Pediatric Thoracic Volume Modeling for Early Onset Scoliosis: A Validation Study

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Disclosures

- Kristin England, MD: no disclosures
- Charles Ledonio, MD:
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- David Polly, Jr, MD:
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- Behrooz Akbarnia, MD:
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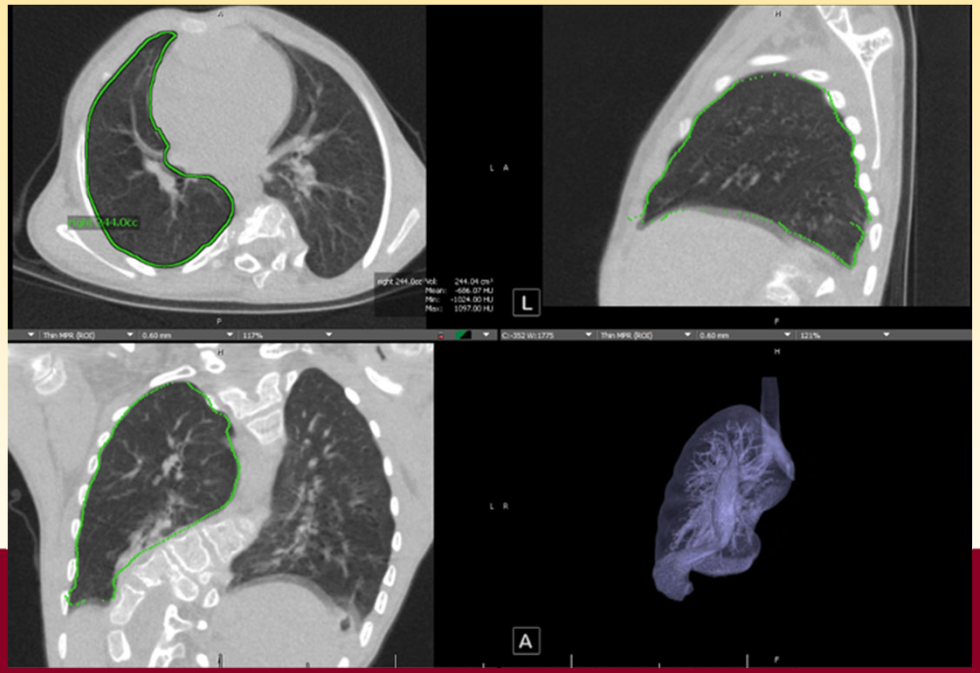
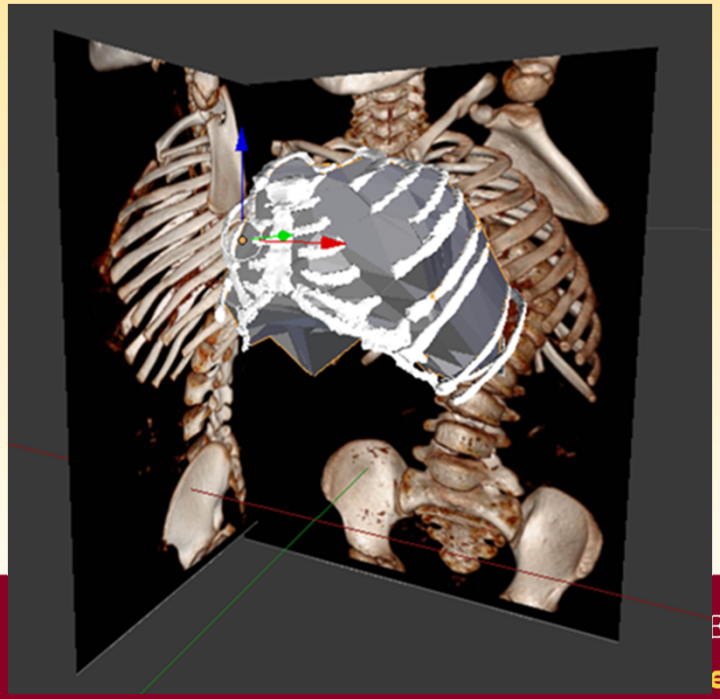
- Eric Hoggard, MD:
  - Consulting: Siemens

