

Development of a Motion Segment Model of the Lumbar Spine

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Introduction

- Recent models of the spine have potential to improve bracing success through clinical application for scoliosis patients
- A spine motion segment model was developed from computed tomography (CT) images
- Simulations based on specific loading conditions were performed on the model

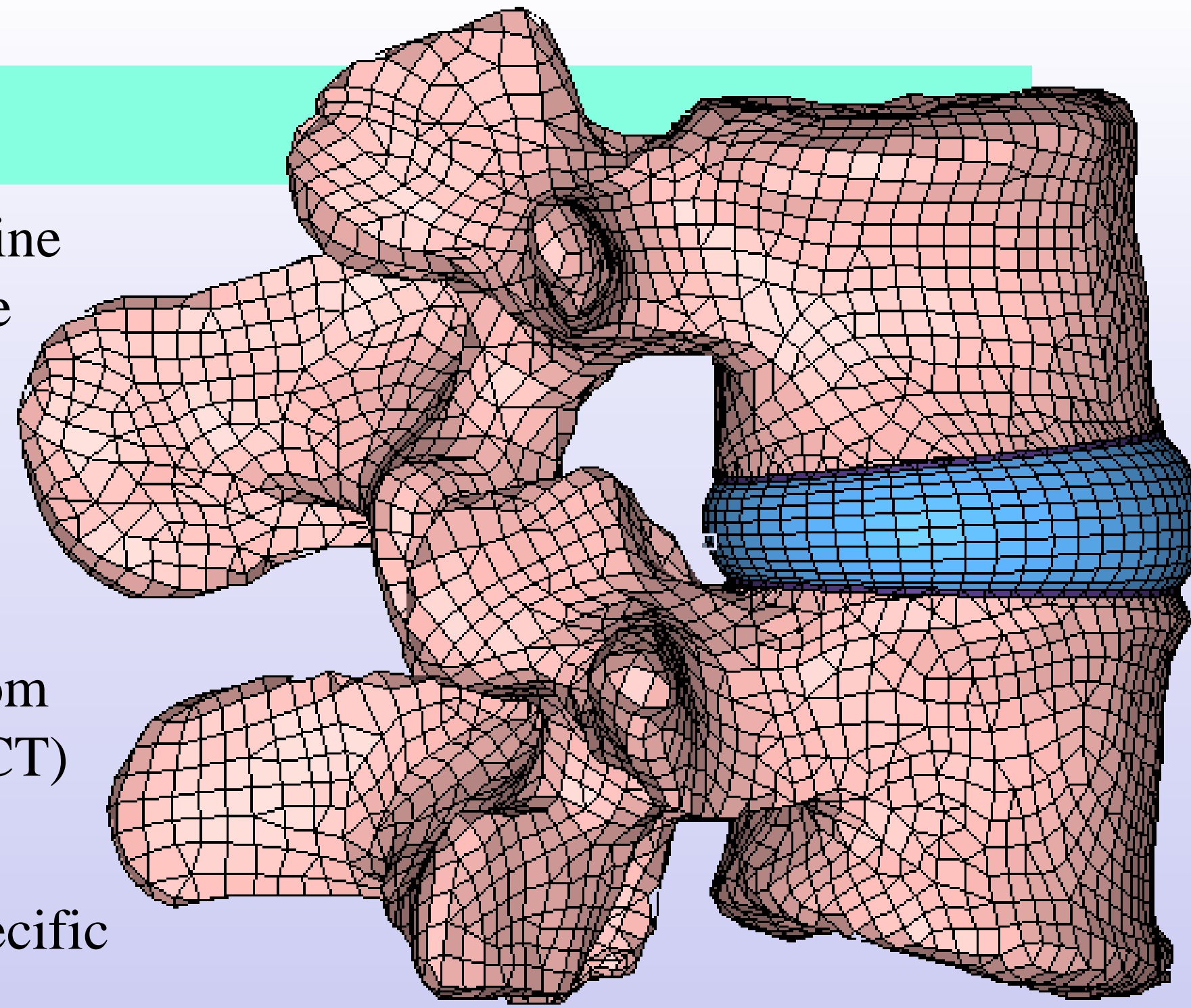


Figure 1: The software model of lumbar vertebrae L4-L5 with an intervertebral disc, fully meshed in Hypermesh.

