Thoracic Volume Modeling in Early Onset Scoliosis

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Disclosures

- David Matson: no disclosures
- Charles Ledonio, MD:
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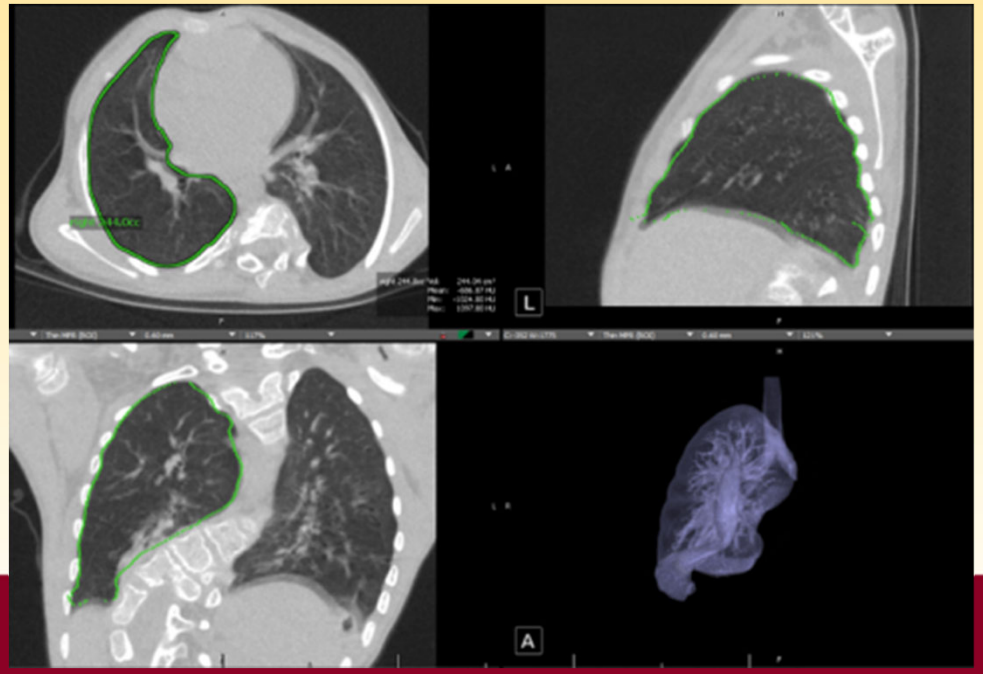
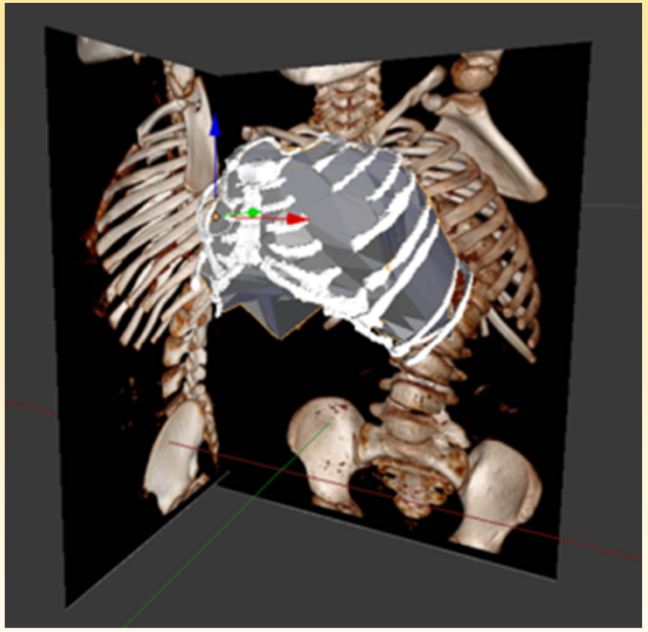
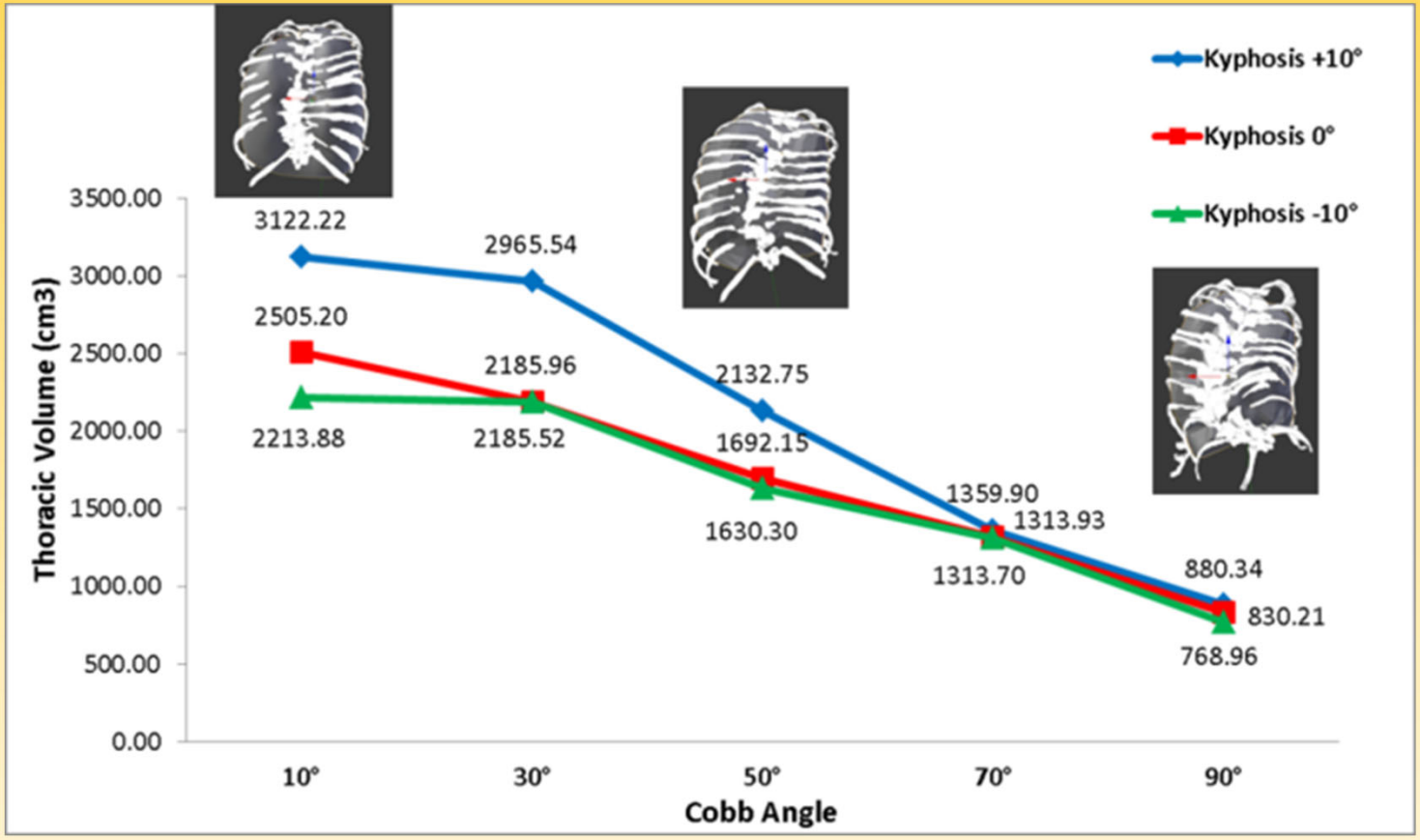
Background