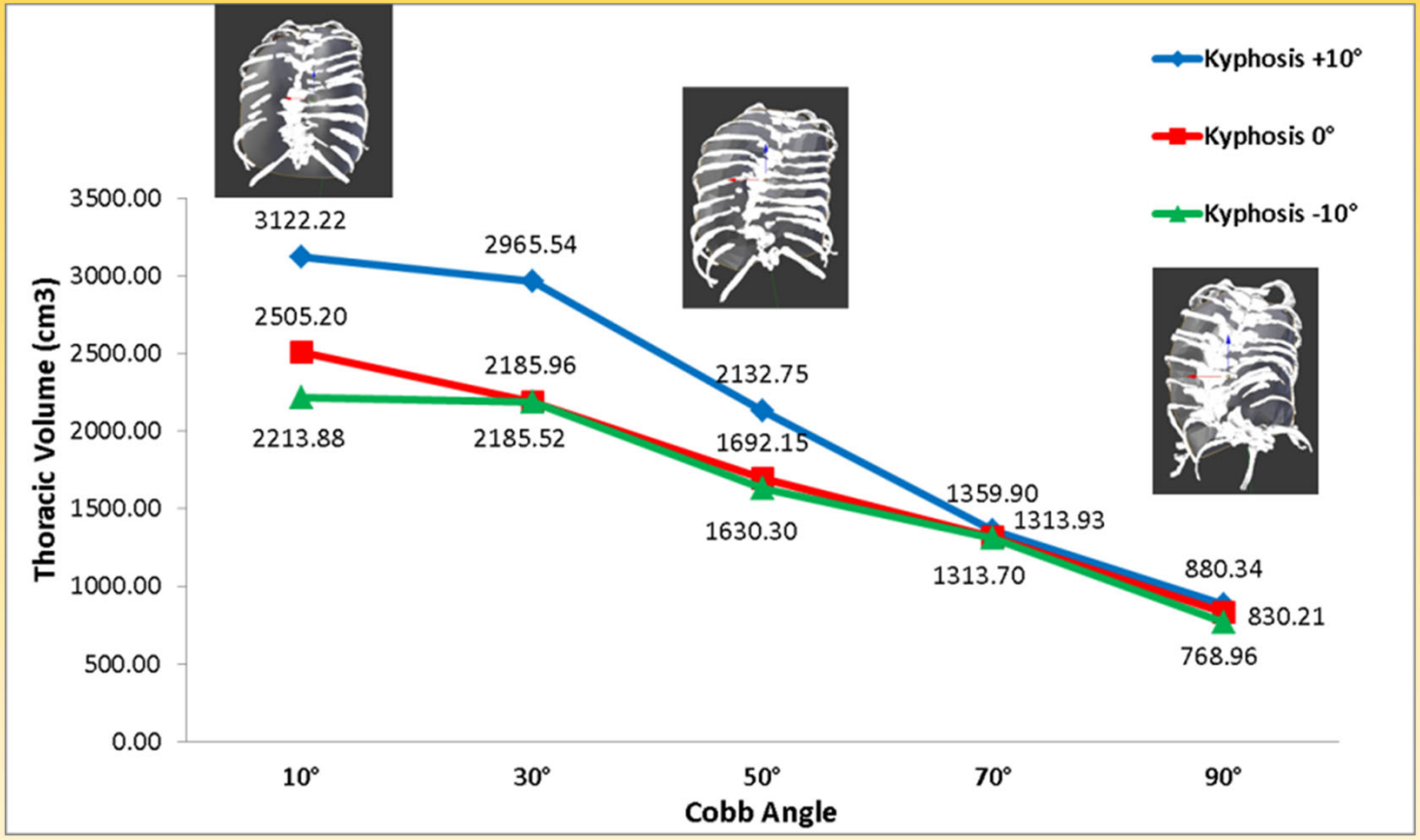
Background

- Early onset scoliosis (EOS) → ↓ thoracic volume and lung volume
- Virtual thoracic volume modeling from plain radiographs has been used in the adolescent idiopathic scoliosis (AIS) population. This correlates within 3% of thoracic volume from CT scans.
- 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

