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# DEVELOPMENT OF A COMPUTATIONAL MODEL TO OPTIMISE ADOLESCENT IDIOPATHIC SCOLIOSIS CORRECTION

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## Introduction

There is little consensus among spinal surgeons on the use of correction techniques in adolescent idiopathic scoliosis (AIS) surgery. For example, the choice of bilateral, concave or convex all-screw instrumentation to achieve optimal correction is debated [1]. As there is lack of biomechanical comparison for pre-operative guidance, the ultimate aim of this project is to assess the solutions for AIS correction across common scoliotic patterns encountered in clinical practice using computer simulations. Previous studies have used patient-specific models (developed from CT/MRI scans), so it is challenging to compare techniques for different cases and draw conclusions. This study aims to develop a validated generic spine model that excludes patient-specific features and can be repositioned to become scoliotic and used for optimising AIS correction.

## Methods

The development of healthy adolescent spine model involved: spine geometry construction, material properties assignment, defining interactions and restraining conditions. The spinal geometry was developed and assembled using computer aided design and included rib cage and seven types of ligaments. Material properties were assigned using values from the literature [2, 3]. Surface contacts and interactions were based on spine anatomy. By using finite element analysis (FEA), a variety of tests were conducted to validate the model in ABAQUS, including range of motion (ROM), intradiscal pressure (IDP) and facet joint forces (FJF). By applying moments to the upper vertebral surface of the spine model, four body postures, flexion, extension, lateral bending and axial rotation, were simulated for ROM. Average FJF was calculated throughout spine sections during the ROM test. Computation of IDP was under pure compression to the spine model.

## Results

The preliminary validation was performed on the lumbar section. Tests results for ROM were compared with Dreischarf's study [2] which used FEA and *in vitro* measurement (Figure 1): our model compared well in flexion, lateral bending and axial rotation; extension was underestimated slightly in comparison to previous FEA study but was within range of the *in vitro* experiments. Results for FJF showed an over-prediction but shared a similar pattern in force transmission between facet joints. Under 1000 N of pure compression, IDP between L4 and L5 compared well in both the FEA and *in vitro* range.

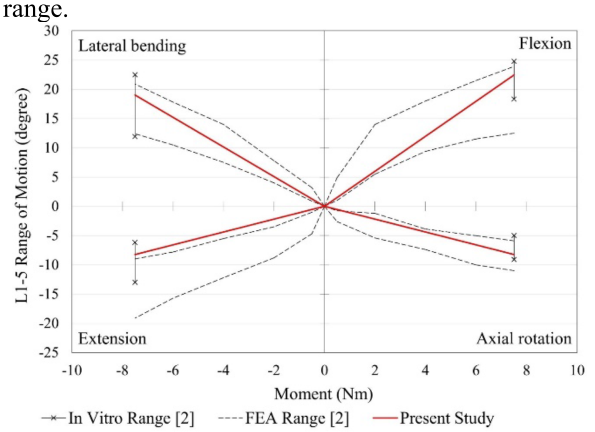


*Figure 1: Comparison of load-deflection relationship curves under 7.5 Nm moment load on lumbar section.*

The developed generic model was morphed (Fig. 2) to generate 42 AIS types based on Lenke's classification.

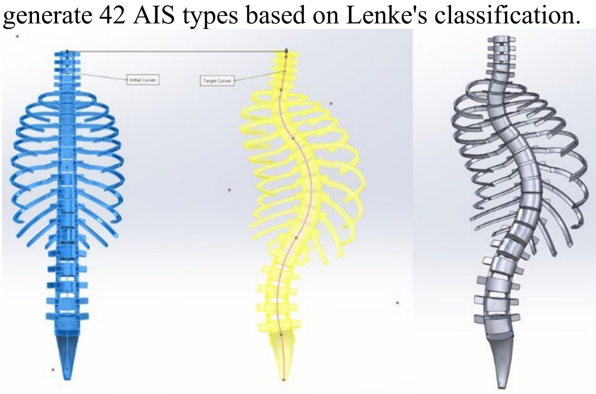

*Figure 2: Distortion of the generic healthy spine model to become scoliotic.*

## Discussion

Model validation on the lumbar section showed that the geometric design and joint connections of the developed generic spine model would result in similar mechanical responses compared to the previous studies. This generic spine model will permit easy evaluation of different scoliosis cases subjected to varying surgical techniques and provide pre-op decision support system for surgeons.

## References

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