- Virtual thoracic volume modeling from plain radiographs has been used in the adolescent idiopathic scoliosis (AIS) and early onset scoliosis (EOS) populations. Thoracic volume from modeling correlates within 3-4% of thoracic volume from CT scans.
- Early onset scoliosis (EOS) → ↓ thoracic volume and lung volume
- For AIS patients with poor pulmonary function, the modeled 2 year post-op thoracic volume change is strongly correlated with the two year post-op pulmonary function test.





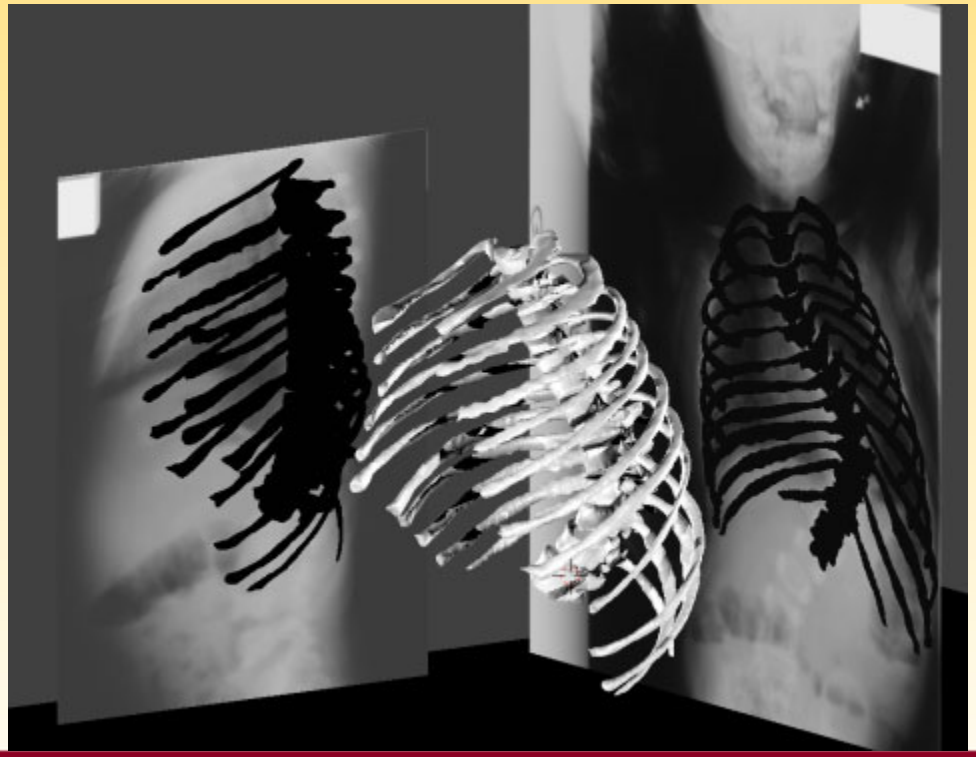
Virtual modeling of scoliotic deformity



- As coronal deformity (Cobb Angle) *increases*, thoracic volume *decreases*
- Cobb Angle >70º, sagittal deformity does not appear to impact thoracic volume (*England)*