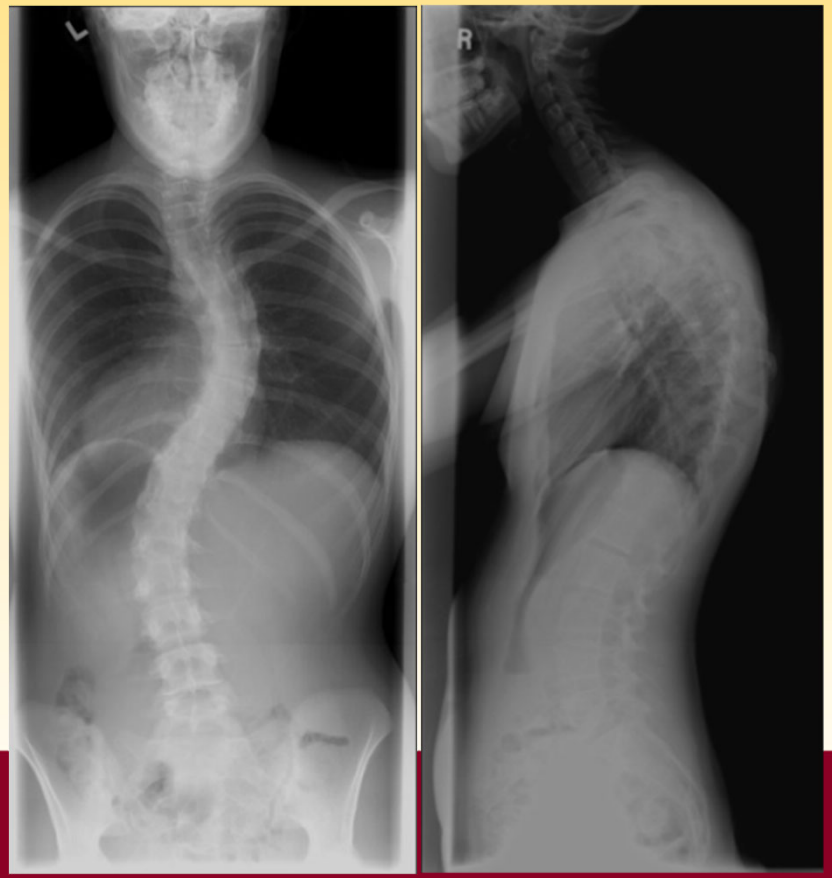


- As coronal deformity (Cobb Angle) *increases*, thoracic volume *decreases*
- Cobb Angle >70º, sagittal deformity does not appear to impact thoracic volume

