THE EFFECT OF SOFT TISSUE PROPERTIES ON OVERALL BIOMECHANICAL RESPONSE OF A HUMAN LUMBAR MOTION SEGMENT: A PRELIMINARY FINITE ELEMENT STUDY

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INTRODUCTION

Finite element (FE) modelling is a popular numerical method used to study the biomechanics of the spine. Existing FE models have been used to investigate the effects of tissue degeneration, fixation implants and vertebral fractures. However, a wide range of geometric and material properties have been used to represent the soft tissues of the spine, and there is no consensus on the best approach for soft tissue modelling, or the relative importance of various soft tissues in governing the biomechanics of the motion segments. This study investigates the relative effect of soft tissue properties on the overall response of a human spinal motion segment using an osseo-ligamentous FE model of the Visible Man L3-L4 intervertebral joint.

METHOD

Model geometry was obtained from the Visible Man CT dataset using custom built image processing software. Non-linear soft tissue properties were obtained from the literature. Displacement controlled simulations were performed in flexion, extension, lateral bending and axial rotation. The effect of each soft tissue structure (including the anular fibres) was assessed by removing it from the model and comparing the predicted overall stiffness to that of the intact segment.

RESULTS

Removal of the capsular ligaments and the collagen fibres in the anulus of the intervertebral disc were seen to have the largest effects on governing the overall stiffness of the motion segment. All other ligament structures had little impact on determining the motion response, with the exception of the anterior longitudinal ligament, which when removed caused the stiffness in extension to fall to 60 percent of the value reached for the intact model.

DISCUSSION

The results from this study demonstrate that some soft tissue structures are more critical than others in determining the characteristic behaviour of the spine. Correct representation of the mechanical properties of both the capsular ligament and anular fibres is most important in generating realistic FE models of the lumbar spine to predict motion segment biomechanics.