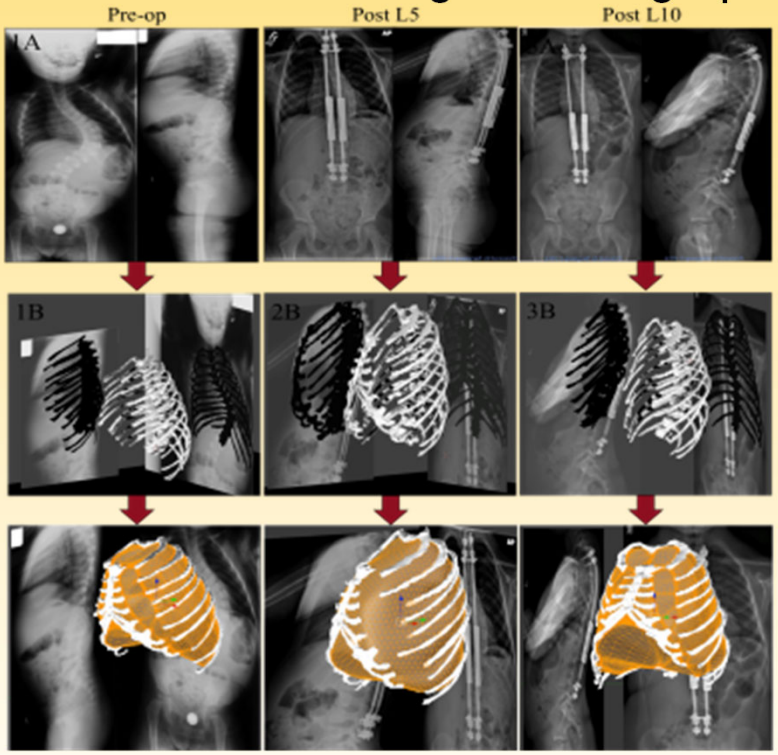
Purpose

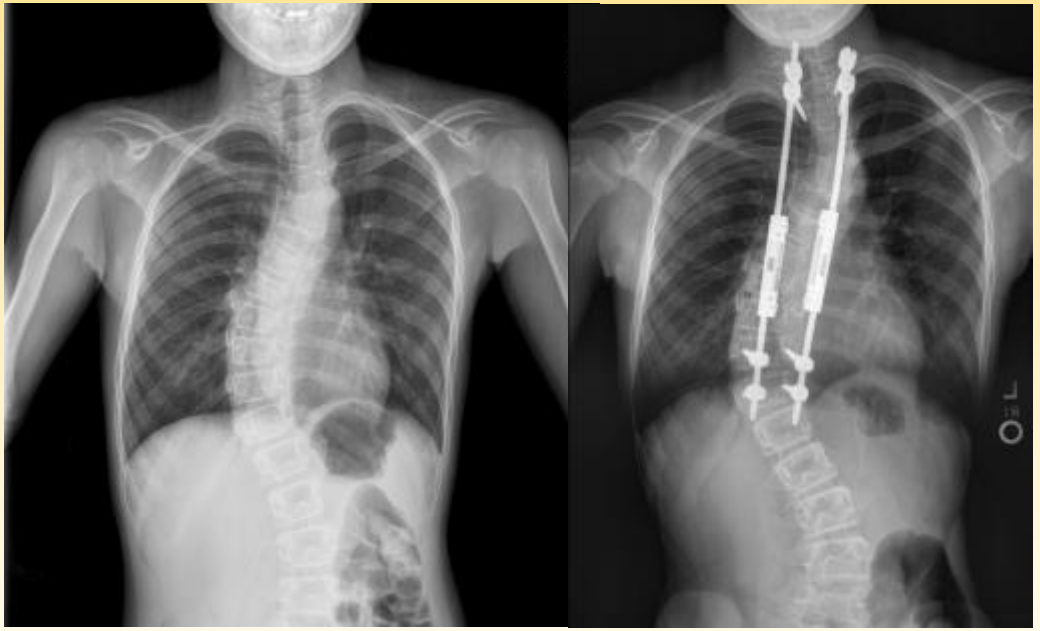
- Objective: to assess thoracic volume change with growing rod interventions in patients with early onset scoliosis.



Methods

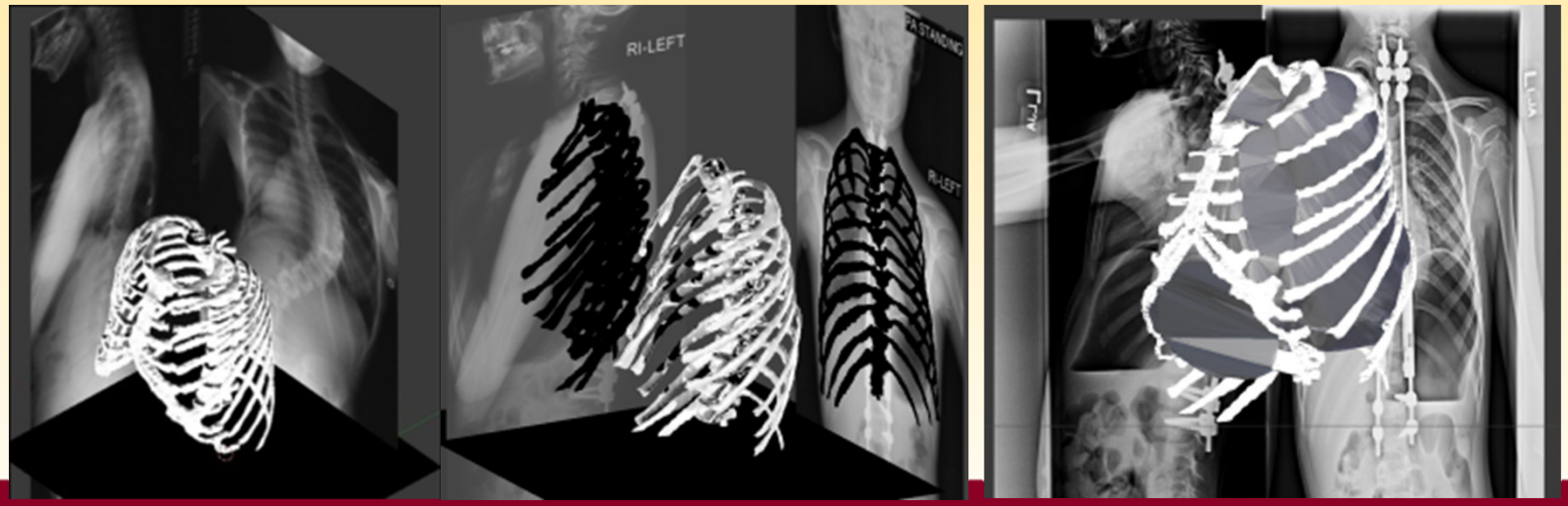
- Retrospective case study of children 10 years of age and younger with diagnosis of EOS
- Convenience sample of 6 patients with EOS from Growing Spine Study Group
- Coronal and sagittal radiographs used to model thoracic volume