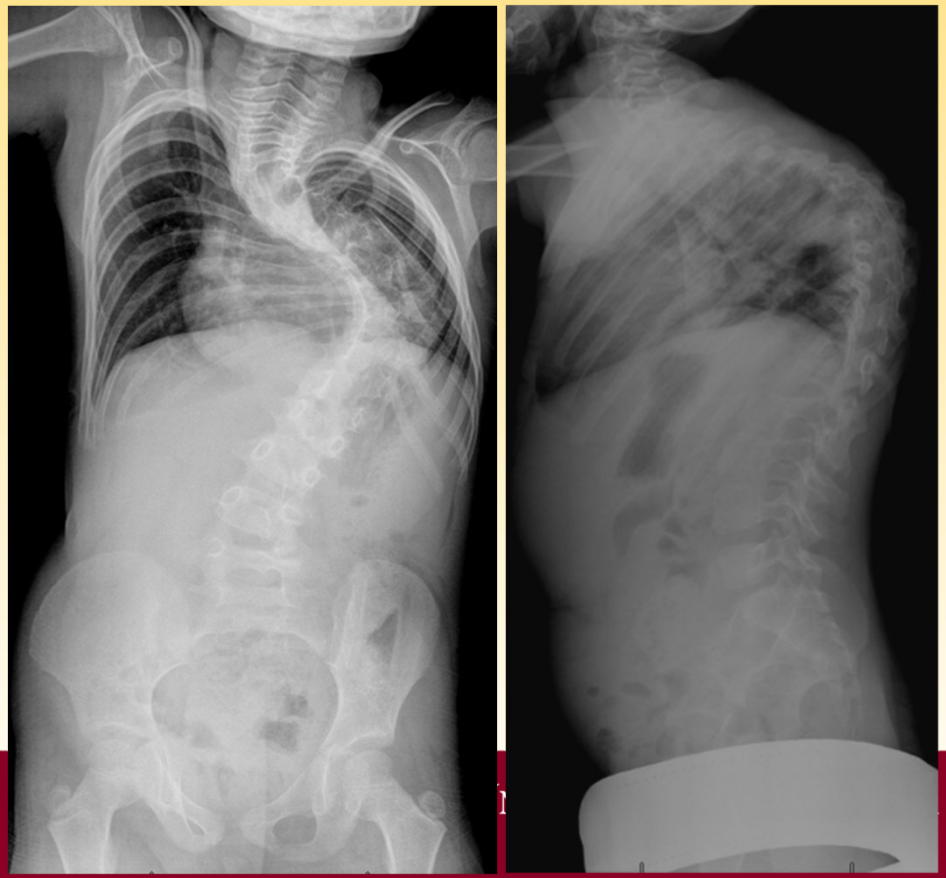
Purpose

- Objective: to validate the use of the *virtual radiograph to actual CT model* to accurately predict lung volume in EOS patients.

AIS

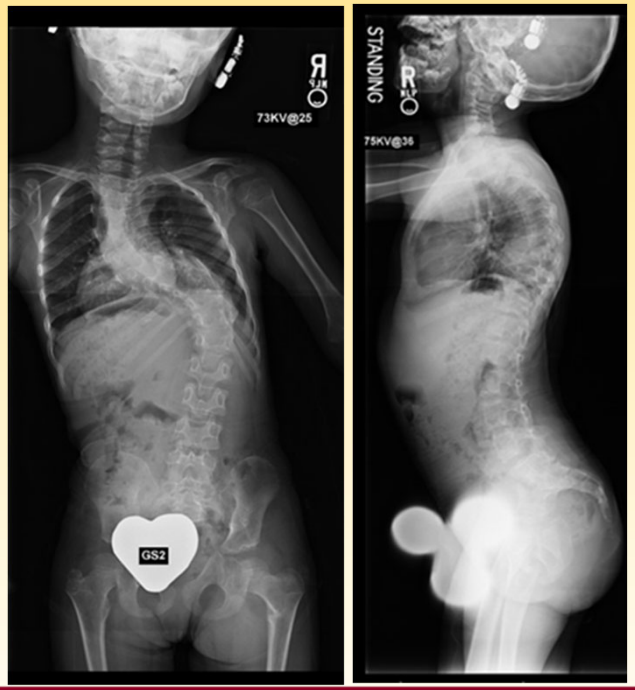


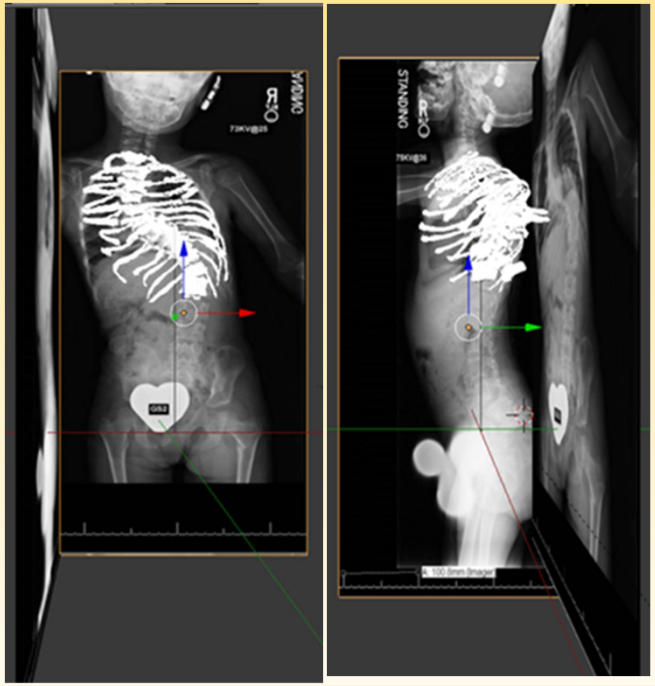
EOS



Methods

- Retrospective case study of children <10 years of age with diagnosis of EOS
- Convenience sample of 3 patients with EOS and CT scans (those with CT-based lung volumes)
- Coronal and sagittal radiographs used to model thoracic volume

