Analysis and Converge Study of Three Dimensional Finite Element Lumber Spine Model

Shou-I Chen, Chih-Han Chang, Chun-Li Lin, Chian-Yuh Lin*

Institute of Biomedical Engineering , National Cheng-Kung University
*Chia Nan Collage of Pharmacy and Science Department of Pharmacy

ABSTRACT

The objective of this study is to establish a three dimensional finite element model whose geometry and material property can more accurately represent the human lumbar spine. Serial transverse slices of a patient's lumbar spine (L3-L4) were obtained from a computerized tomography (CT) system. The geometric boundaries of the spine were detected from these CT images with a self-developed image processing system, these boundaries were then transferred to an automatic mesh program to generate the three dimensional spine mesh. The material properties of each element were obtained directly from the CT numbers. This finite element model could express the variation in material properties and the complicated geometry of the spine. To validate the mechanical response of this model, axial compression loading were applied on the superior surface of L3. The principal stresses under this static loading were found to have the same trend as those of the bone density distribution and trabecular bone orientation which were constructed with the Wolff's Law predication. From the analysis, the number of material types should be greater than eight in order to achieve a better convergence, and this model has the better approximate geometry and mechanical property behavior. From the convergence study of this model, it showed that under this simple loading eight kinds of material distribution of cancellous bone could achieve a 99% of strain energy convergent rate. The 3.5mm element size employed in this model also achieve a good convergent results while comparing the stress distribution and strain energy with low order and high order elements.

Key words: Converge study, Finite element model, Lumbar Spine