Material Sensitivity Study on Lumbar Motion Segment (L2-L3) under Sagittal Plane Loadings using Probabilistic Method
K.K. Lee and E.C. Teo*

Journal of Spinal Disorders & Techniques
2005 18(2):163-170

Abstract

In this study, the probabilistic responses of a three-dimensional finite element L2-L3 motion segment, with and without posterior elements, tested under sagittal plane loadings are presented. Understanding the effect of biological uncertainties and variations on the biomechanical response provides an insight into spinal behavior under normal and degenerated conditions. Biological variability of 19 spinal components (nucleus, annulus, ligament, cortical/cancellous bone, endplate and ligaments) in the motion segment was incorporated using statistical distributions into the model. A total of 2000 runs were performed using Monte Carlo probabilistic algorithms to compute the probabilistic response. This study establishes the relative importance of the spinal components in resisting the loading modes. The results show that, for an intact motion segment, posterior ligaments are more dominant than intervertebral disc in resisting flexion moment. In extension, the capsular ligaments were found to be the most influential parameter. The intervertebral disc (i.e., nucleus and annulus) affects the angular response of the disc-body segment more than the hard tissues (i.e., cortical and cancellous bone). The application of the probabilistic analysis provides a new approach whereby the influences of inherent uncertainties and variations in biological structures could be studied and the biomechanical response could be assessed.

Keywords: Biomechanics, Finite element analysis, Probabilistic analysis, Sensitivity