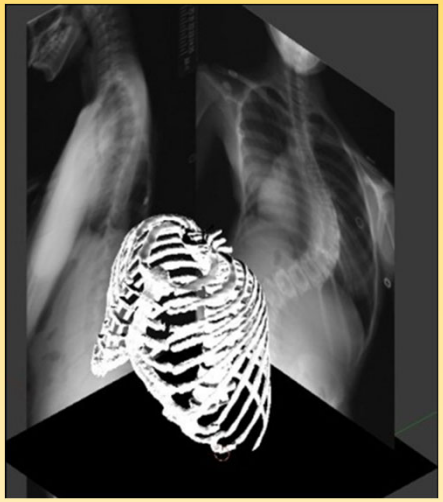




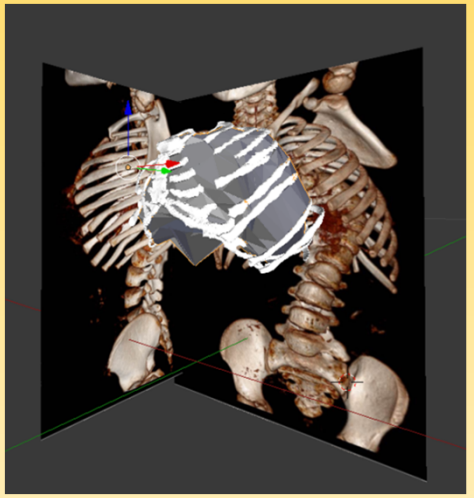
Methods

- Blender software (2.67b, open access) to create 3D image
  - ‘computationally deformed’ to match chest X-rays
- MiniMagics (v3, Materialise, Plymouth MI) to calculate the volume of the thoracic cavity
- Voxar 3D software (Toshiba, Edinburgh UK) used by Pediatric Radiologist to determine mediastinal volume
- Compare calculated (virtual) volume to gold standard CT-based volume; calculate percent error

