Distraction-Based Treatment Maintains Predicted Thoracic Dimensions in Early Onset Scoliosis

2013 ICEOS Podium Presentation

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Disclosures

- **Michael P Glotzbecker, MD:**
  5 (Synthes, Via Chest wall and Spinal Deformity Study Group);
- **Meryl Gold, BA:** none
- **Patricia Miller, MS:** none
- **Behrooz A Akbarnia, MD:**
  1 (DePuy Spine Nuvasive);3B (Nuvasive, K2M, Ellipse, K Spine;);4 (Nuvasive, Ellipse, K Spine, Nocimed);5 (DePuy Spine, Nuvasive,);
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- **Francisco Sanchez Perez Grueso, MD:** none
- **Suken A Shah, MD:**
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- **John Emans, MD:**
  1 (Synthes);3B (Medtronic Sofamor Danek; Synthes);3C (Medtronic Sofamor Danek; Synthes);

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Background

- **EOS treatment goals include:**
  - Maximum spine length
  - Maximum thoracic function/dimensions
- **EOS patients:**
  - Include multiple etiologies
    - Congenital (C)
    - Neuromuscular (N)
    - Syndromic (S)
    - Idiopathic (I)
  - May have abnormal growth rates

Problem

- **How to measure anatomic success/failure of EOS treatment when:**
  - Baseline measurements abnormal
  - Growth rate may be abnormal

- **Standard spine and thoracic dimensions**
  - *Based on normals*

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Prediction of Thoracic Dimensions and Spine Length Based on Individual Pelvic Dimensions in Children and Adolescents

An Age-Independent, Individualized Standard for Evaluation of Outcome in Early Onset Spinal Deformity

John B. Emans, MD,* Michelle Ciarlo, BS,* Michael Callahan, MD,†
and David Zurakowski, PhD*

Spine
DIAGNOSTICS
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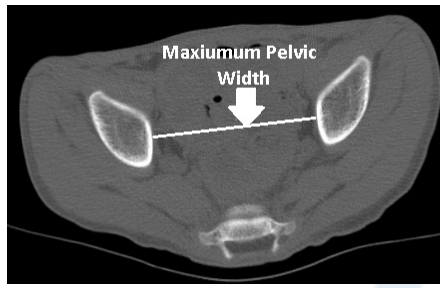
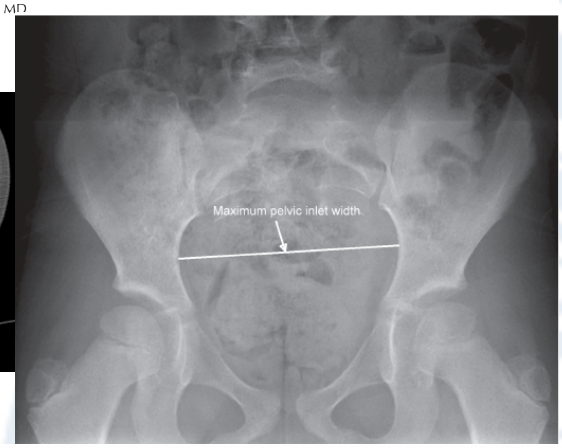
Prediction of Thoracic Dimensions and Spine Length Based on Individual Pelvic Dimensions

