Finite Element Analysis of Moment-Rotation Relationships for Human Cervical Spine

Qing Hang Zhang¹, Ee Chon Teo¹*, Hong Wan Ng¹, Vee Sin Lee²

¹School of Mechanical and Production Engineering, Nanyang Technological University, Singapore, 639798
²Defence Medical and Environmental Research Institute @ DSO National Laboratories, Singapore 117510

J Biomechanics 2006 Jan; 39(1): 189-193

Abstract

A comprehensive, geometrically accurate, nonlinear C0-C7 FE model of head and cervical spine based on the actual geometry of a human cadaver specimen was developed. The motions of each cervical vertebral level under pure moment loading of 1.0Nm applied incrementally on the skull to simulate the movements of the head and cervical spine under flexion, tension, axial rotation and lateral bending with the inferior surface of the C7 vertebral body fully constrained were analysed. The predicted range of motion (ROM) for each motion segment were computed and compared with published experimental data. The model predicted the non-linear moment-rotation relationship of human cervical spine. Under the same loading magnitude, the model predicted the largest rotation in extension, followed by flexion and axial rotation, and least ROM in lateral bending. The upper cervical spines are more flexible than the lower cervical levels. The motions of the two uppermost motion segments account for half (or even higher) of the whole cervical spine motion under rotational loadings. The differences in the ROMs among the lower cervical spines (C3-C7) were relatively small. The FE predicted segmental motions effectively reflect the behavior of human cervical spine and was in agreement with the experimental data. The C0-C7 FE model offers potentials for biomedical and injury studies.

Keywords: Finite element, Physiological loading, Cervical spine, Motion, Biomechanics