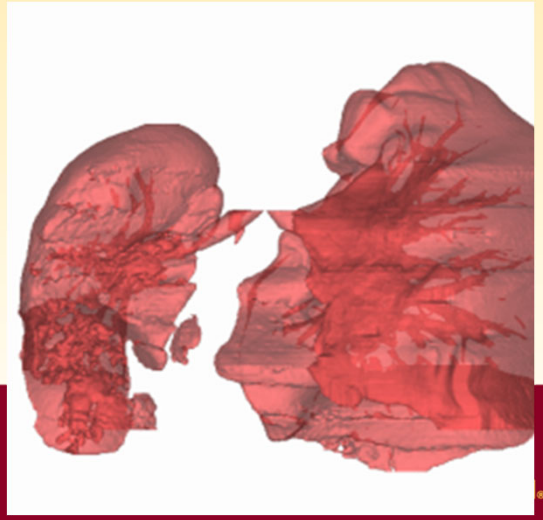
Blender default model



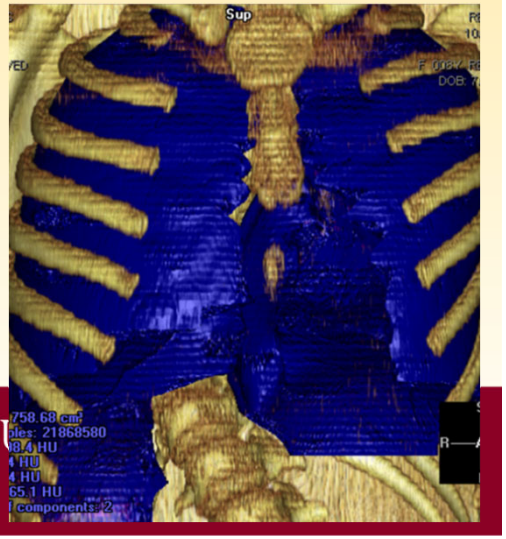
Deformed virtual model

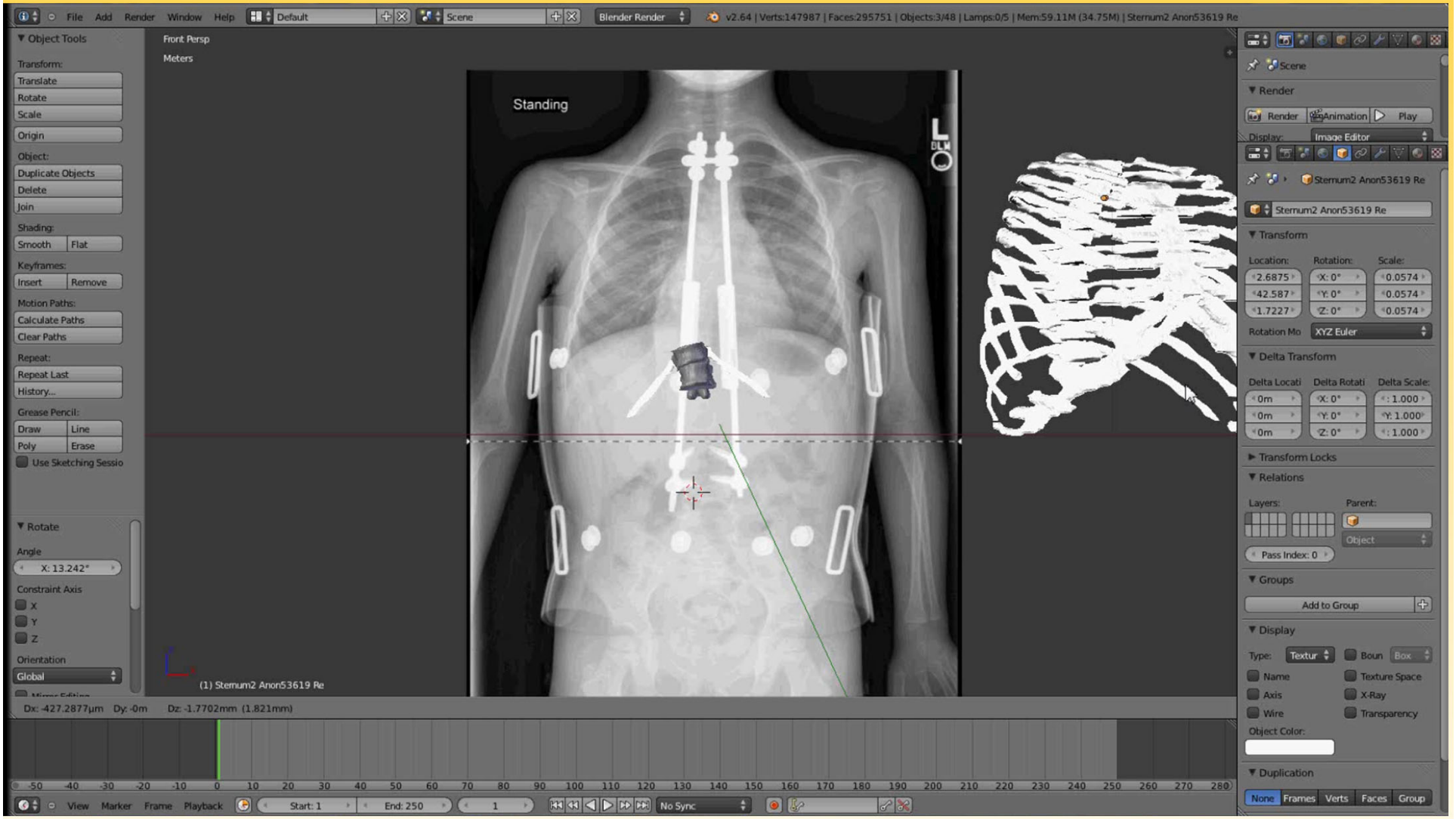


Actual CT lung volume



