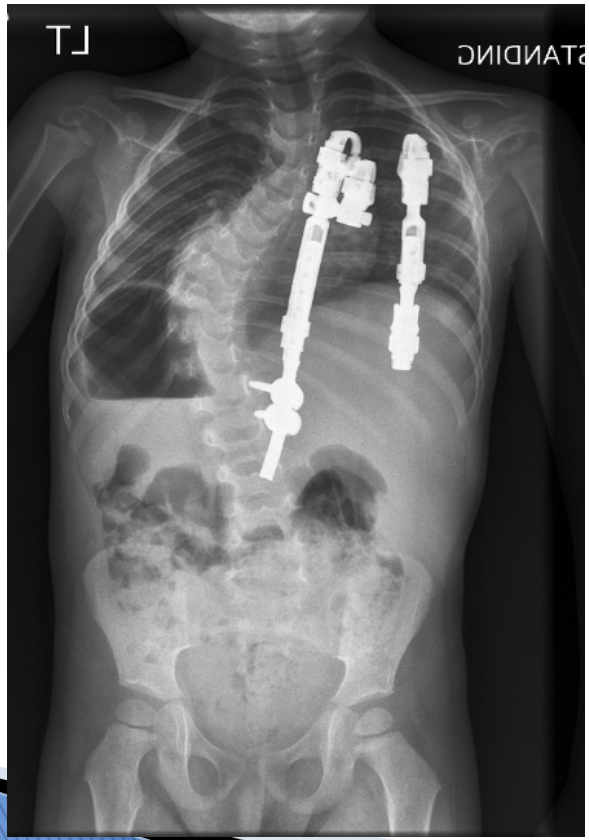
The Effect of Rib-Based Distraction Surgery on Spine Growth

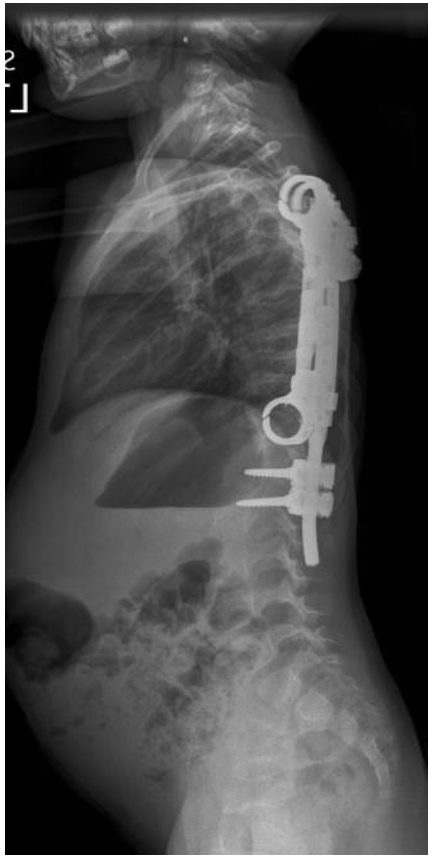
Chest Wall & Spine Deformity Study Group



Alternative Explanation

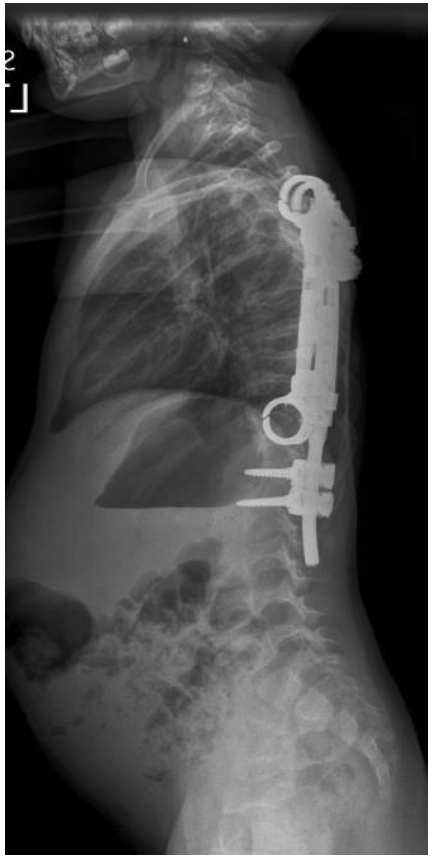
- Growth only measured on PA radiograph





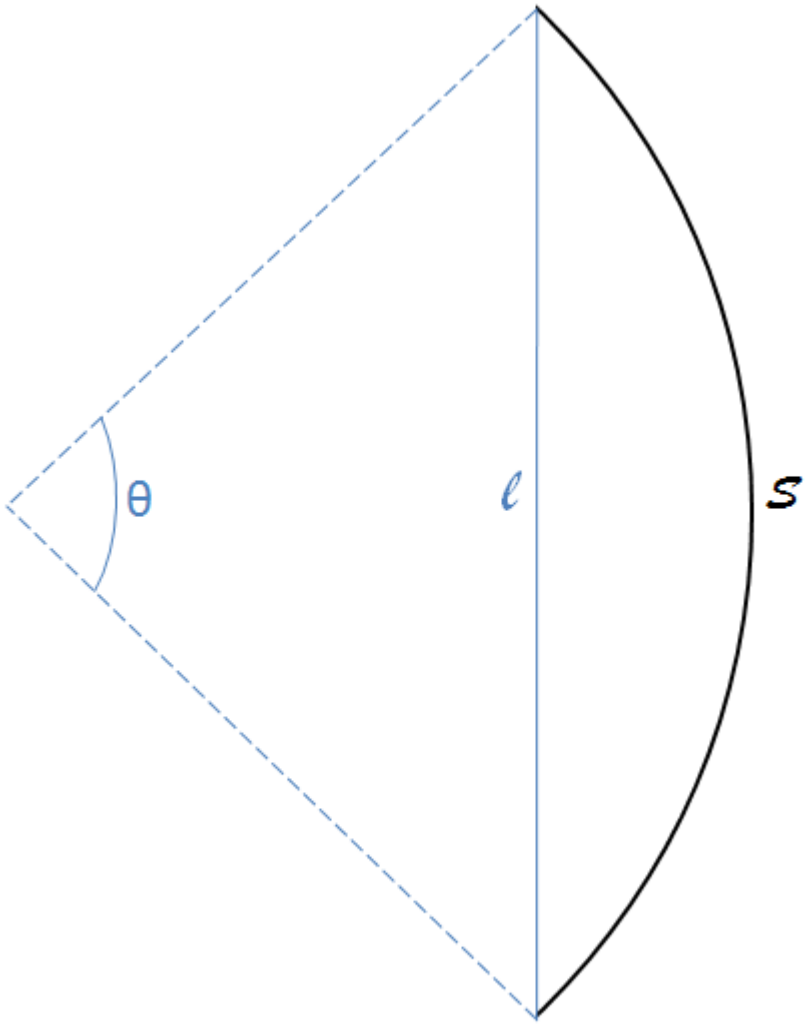
Alternative Explanation

- Growth only measured on PA radiograph
  - Kyphosis
    - 40 degrees pre-op
    - 65 degrees at L15
  - T1 moves anterior
  - Relatively lower T1-T12