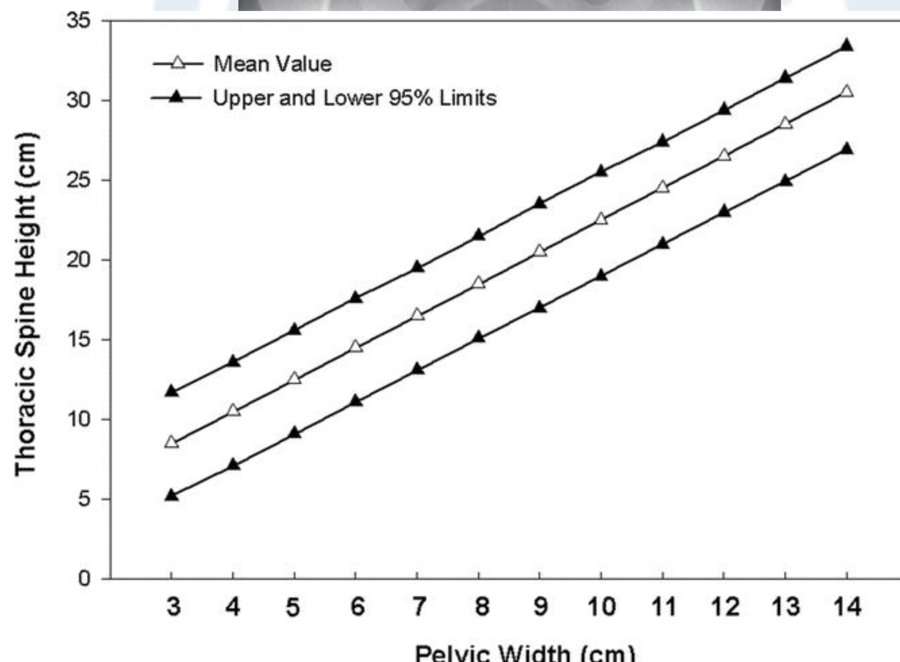
Validation of the Use of Pelvic Inlet Width Obtained With Radiographs Compared to CT

Meryl Gold, BA, Michael Dombek, BS, Patricia E. Miller, MS, John B. Emans, MD, and
Michael P. Glotzbecker, MD

- ***Individualized, disease and age-independent***, **standard for evaluation of outcome in early onset spinal deformity**
- **Pelvic width gives predicted thoracic dimensions**
- **Normal patients who had CT scans**
- **Recently validated for plain radiograph**







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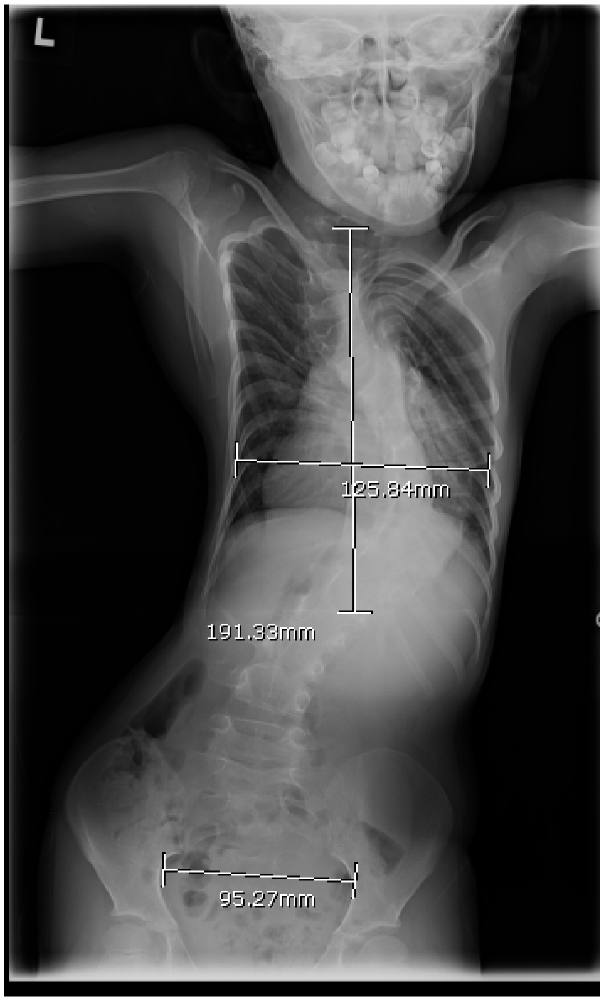
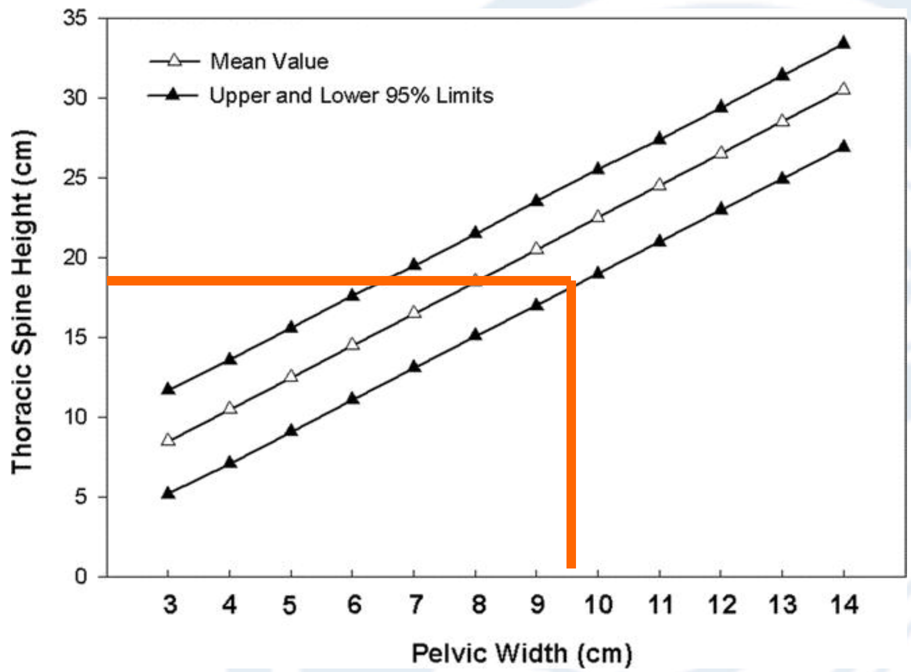
Preoperative Patient