Virtual model volume



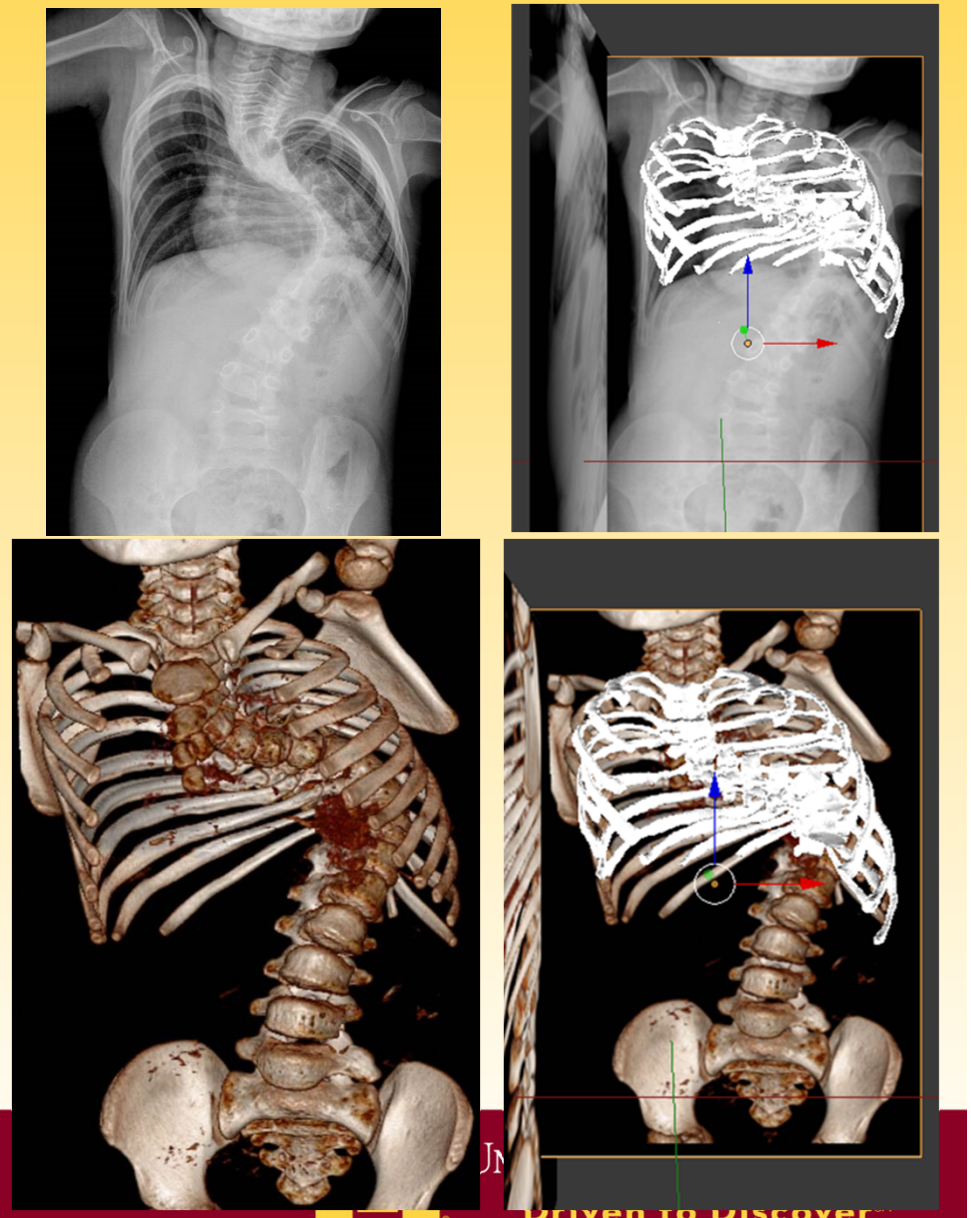


Case 1 – 5 yr 7 months, Cobb 74º

Subject 1	
Predicted (CT) volume	751.9cc
Modeled (calculated) volume	764.8cc
Percent (%) error	1.60%