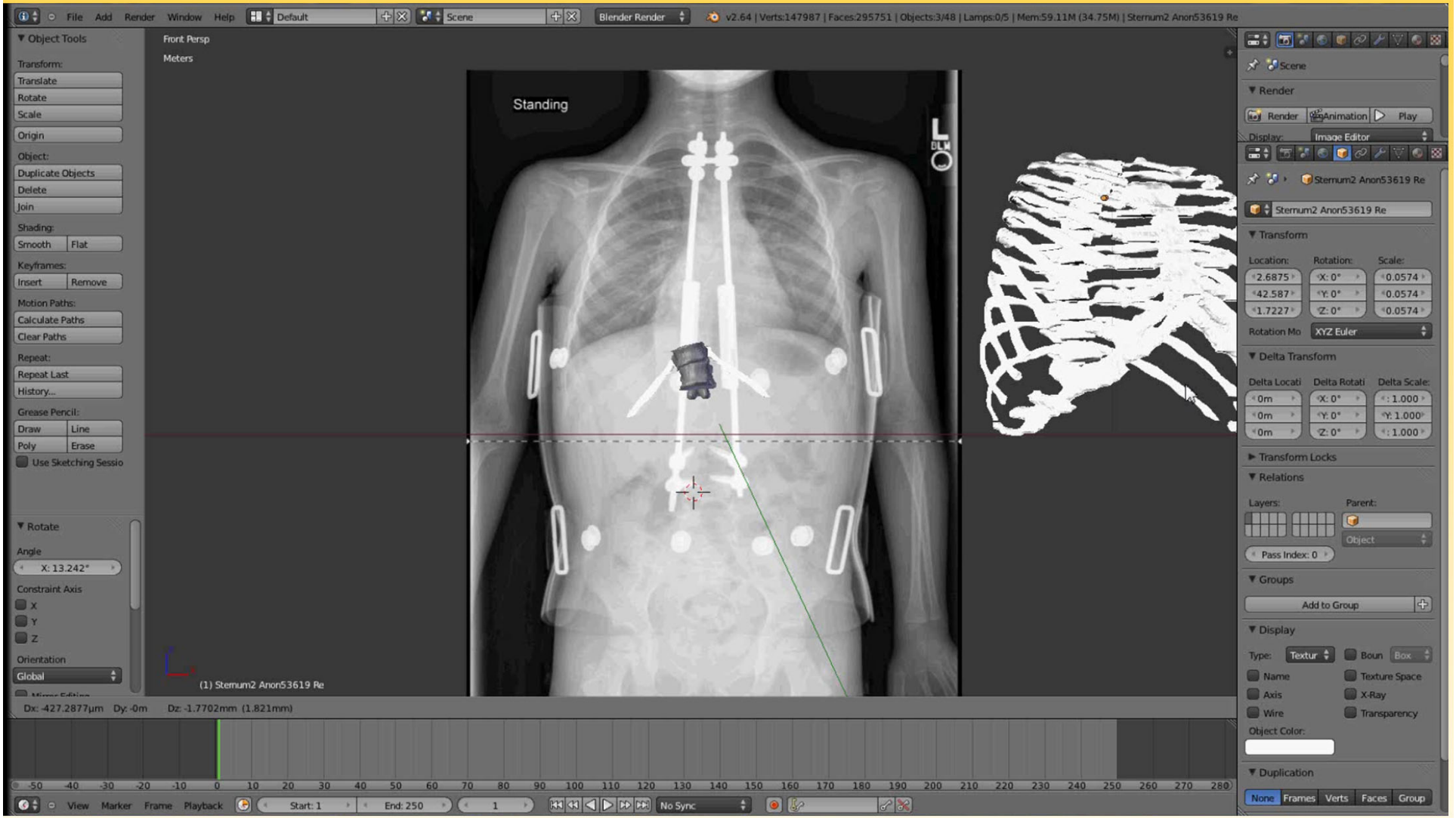




Methods

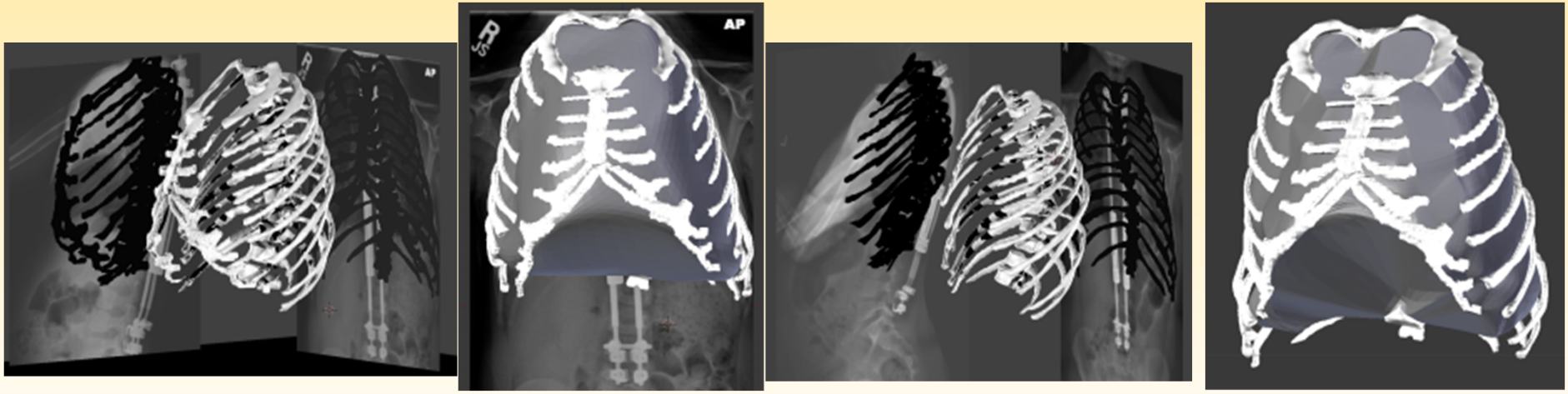
- Patients all underwent growing rod surgery with varying number of lengthening procedures for treatment of diagnosed early onset scoliosis
- Blender software (2.71, open access) to create 3D model from coronal and sagittal radiographs
  - ‘computationally deformed’ to match chest X-rays
- 3D models created with pre- and post-operative radiographs
  - Post-op taken from midpoint of treatment and final lengthening
  - Up to 3 models per patient
- Thoracic volume determined from models in Blender



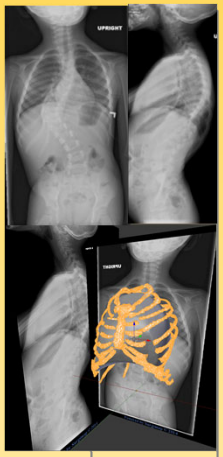


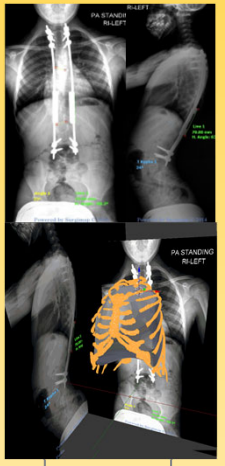
Results

- Pre-op thoracic volume = 1384-2943 cc
- Thoracic volume increased 19-62% over the course of treatment
- Pre-op major curve (Cobb angle) = 42-87˚
- Cobb angle corrected 13-71% over the course of treatment