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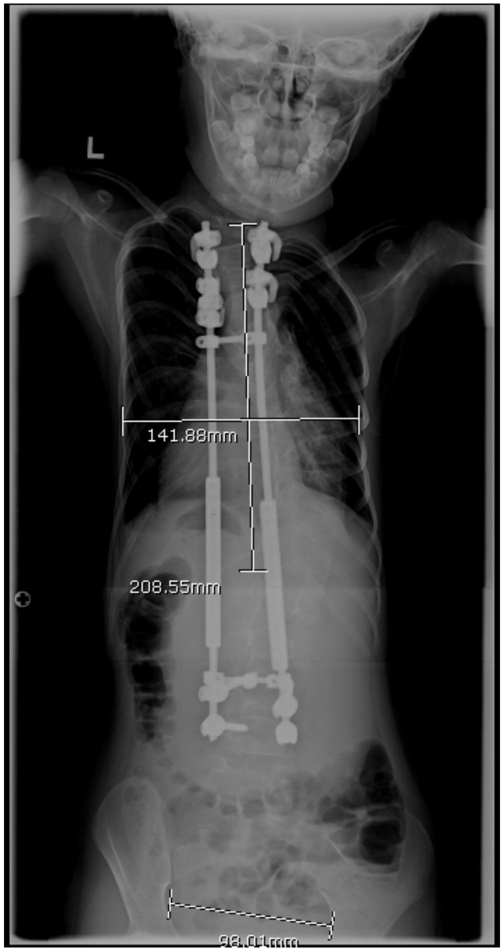
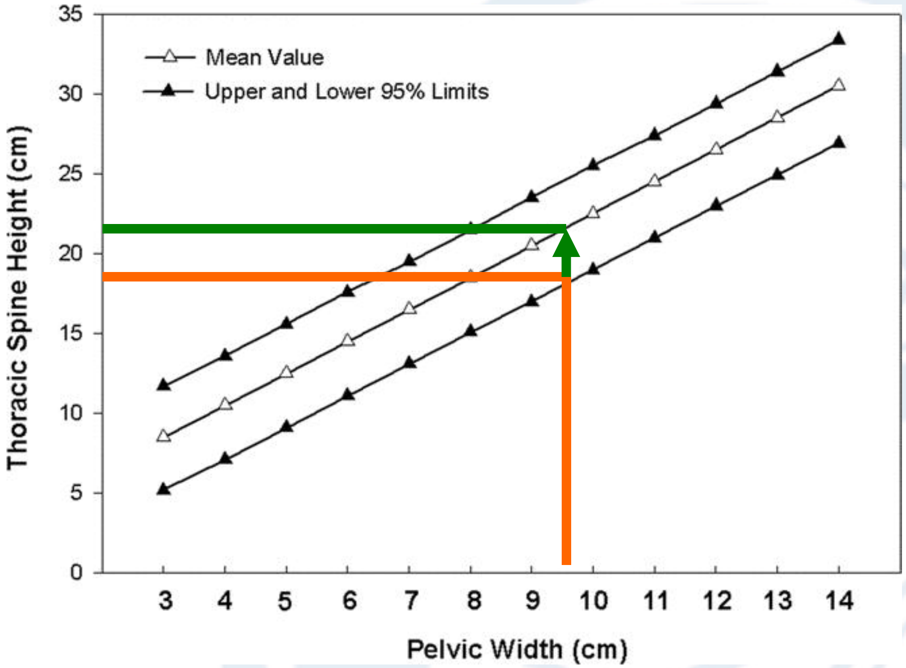
Improved Spine Height/Pelvic Width After GR Insertion





