AN ACCURATE FINITE ELEMENT MODEL OF C4-C5 CERVICAL SPINE SEGMENT

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Introduction

Finite element (FE) model has been introduced as one of biomechanical models used in understanding underlying mechanisms of injury and dysfunction in cervical spine. By using FE model of cervical spine it is feasible to define roles of various anatomic elements (e.g., facets and intervertebral discs) in supporting physiologic and traumatic loads applied to the cervical spine, Panjabi (1988). The aim of this paper was to develop a detailed FE model of C4-C5 segment of cervical spine in each tissue level. The focus was on accurate representation of geometry and material properties. The model was validated against the reported datasets in literature with different loading types.

Materials and Methods

The accurate geometry of C4-C5 segment was achieved from CT data of a 35-year old man. In order to create fine hexahedral mesh on vertebrae and discs surfaces, multiblock approach introduced by Kallemeyn et al. (2009) in IA-FEMESH software (The University of Iowa, Iowa City, IA) was used, Fig. 1. All five different groups of ligaments were simulated using truss elements with no compression option. Facet joints were simulated using gap elements with softened exponential contact and initial gap distance. The annulus parts of the disc were embedded with fiber and the ground substance was modelled with hyperelastic material.

Results and discussion

The model was validated against the published *in vitro* studies (Goel et al., 1988; Panjabi et al., 2001; Wheeldon et al., 2006) in flexion, extension, right lateral bend and right axial rotation loading, Fig. 2. The simulated results were stiffer in flexion with 0.33 Nm load but in 1.0 Nm load it was in the corridor of both Panjabi et al. (2001) and Wheeldon et al. (2006). The model accurately predicted the extension rotation in comparison to the results of Wheeldon et al. (2006) in both lower and higher loads. In right lateral bend the FE model was stiffer than the both *in vitro* studies. In right axial rotation the rotation response was in the corridor of Goel et al. (1988) while it showed higher amount of rotation than the result of Panjabi et al. (2001). In general, there are some differences between the experimental reported datasets due to couple of factors, i.e. specimen age, fixation and resulting boundary conditions, Nightingale et al. (2007). The results of current model are mostly within the corridor of different experimental datasets for the lower and higher load cases.

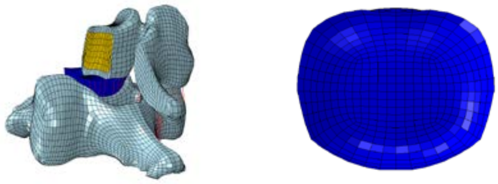

Fig. 1. Sectioned view of C4-C5 segment and disc.

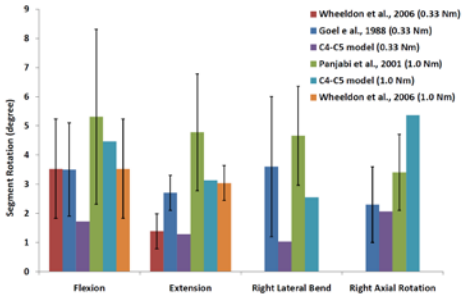

Fig. 2. Rotation response of the C4-C5 segment in different loading types.

References

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