Purpose

- To gain a better understanding of biomechanical response to applied forces based on differences in geometry
- This knowledge can help orthotists apply a brace and ensure that it prevents a patient's scoliotic curve from worsening

Methods

- Imported L4-L5 (vertebral bodies) CT scans into Simpleware, where it is then converted into solid model
- Since soft tissues do not show up well in CT images, the intervertebral disc is generated in SolidWorks
- Creation of a mesh (a set of elements) in Hypermesh. Components of the model are broken down into blocks to allow for the calculation of the distribution of forces
- Validation and analysis in Ansys. This is done by calibrating material properties and running simulations of various applied moments as performed by another researcher, Schmidt.

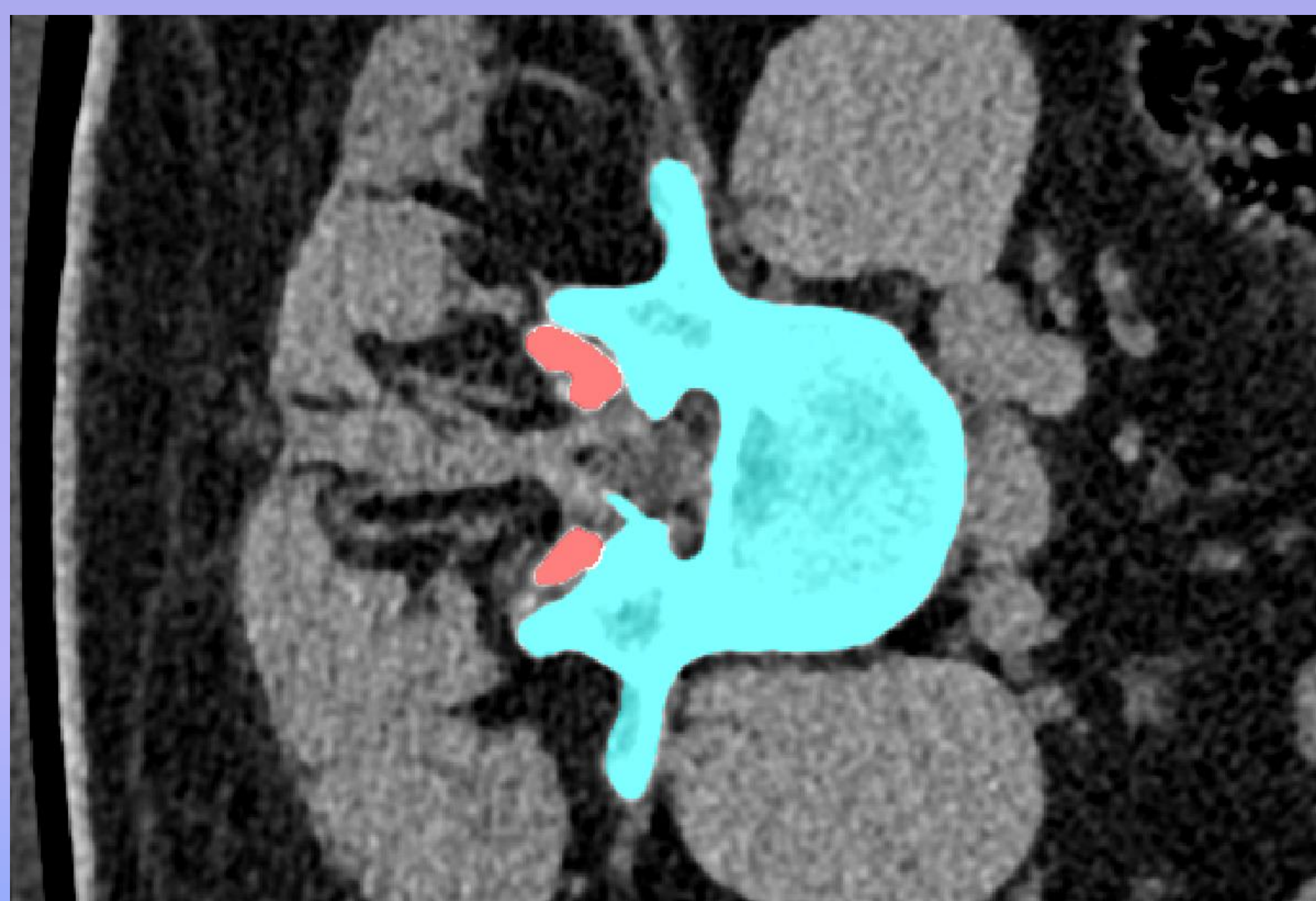
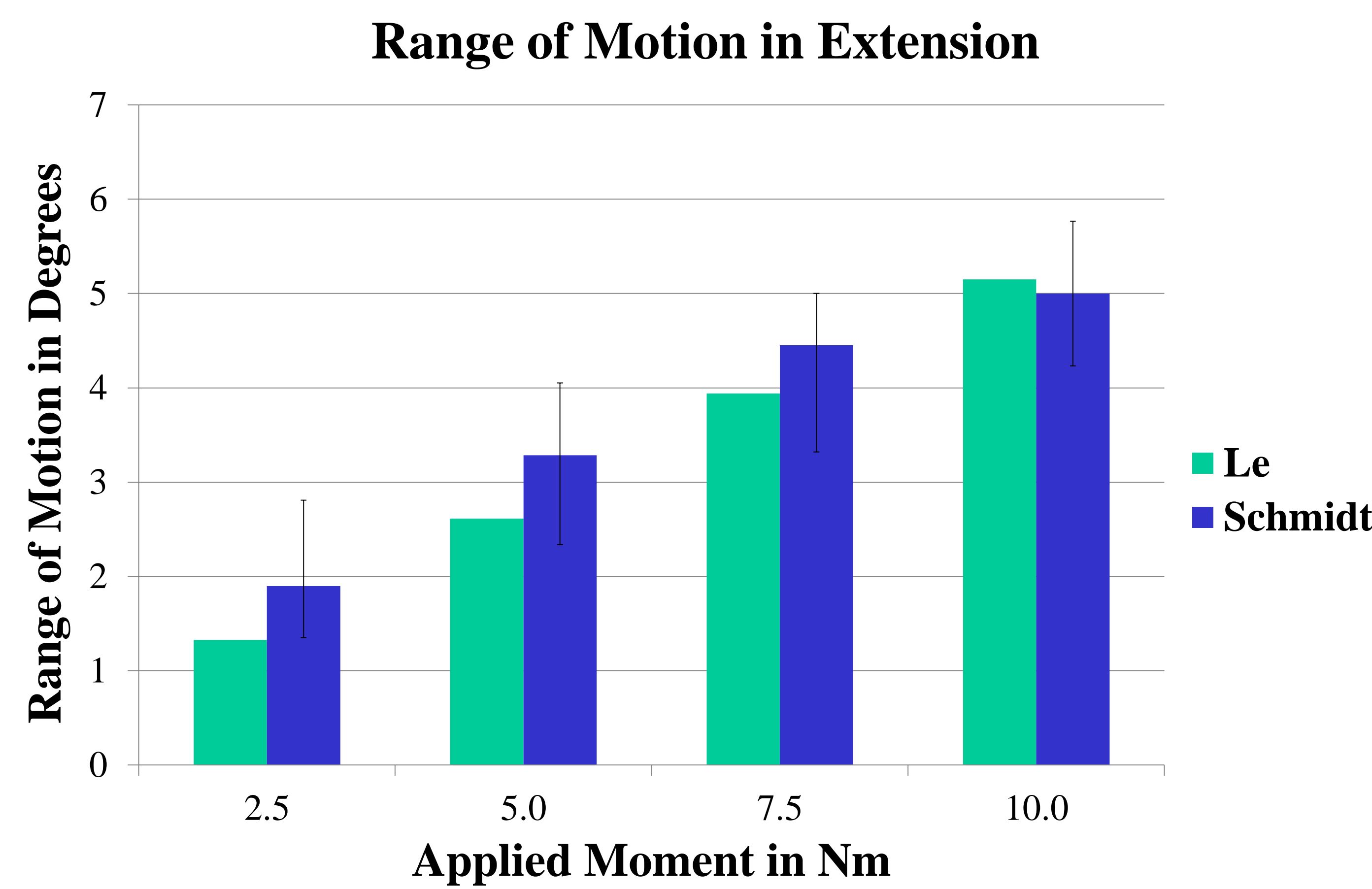
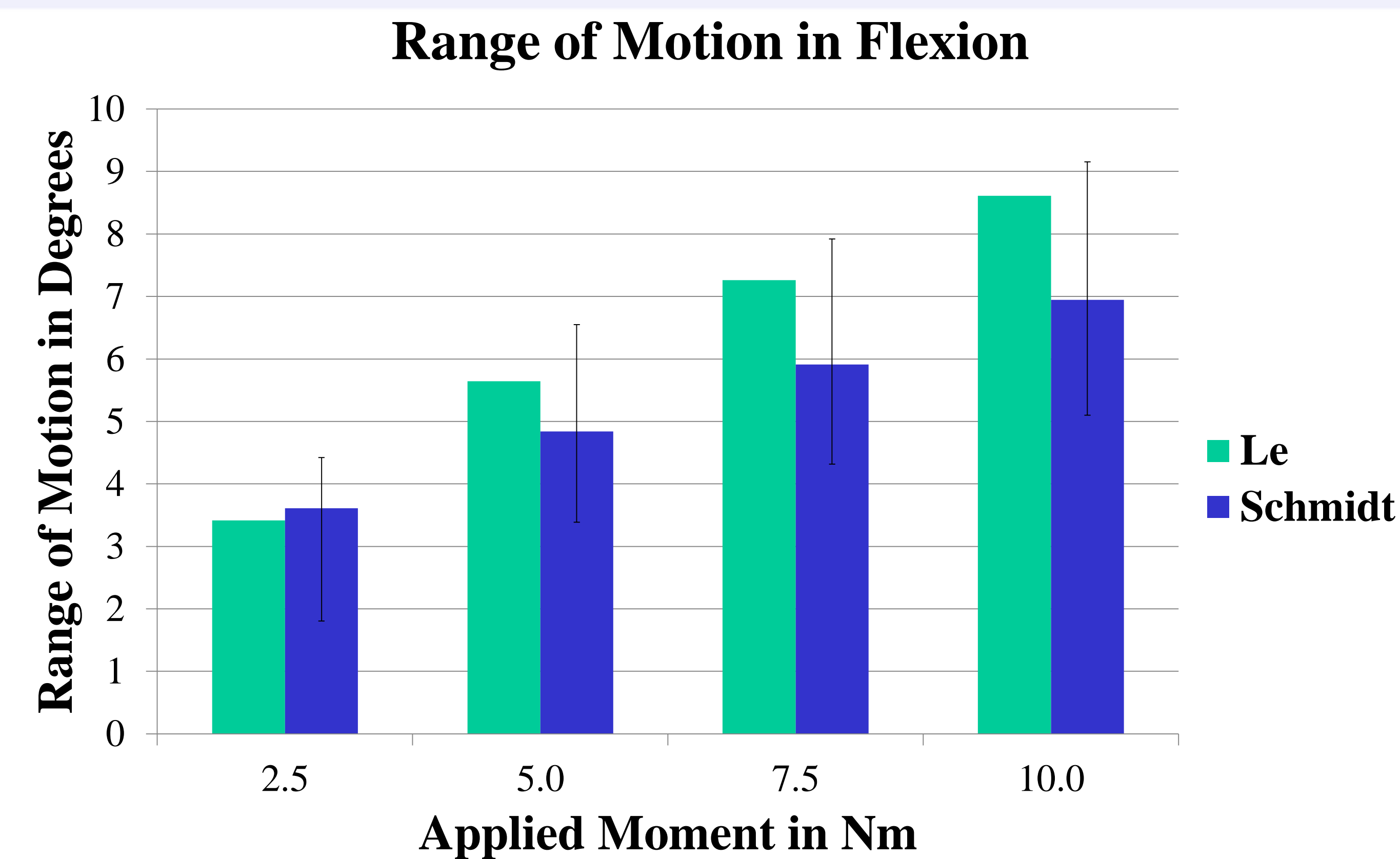