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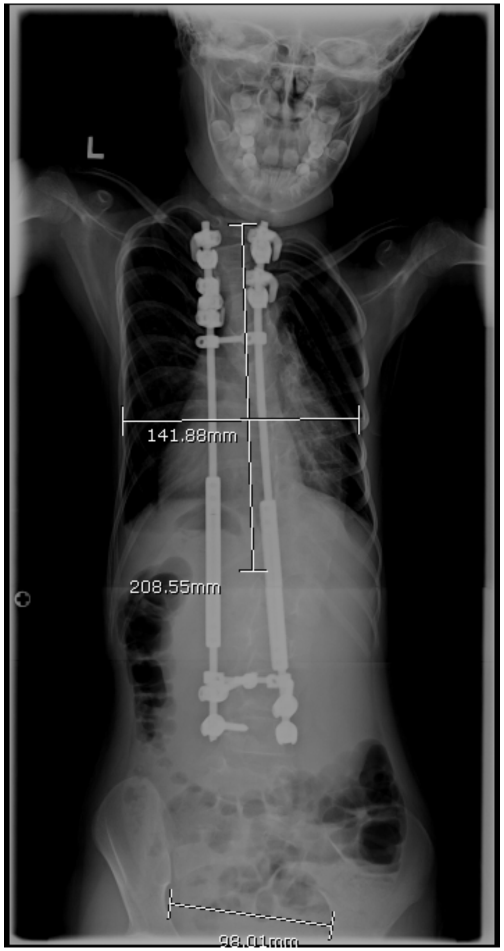
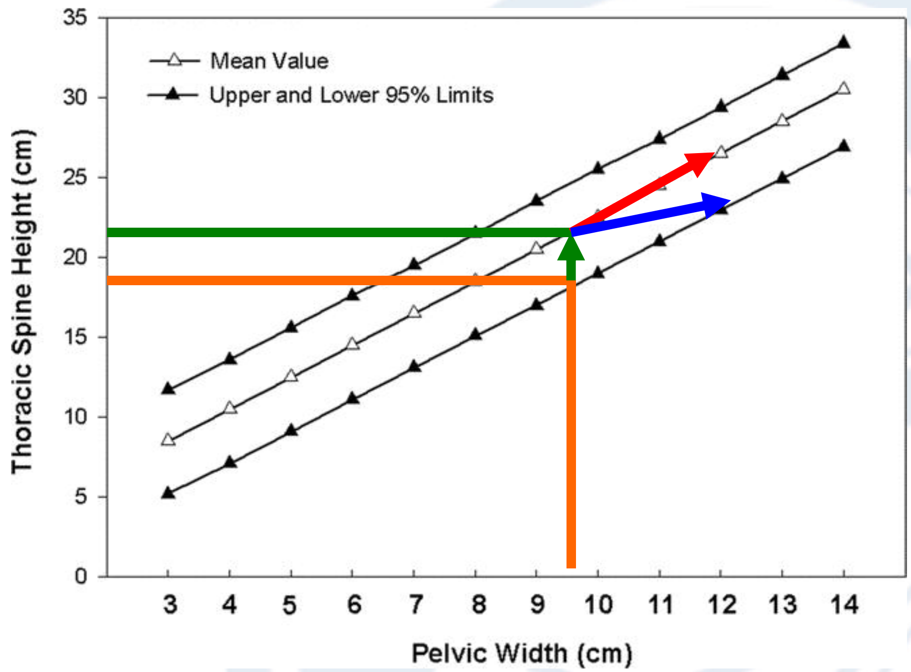
Improved Spine Height/Pelvic Width





Which path will it follow?