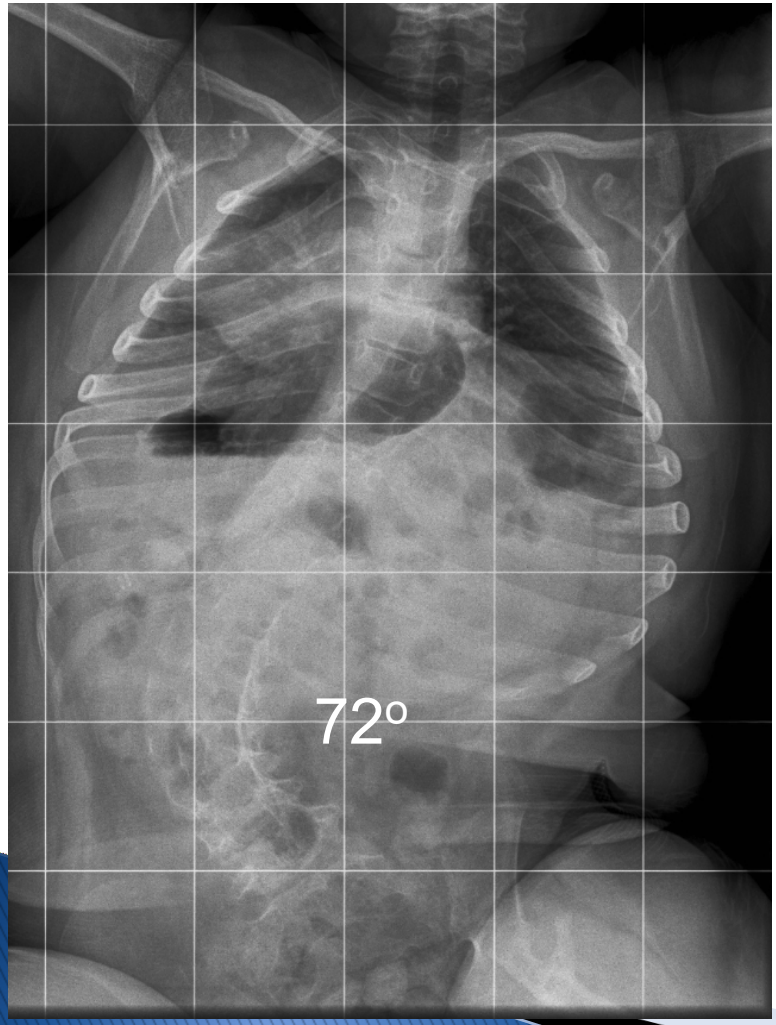
Alternative Explanation

Where: s is the Arc Length
ℓ is the Chord Length
θ is the Kyphosis Angle

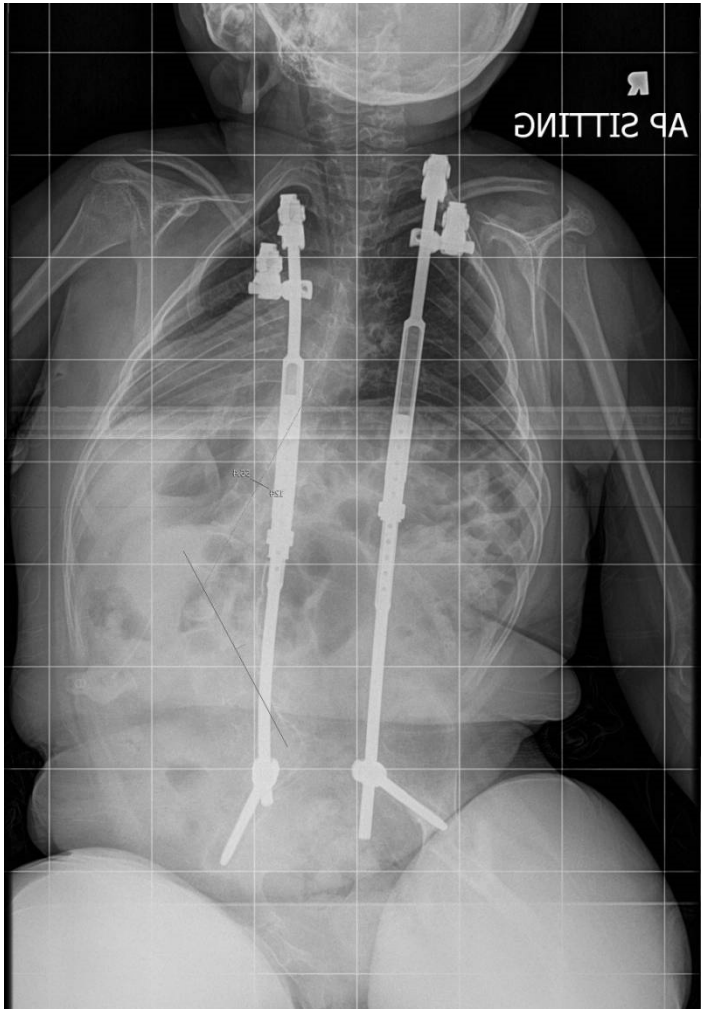


GMFCS 5

Nov 2010

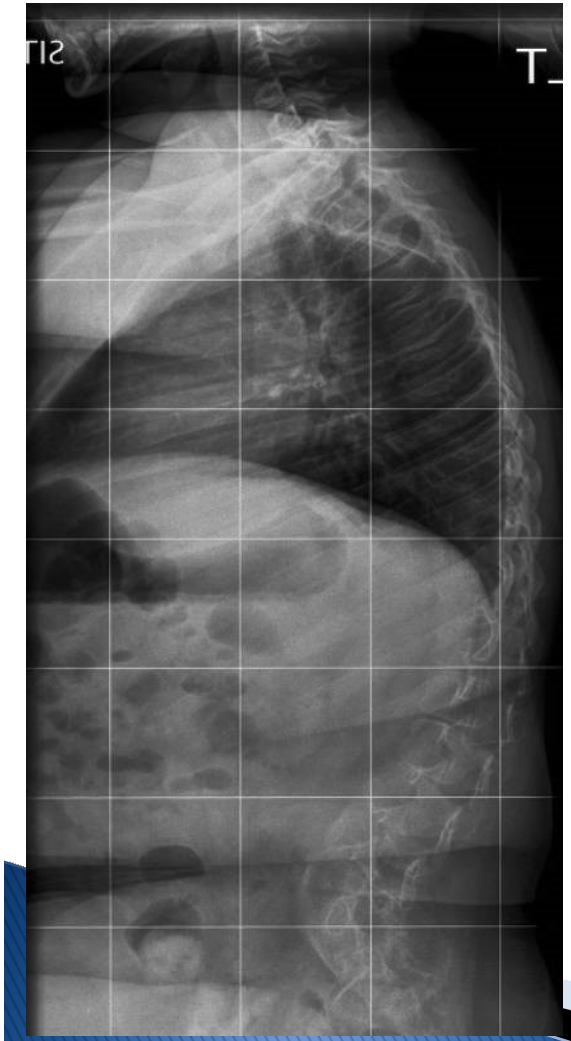


June 2013

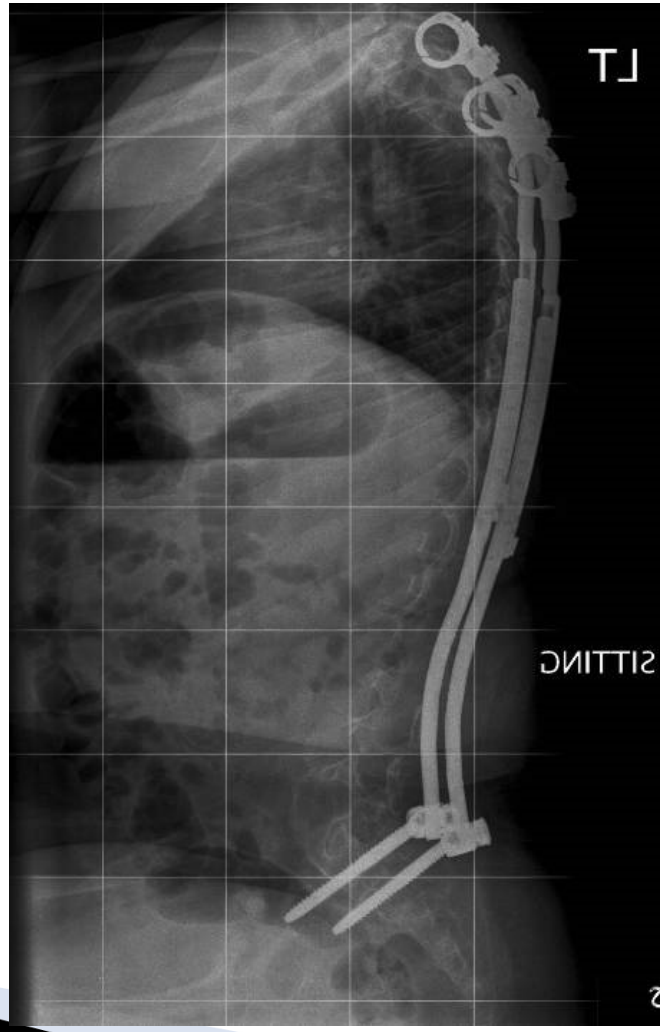


GMFCS 5

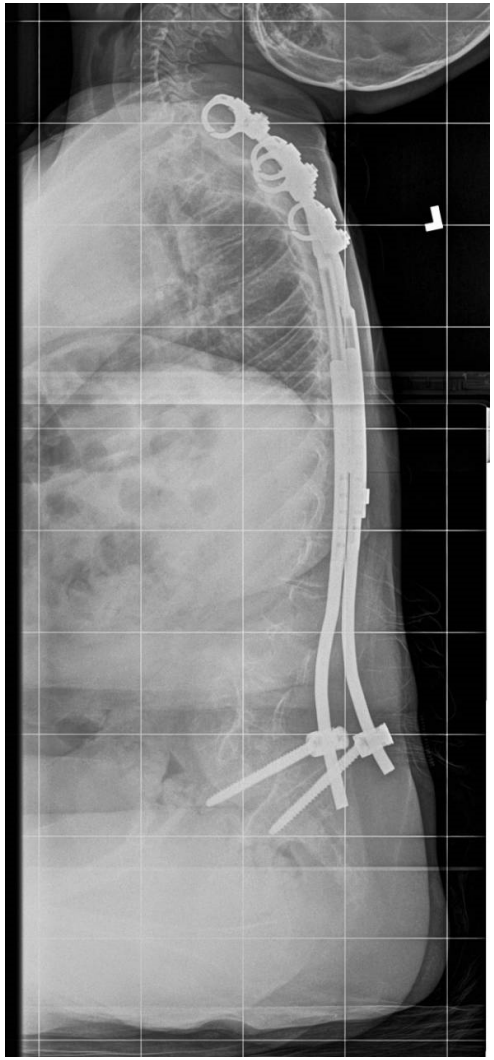
Nov 2010



Dec 2010