Figure 2: L4-L5 vertebral body scans masked in Simpleware (top view).

Results



Standard Deviation in-vitro data

Figure 3: Flexion and extension of the motion segment model under various applied moments in Nm in comparison to Schmidt's finite element (FE) model. The bars represent the numerical results of the models and the error bars represent the standard deviation for in vitro results.

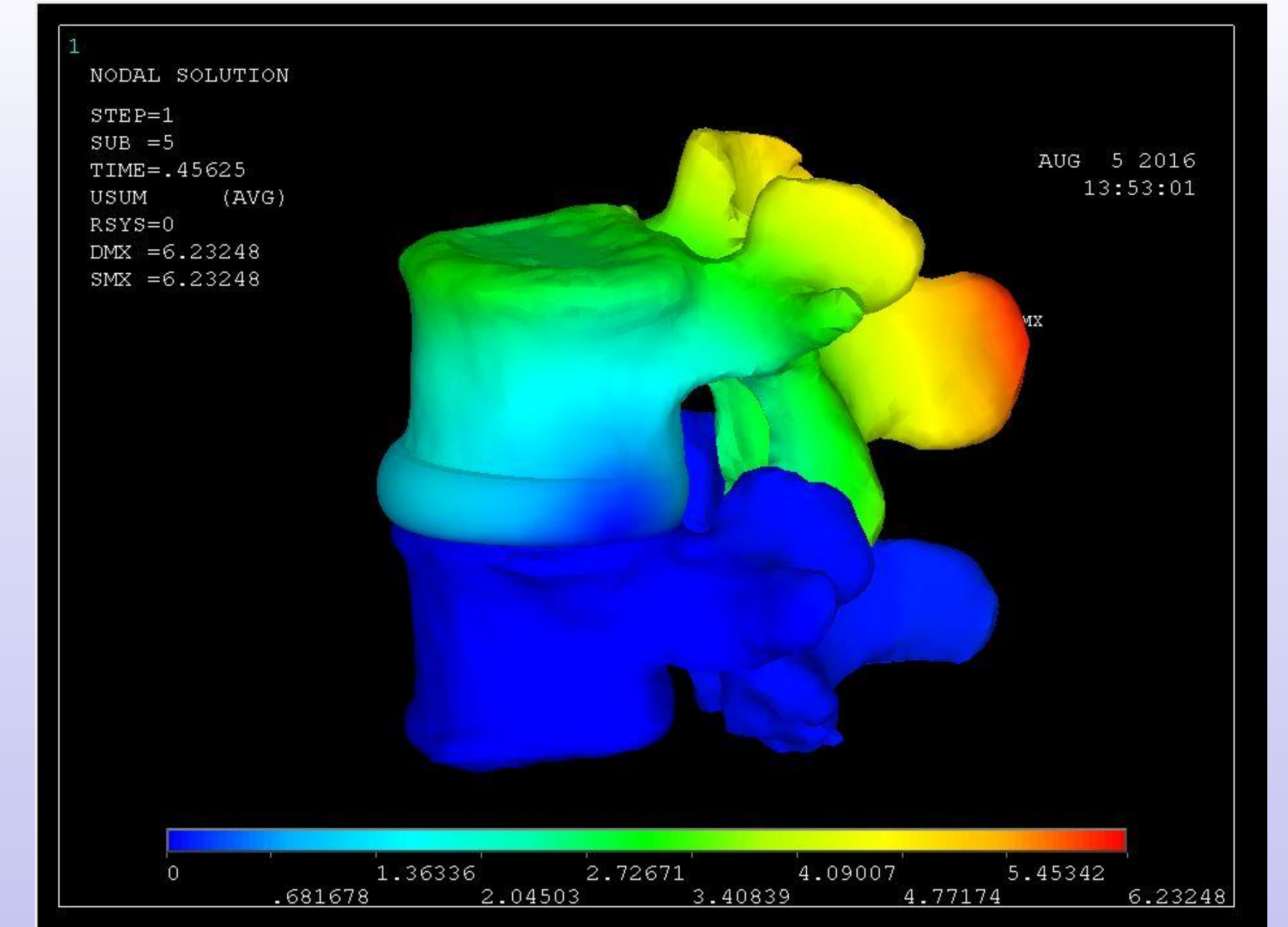


Figure 4: Flexion of the motion segment model under an applied moment of 10 Nm, solved using Ansys. Colours indicate the amount of displacement.

Discussions

- The motion segment model is relatively accurate, the results of the range of motion being within 2 degrees of Schmidt's FE model. Almost all data fits within one standard deviation of in vitro data. Thus, the model was validated
- Since the model was created from CT scan images, it accurately represents the geometry of the spine
- Modifying material properties is vital to obtaining accuracy
- The time for simulation could be decreased in order for practical clinical use on patients to help orthotists visualize loading on the lumbar spine for effective treatment

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Literature Cited

Schmidt, H., Heuer, F., Drumm, J., Klezl, Z., Claes, L., and Wilke, H. J., 2007, "Application of a Calibration Method Provides More Realistic Results for a Finite Element Model of a Lumbar Spinal Segment," Clin. Biomech. (Bristol, Avon), 22(4), pp. 377-384.