-Regress to previous percentile?

-Can initial improvement be maintained?

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Hypothesis

- **<u>Surgical treatment of EOS:</u>**
  - Improves spine and thoracic dimensions as a percentile of normal based on pelvic inlet width

AND

  - Maintains this improvement over time

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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

Methods

- **Inclusion:**
  - Growth friendly procedure (VEPTR or GR)
  - Minimum 5 years follow up

- **Assessment of the differences in chest width, thoracic height, chest percentile and thoracic percentile normalized by pelvic width at different time points**

Study Population

- **46 patients**
  - Chest and pelvic measurements at pre-op, post-op and time point at least 5 years post-op
  - C (16), N (11), S (8), I (11)
- **25 girls, 21 boys**
- **Average age initial surgery:**
  - 4.6 yrs (range: 0.8-9.3, SD 2.2)
- **Median follow-up:**
  - 6.5 yrs (range: 5.0-13)

Results

Table 1: Summary of outcome measurements. Mean ±SD (*mm*).			
	Preoperative	Postoperative	Most recent follow-up
Maximum chest width	170.01 ± 18.59	166.55 ± 20.22	206.91± 38.09
Thoracic height	141.63 ± 24.98	159.79 ± 24.19	203.45 ± 42.79
Pelvic inlet width	76.12 ± 12.37	77.16 ± 11.14	107.46 ± 22.41

Table 2: Summary of chest and thoracic percentiles. Mean ± SD.			
	Preoperative	Postoperative	Most recent follow-up
Chest percentile	0.937 ± 0.092	0.906 ± 0.111	0.911 ± 0.117
Thoracic percentile	0.788 ± 0.105	0.876 ± 0.107	0.858 ± 0.129

Figure 1. Chest Width Percentile

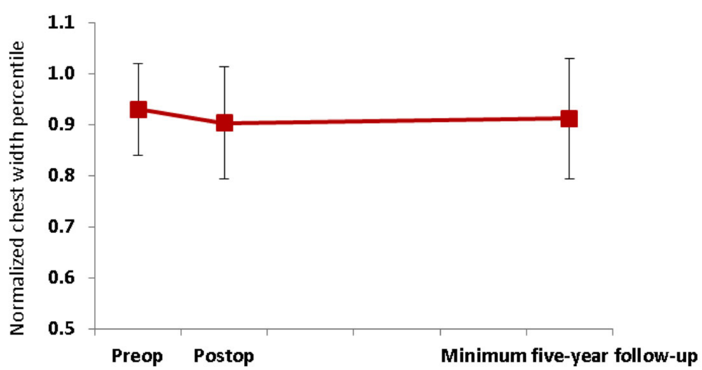

Figure 2. Thoracic Height Percentile

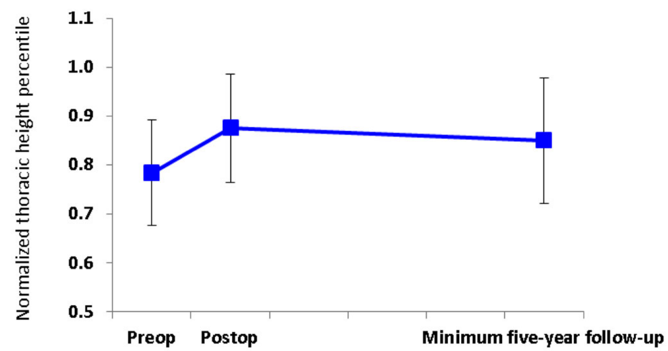

Table 3: Patterns of improvement based on linear mixed models.				
	Preoperative to postoperative		Postoperative to follow-up	
	Slope ± SD	P-value	Slope ± SD	P-value
Chest width percentile	-0.029 ± 0.013	0.029	0.005 ± 0.013	0.685
Thoracic percentile	0.092 ± 0.015	<0.001	-0.023 ± 0.015	0.131