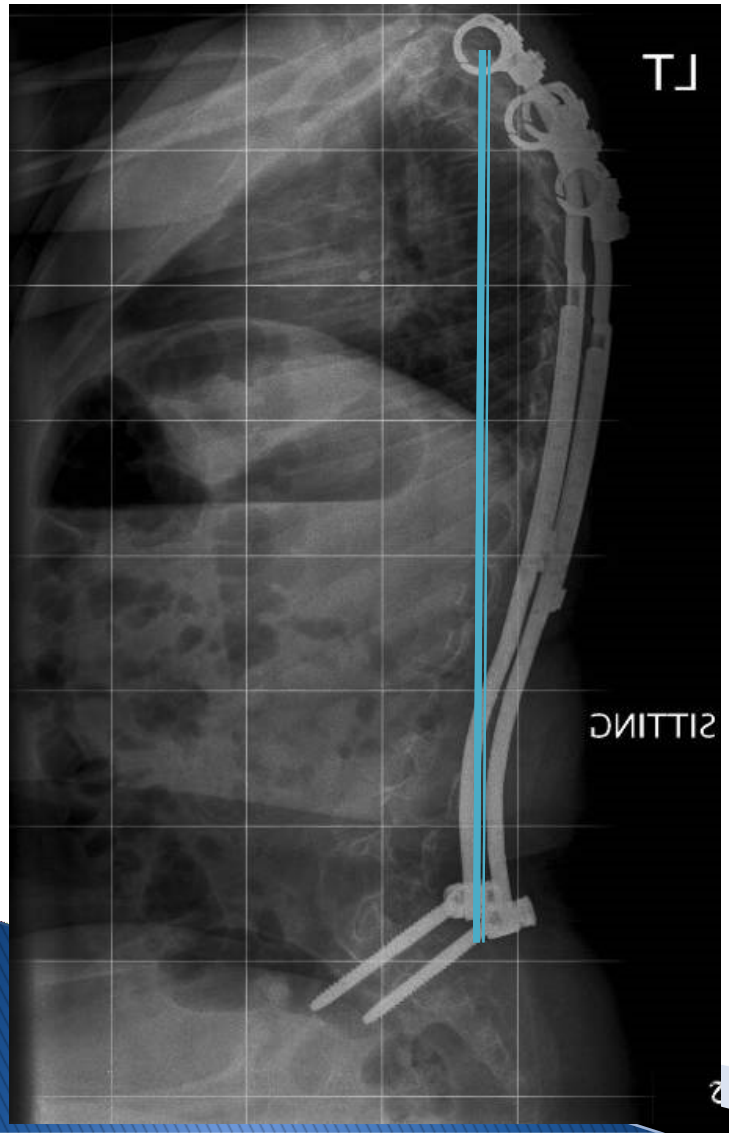


June 2013

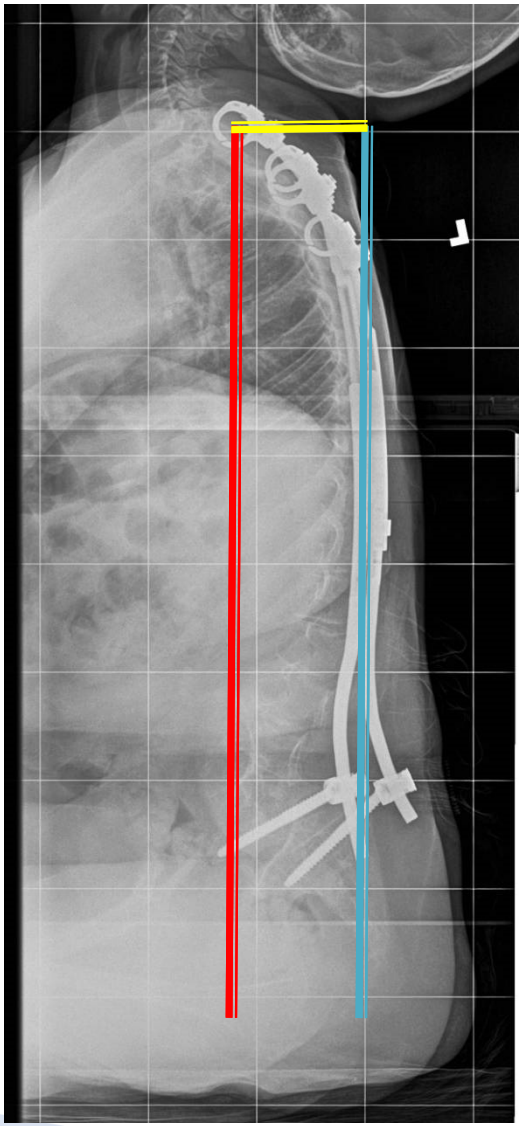


Alternative Explanation

Dec 2010

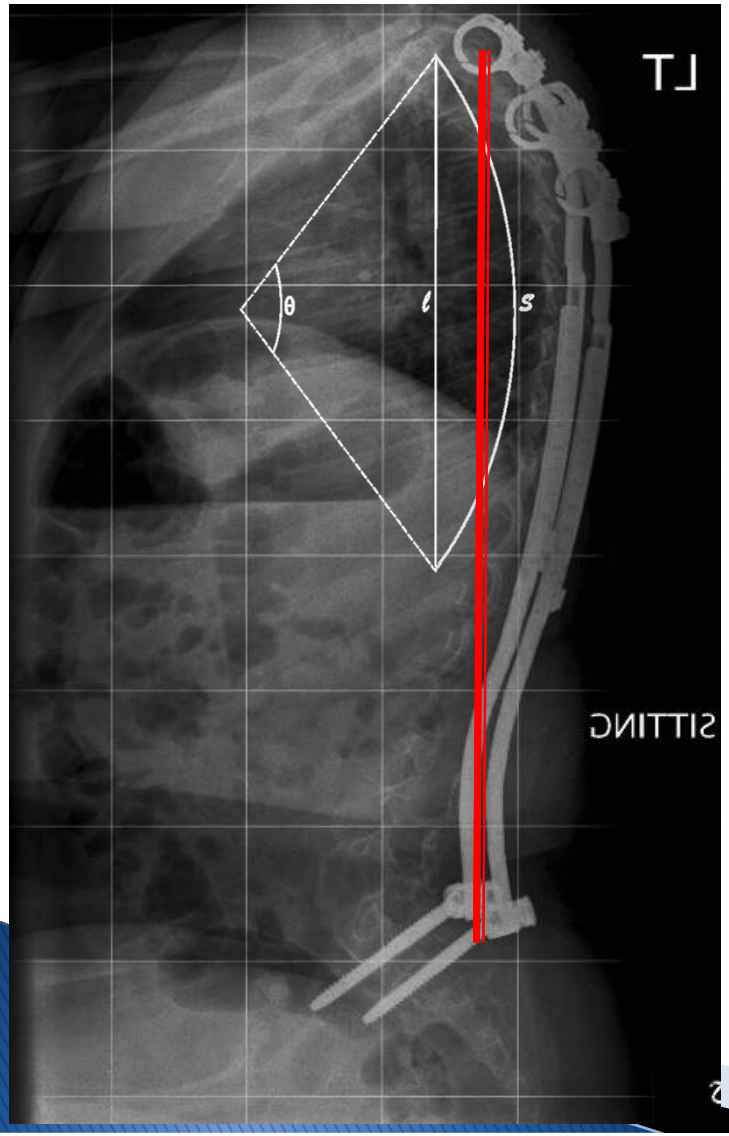


June 2013

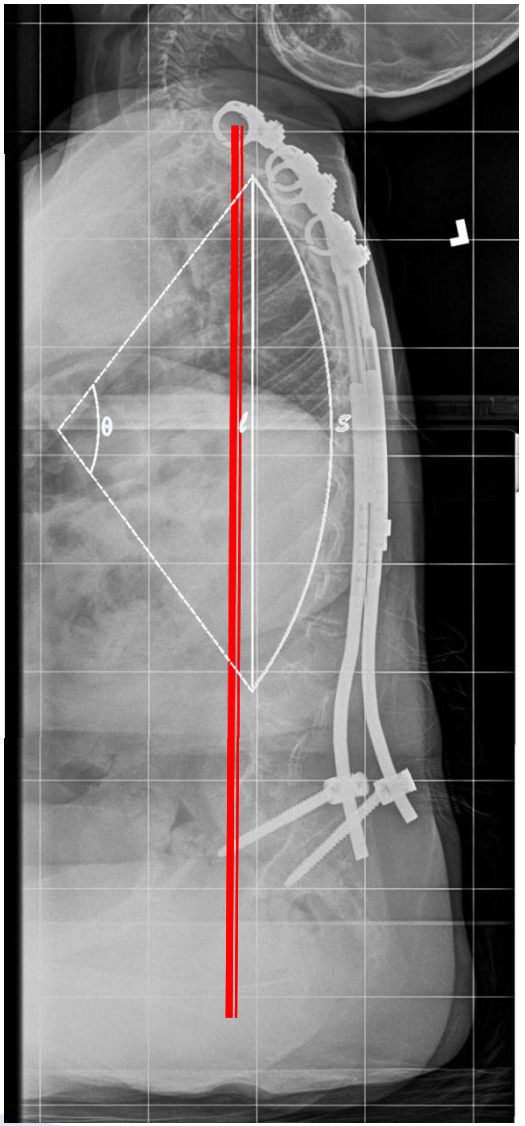


Alternative Explanation

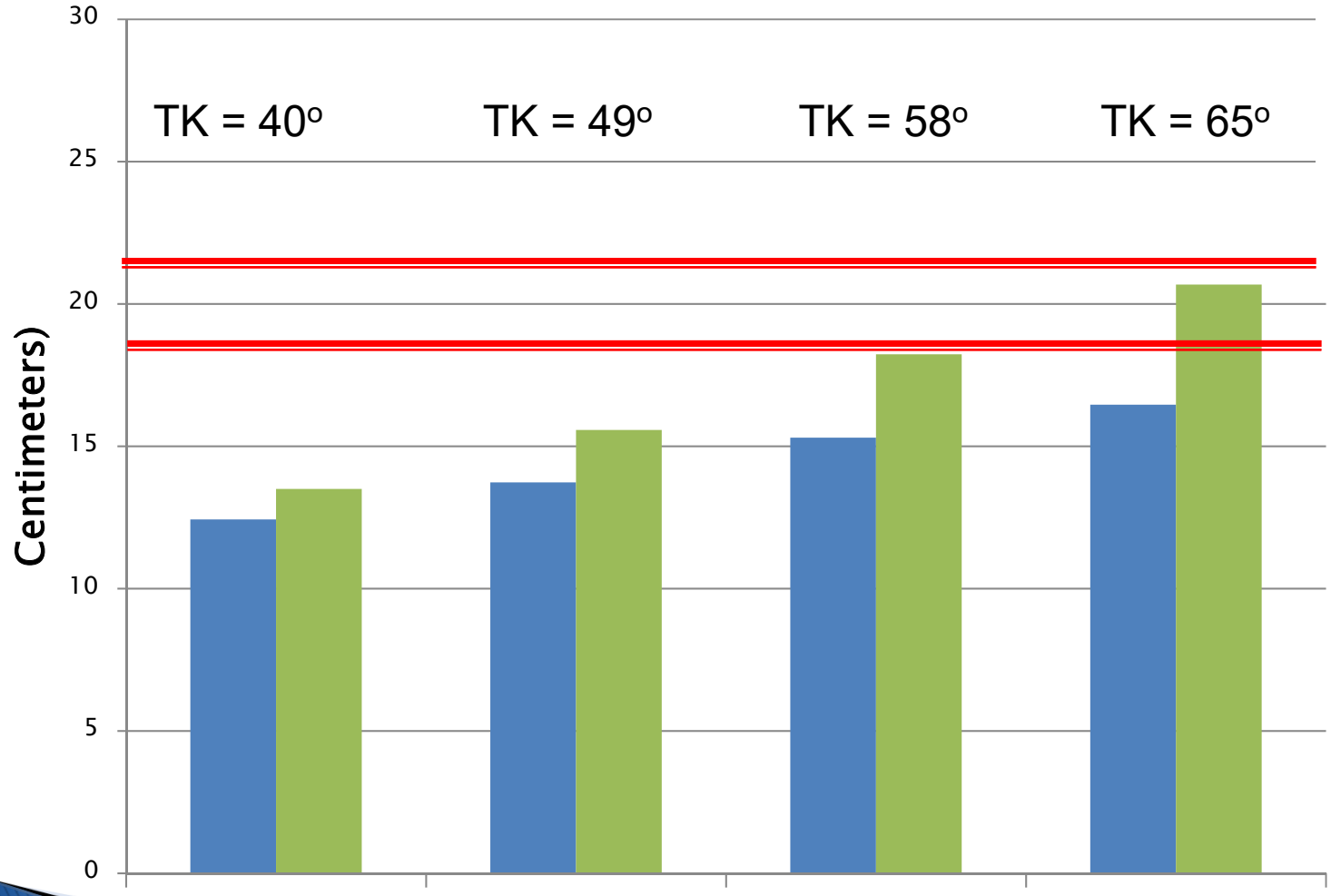
Dec 2010

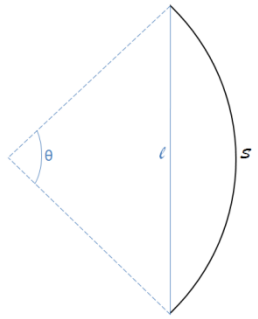


June 2013



Thoracic Height





Thoracic Height vs. Arc Length

Coronal T1-T12 Height

- Might be under-calling “true” spinal height

Arc Length

- Increases in spine length along the arc of kyphosis should still represent increases in 3D thoracic volume.

Complications

Complications of Growing-Rod Treatment for Early-Onset Scoliosis

Analysis of One Hundred and Forty Patients

By Shay Bess, MD, Behrooz A. Akbarnia, MD, George H. Thompson, MD, Paul D. Sponseller, MD, Suken A. Shah, MD, Hazem El Sebaie, FRCS, MD, Oheneba Boachie-Adjei, MD, Lawrence I. Karlin, MD, Sarah Canale, BS, Connie Poe-Kochert, RN, CNP, and David L. Skaggs, MD

- 140 Growing Rod Patients
- **58% Complication Rate**
- Rate decreased by 13% per each year of patient age at time of initial implant
- Rate increased by 24% per additional surgical procedure