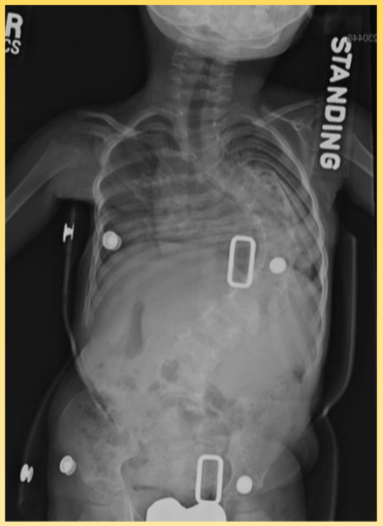
Case 2 – 4yr 10 months, Cobb 92º

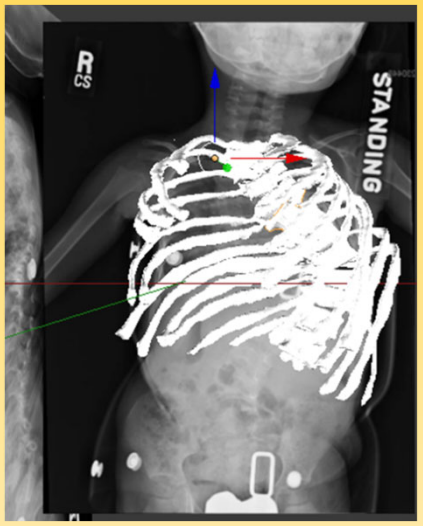
Subject 2	
Predicted (CT) volume	500.0cc
Modeled (calculated) volume	544.0cc
Percent (%) error	8.30%

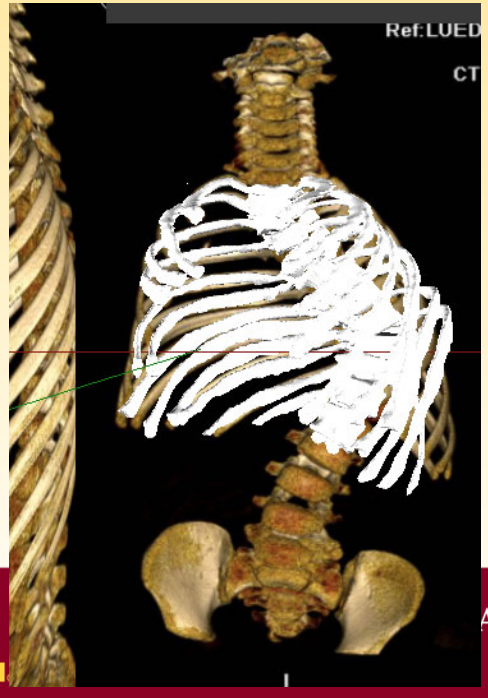


Case 3 – 2yr 10 months, Cobb 76º

Subject 3	
Predicted (CT) volume	530.0cc
Modeled (calculated) volume	542.0cc
Percent (%) error	2.20%

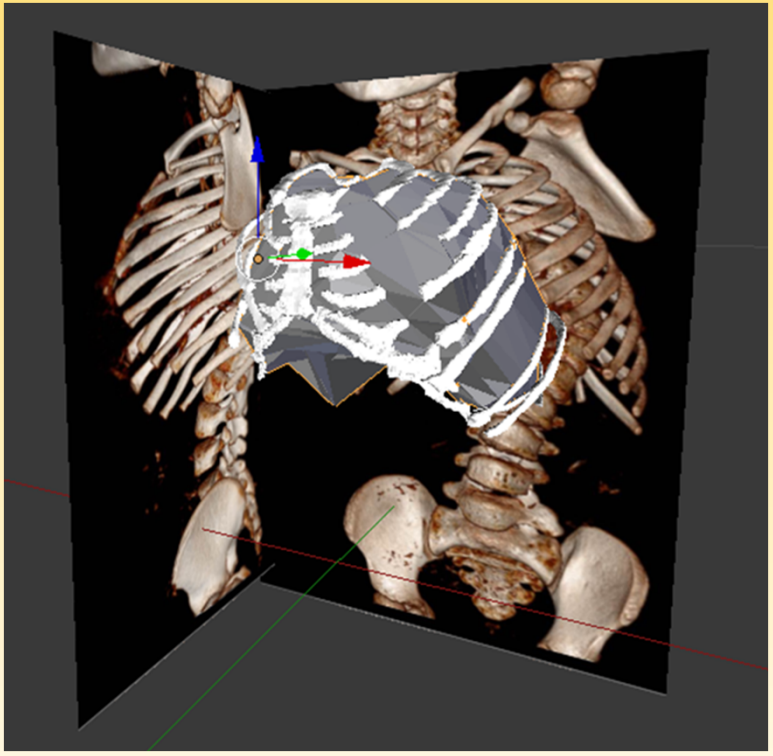






Conclusion

- Within 4.0% accuracy of predicted CT volumes → valid comparator to gold standard
- Effective method to analyze lung volume in EOS patients
- Applicability for patients undergoing long-term monitoring, to prevent unnecessary radiation exposure



Discussion

- Applications/recommendations:
  - EOS lengthening – growing rod
  - Compare interventions – growing rod vs other treatment strategies

Thank you!