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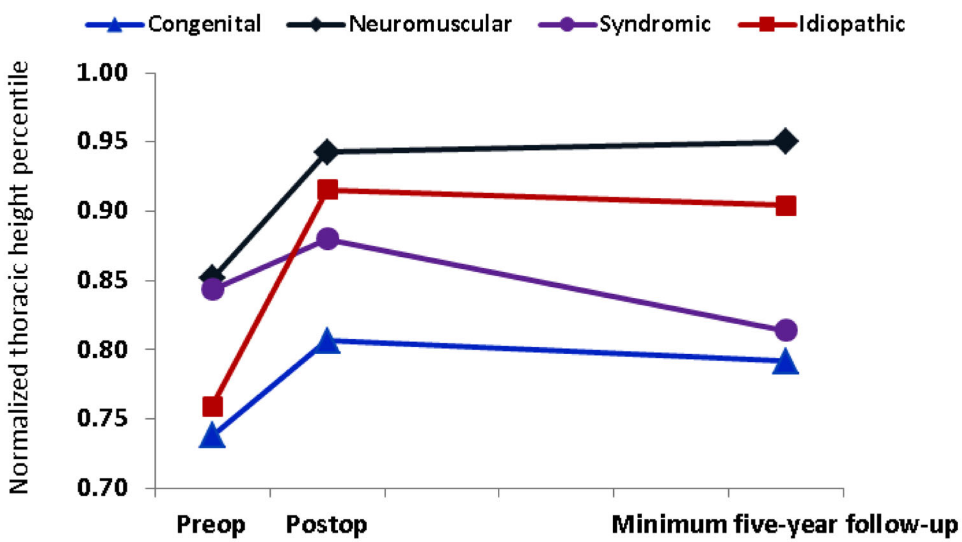
Results

Table 5: Thoracic height normalized percentiles by etiological diagnosis. Mean ± SD *(mm)*.			
	Preoperative	Postoperative	Most recent follow-up
Congenital	0.738 ± 0.11	0.806 ± 0.09	0.792 ± 0.10
Neuromuscular	0.851 ± 0.08	0.943 ± 0.10	0.950 ± 0.09
Syndromic	0.843 ± 0.12	0.880 ± 0.12	0.814 ± 0.16
Idiopathic	0.759 ± 0.06	0.915 ± 0.06	0.904 ± 0.11

Figure 4. Change in thoracic height percentile by patient etiology



Conclusions

- Thoracic height (absolute measurement) ***increased*** after surgery and ***increased*** over time at latest follow up
- Significant ***improvement*** of thoracic height percentile normalized for expected values by pelvic width after initial surgery, and this percentile was ***maintained*** over time
- Significant increase in thoracic height percentile in idiopathic patients
- For other etiologies, thoracic height percentile was maintained but was not increased significantly

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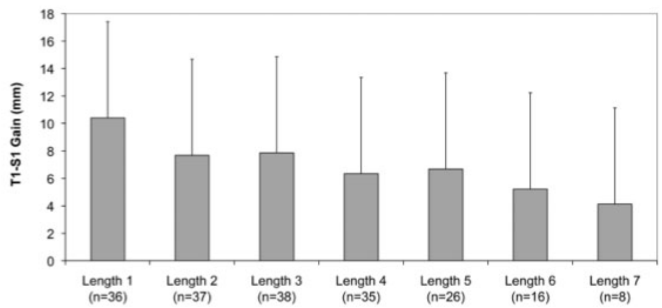

Figure 2. T1-S1 gain *versus* number of lengthenings.

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Conclusions

- Initial growth procedure brings patients closer to their predicted thoracic height and improvement is maintained 5 year follow-up
- Subgroup analysis suggests that this increase may not be true for all etiologies (underpowered or different?) but percentile is maintained
- Reporting thoracic parameters as a percentile compared to normalized values referenced to pelvic width may be a more accurate gauge of treatment success than traditional absolute values

Limitations

- **Select for good results (lose those that had to stop lengthening)**
- **Are 2D thoracic measurements a good outcome measure?**
  - Easy, accessible
- **We care about pulmonary function!**
  - Chest wall stiffness, diaphragm efficiency, 3D deformity

Thanks

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