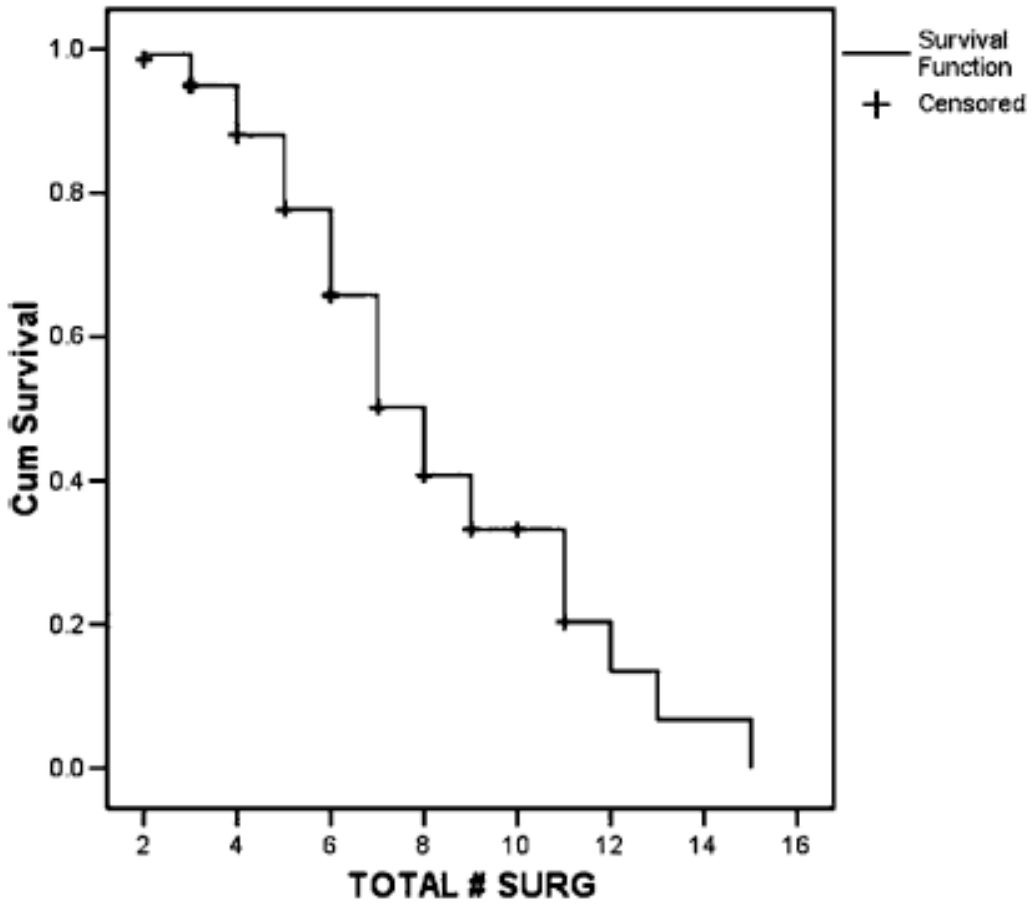
J Bone Joint Surg Am. 2010;92:2533-43

Complications of Growing-Rod Treatment for Early-Onset Scoliosis

Analysis of One Hundred and Forty Patients

By Shay Bess, MD, Behrooz A. Akbarnia, MD, George H. Thompson, MD, Paul D. Sponseller, MD, Suken A. Shah, MD, Hazem El Sebaie, FRCS, MD, Oheneba Boachie-Adjei, MD, Lawrence I. Karlin, MD, Sarah Canale, BS, Connie Poe-Kochert, RN, CNP, and David L. Skaggs, MD

Kaplan-Meier Analysis of Total Complications



J Bone Joint Surg Am. 2010;92:2533-43

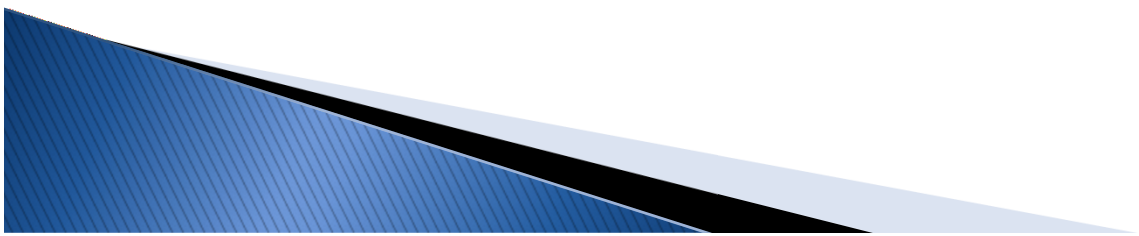
Complications

- Classification
  - Severity Grade I – Not require unplanned surgery
  - Severity Grade II – Requires unplanned surgery(ies)
  - Severity Grade III – Alters planned course

- 65 patients from 5 institutions
  - **Only 9% were Grade III**

Smith, Johnston, Skaggs, Flynn, Vitale, ICEOS 2012

HRQOL



HRQOL

- (EOSQ-24) – **Improvements** in multiple domains of health-related quality of life after **growth friendly surgery** in 68 patients with an average age of 6.2 years (range 0 -11 years).

- Nutritional status has also been observed to improve after insertion of growth friendly implants.
  - Especially true for those children who had failed to thrive (<5th percentile body weight).

Matsumoto, IMAST 2012

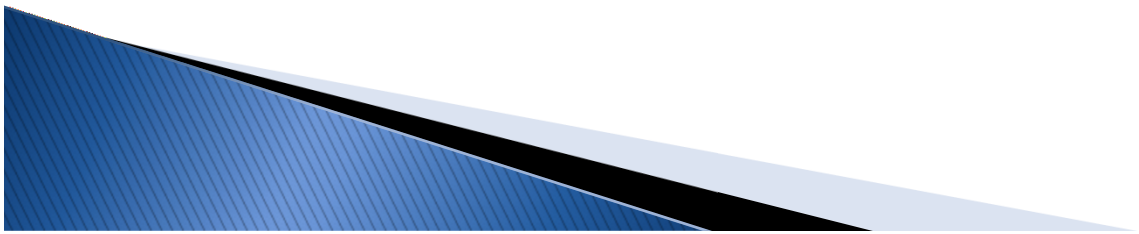
HRQOL

- 69 patients treated with casting from CSSG and GSSG – EOSQ-24
- “HRQOL decreases and burden of care increases after undergoing casting.”
- This may just be a short term effect.
- More study is needed.