Percent change in thoracic volume with growing rod treatment in EOS





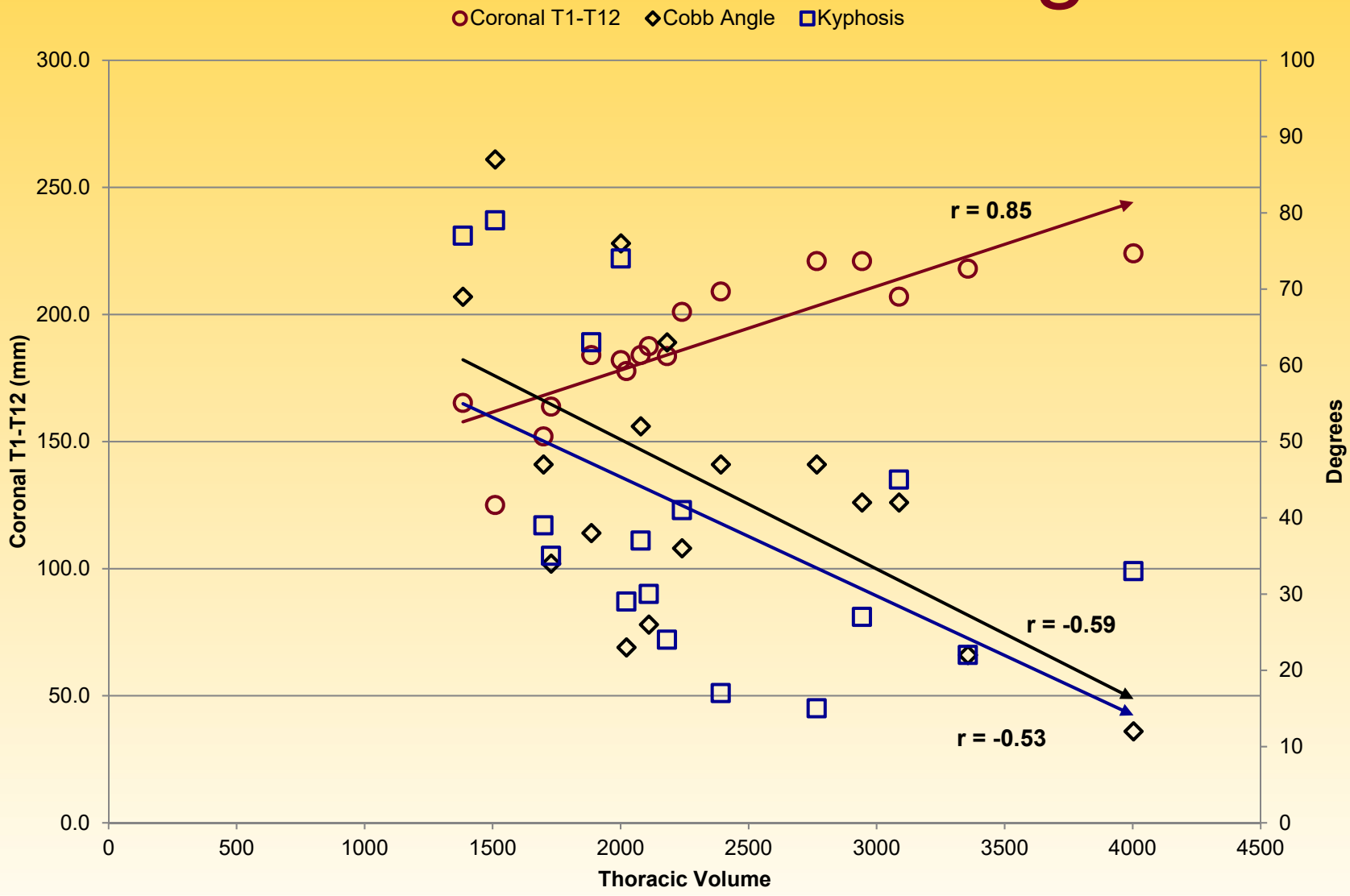
Baseline Thoracic Volume
Case 1: 1384 cc
Case 2: 1510 cc
Case 3: 1699 cc
Case 4: 2079 cc
Case 5: 2182 cc
Case 6: 2943 cc

	Pre Index	Post L1	Post L2	Post L3	Post L4	Post L5	Post L6	Post L7	Post L8	Post L9	Post L10	Post Fusion
Case 1	0%	2% 2111 cc Cobb 26°		36% 1886 cc Cobb 38°		62% 2240 cc Cobb 36°						
Case 2	0%					33% 2001 cc Cobb 76°						30% 4004 cc Cobb 12°
Case 3	0%					2% 1729 cc Cobb 47°					19% 2023 cc Cobb 47°	
Case 4	0%				61% 3357 cc Cobb 22°							
Case 5	0%			10% 2391 cc Cobb 47°		27% 2766 cc Cobb 68°						
Case 6	0%			5% 3088 cc Cobb 53°								

Correlational Findings: Thoracic Volume

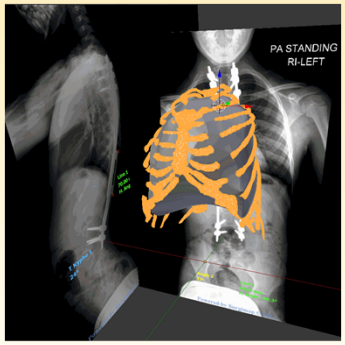
- Strong correlation with T1-T12 thoracic height (r = 0.85, 95% CI: 0.94, 0.62)
- Moderate inverse correlation with Cobb angle (r = -0.59, 95% CI: -0.84, -0.16)
- Moderate inverse correlation with kyphosis (r = -0.53, 95% CI: -0.81,-0.07)
- All correlations statistically significant ($p<0.05$)