Matsumoto, ICEOS 2013

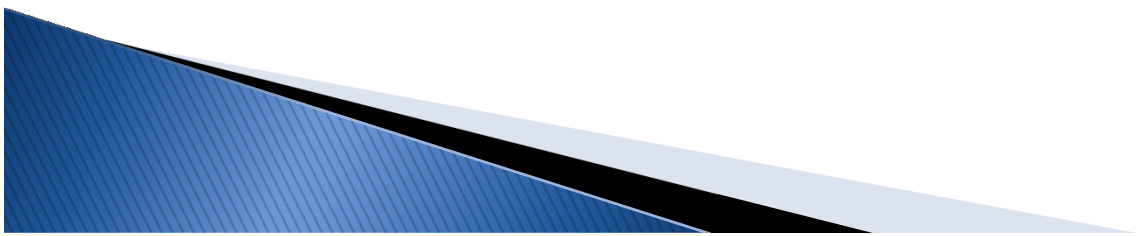
Summary

- Casting as a “delay tactic”
  - Pulmonary effects of casting
    - Not known
  - Diminishing Returns
    - May not hold true for Rib-based systems
    - Alternative explanation – sagittal plane
  - Complications
    - 58% complication rate vs. 9% SV III



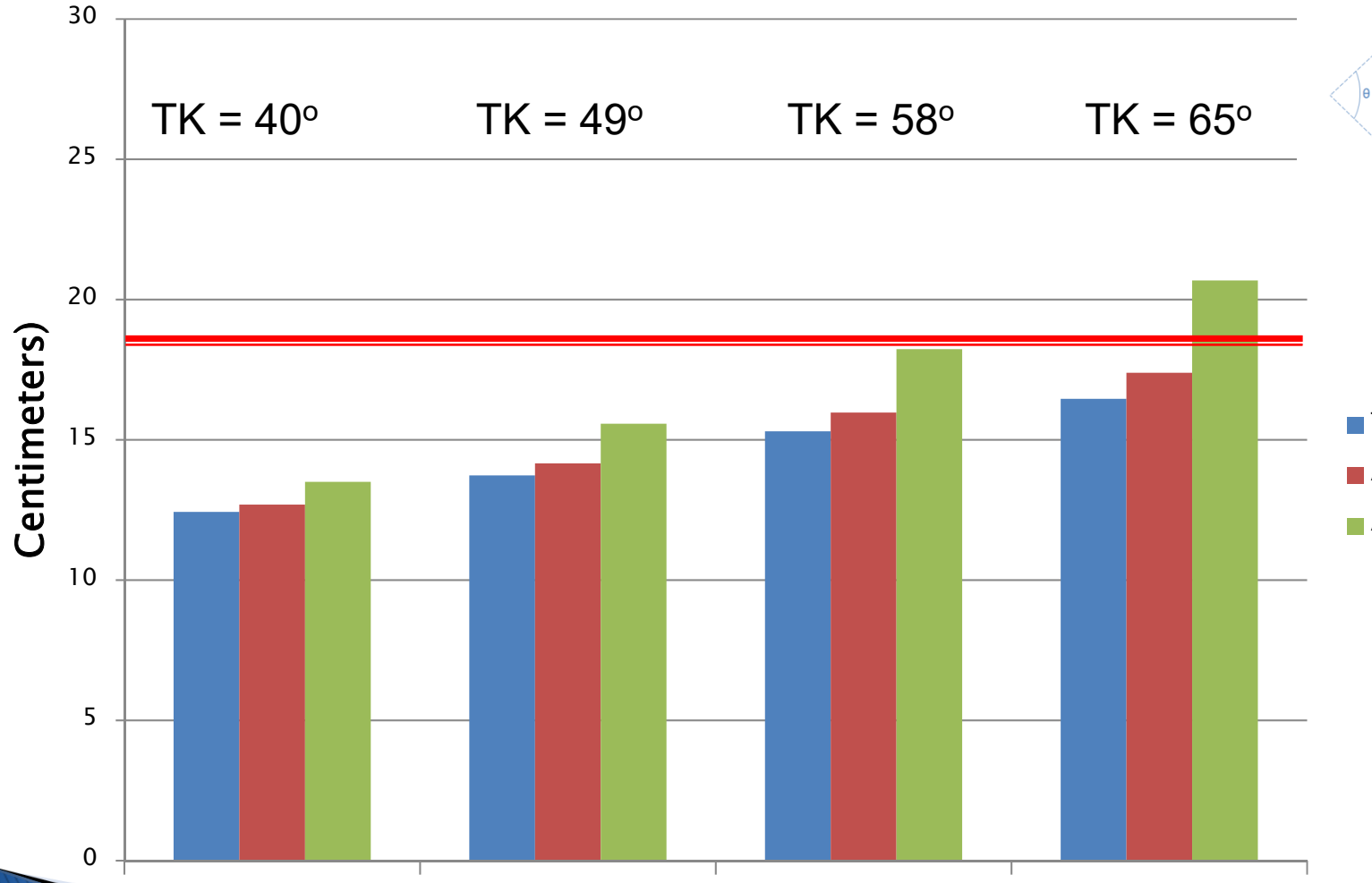
Summary

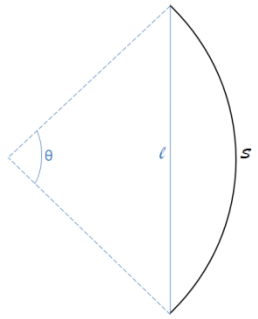
- Early surgery
  - Maintain spine growth
    - Bimodal. 0-5 years of age
  - Golden period
    - Pulmonary development 0-8 years of age
  - Growth modulation
    - May justify surgical treatment 0-5 years of age



Thank You

Thoracic Height





Thoracic Height vs. Arc Length

Coronal T1–T12 Height

- Initial = 12.4 cm
- L15 = 16.5 cm
- Delta = 4.1 cm
- **Percent = 33%**

Arc Length (C)

- Initial = 12.7 cm
- L15 = 17.4 cm
- Delta = 4.7 cm
- **Percent = 37%**

Thoracic Height vs. Arc Length

Coronal T1–T12 Height

- Initial = 12.4 cm
- L15 = 16.5 cm
- Delta = 4.1 cm
- **Percent = 33%**

Arc Length (H)

- Initial = 13.5 cm
- L15 = 20.6 cm
- Delta = 7.1 cm
- **Percent = 53%**

The Shilla Growth Guidance Technique for Early-Onset Spinal Deformities at 2-Year Follow-Up: A Preliminary Report

Richard E. McCarthy, MD, Scott Luhmann, MD,† Lawrence Lenke, MD,† and Frances L. McCullough, RNP, MNSc‡*