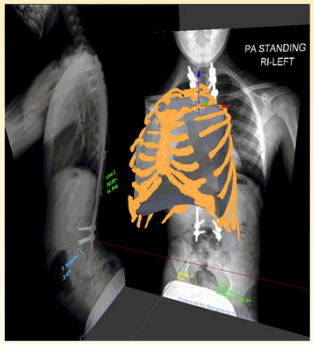
Correlational Findings

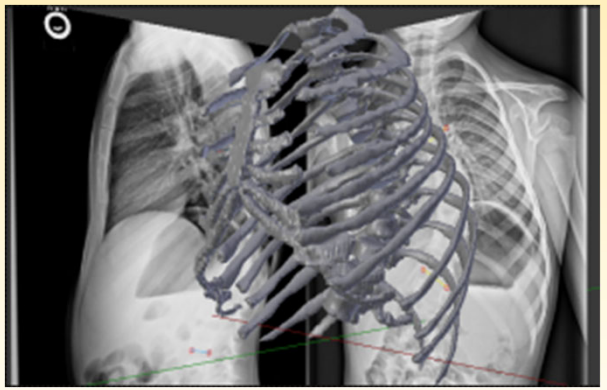


Conclusion

- Growing rod technique effectively increases thoracic volume with subsequent lengthenings
- Increased thoracic space for lung expansion during child growth
- Changes in thoracic volume correlate significantly with other markers such as thoracic height, Cobb angle, and kyphosis

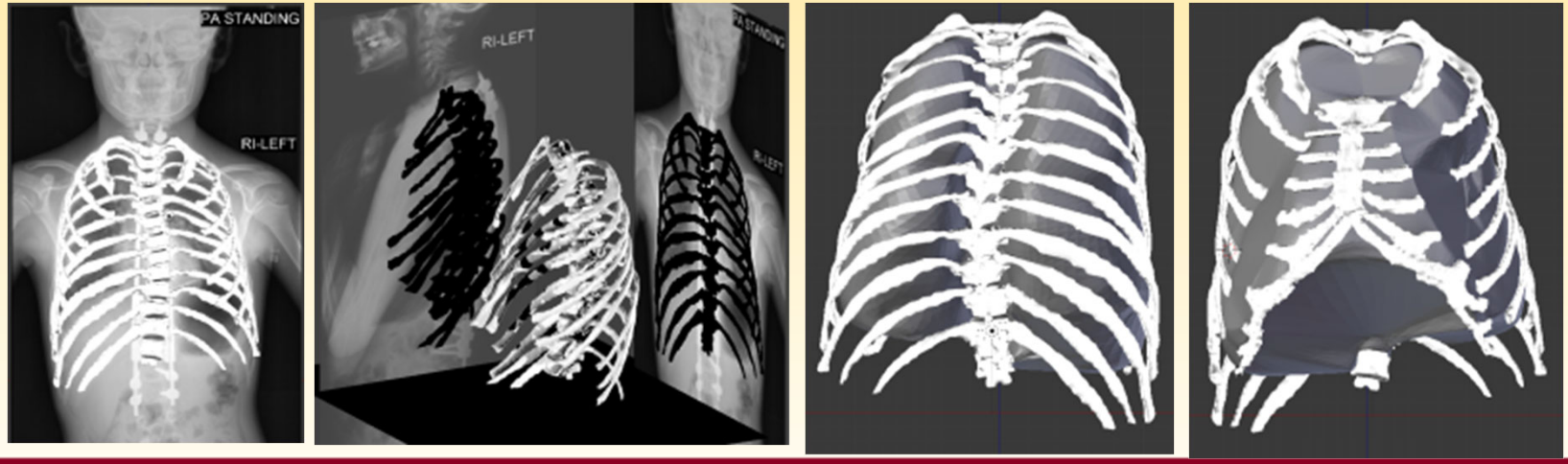






Discussion

- Alternative assessment of spinal deformity and thoracic volume to CT scan, reducing radiation exposure to pediatric patients
- Quantitative analysis and comparison of techniques used to treat EOS and other chest wall and spinal deformities
- May prompt earlier intervention in pediatric patients with severely compromised volume when used as an alternative assessment to pulmonary function testing
- Surgical intervention simulations with patient-specific models may improve pre-op planning and inform treatment decisions



Thank You!