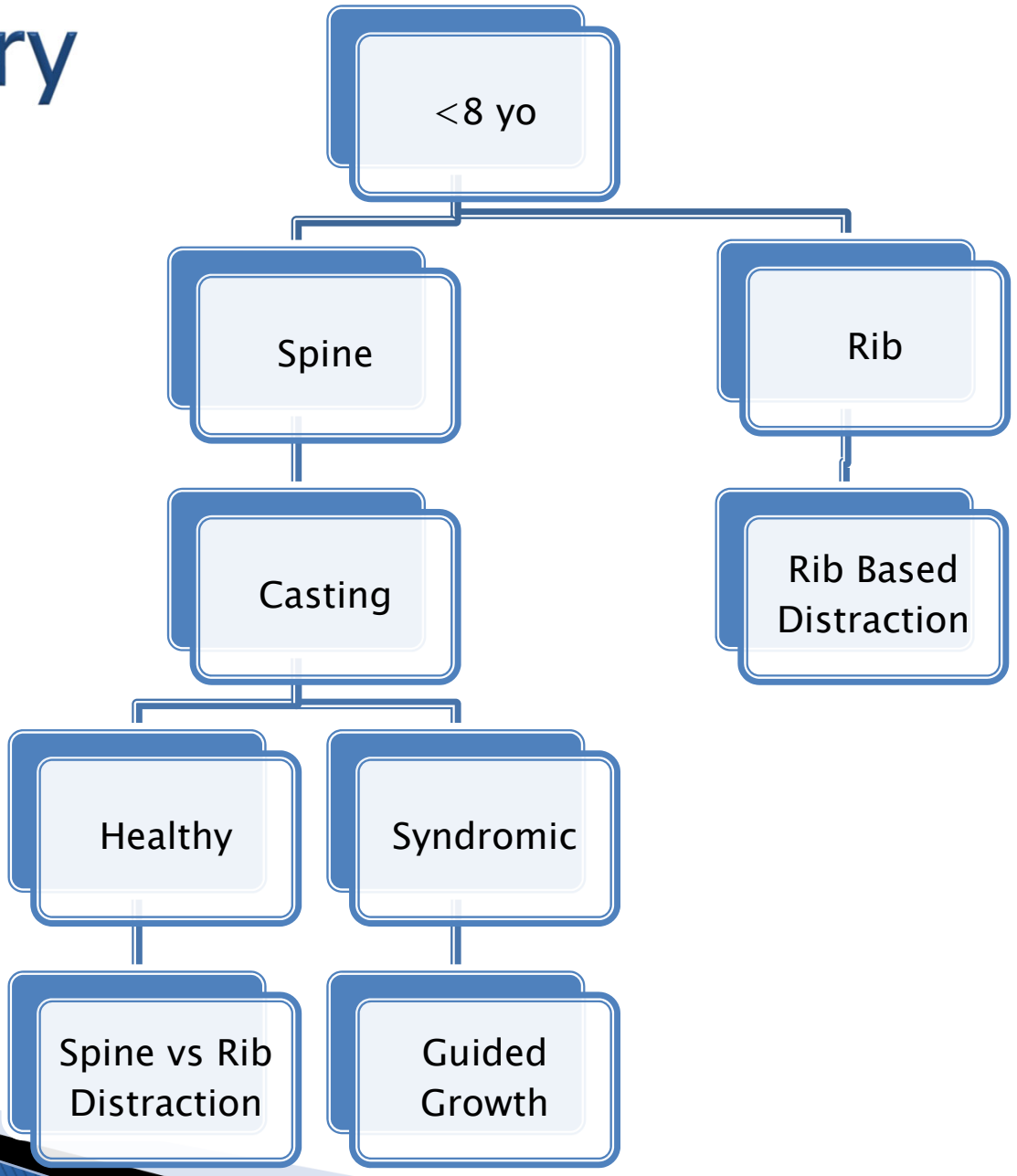
- 10 patients with a mean age of 7+6 years
- 2-Year Follow-up
- Pre-op 70 degrees was corrected to 27 deg.
- Space available for lung improved 13%.
- Truncal height (C7 to S1) increased 12%.

The Shilla Growth Guidance Technique for Early-Onset Spinal Deformities at 2-Year Follow-Up: A Preliminary Report

Richard E. McCarthy, MD, Scott Luhmann, MD,† Lawrence Lenke, MD,† and Frances L. McCullough, RNP, MNSc‡*

- These patients would have had 49 scheduled lengthening procedures after their initial correction if treated by conventional distraction growing rod methods.

Summary


<8 yo
Spine
Rib
Casting
Rib Based Distraction
Healthy
Syndromic
Spine vs Rib Distraction
Guided Growth

Serial Casting as a Delay Tactic in the Treatment of Moderate-to-Severe Early-onset Scoliosis

Nicholas D. Fletcher, MD, Anna McClung, BSN, RN,† Karl E. Rathjen, MD,† Jaime R. Denning, MD,‡ Richard Browne, PhD,† and Charles E. Johnston III, MD†*

- Retrospective review of 29 patients
  - 12 Idiopathic
  - 17 Non-Idiopathic
- Average age first cast = 4.4 years
- 3 Casts over 1.4 years

J Pediatr Orthop 2012;32:664–671

Serial Casting as a Delay Tactic in the Treatment of Moderate-to-Severe Early-onset Scoliosis

Nicholas D. Fletcher, MD, Anna McClung, BSN, RN,† Karl E. Rathjen, MD,† Jaime R. Denning, MD,‡ Richard Browne, PhD,† and Charles E. Johnston III, MD†*

- Cobb Angle
  - Initial 69°
  - In Cast 39°
  - Post Cast 61°
  - Final (5.5 yr) 76°
- T1–T12 1.1 cm

J Pediatr Orthop 2012;32:664–671

Serial Casting as a Delay Tactic in the Treatment of Moderate-to-Severe Early-onset Scoliosis

Nicholas D. Fletcher, MD, Anna McClung, BSN, RN,† Karl E. Rathjen, MD,†*
Jaime R. Denning, MD,‡ Richard Browne, PhD,† and Charles E. Johnston III, MD†

Although a cure cannot be expected, an average of 39 months of delay was achieved in this patient cohort and 72.4% have avoided growing spine surgery.

J Pediatr Orthop 2012;32:664–671

Alternative Explanation

- Implant Design – Radius of curvature
  - T1 moves anterior
  - Relatively lower T1-S1

HRQOL

- Our findings suggest that EOS patients with abnormal psychosocial scores were **younger** at the time of their initial scoliosis surgery.
- The **number of repetitive surgeries** also correlated positively with 3 behavioral problem scores.
- …there is a clear need for further investigation of this issue by prospective, multicenter efforts.

Matsumoto, JPO 2013

The Effect of Rib-Based Distraction Surgery on Spine Growth

Chest Wall & Spine Deformity Study Group

- Normalized to age, change in T1-S1/Lengthening
  - L1-L5 159% Expected Growth
  - L5-L10 46% Expected Growth
  - L11-L15 47% Expected Growth

Growth

- Makes sense to preserve growth and allow for pulmonary development.