Study of Neck Geometry Effects on Whiplash Injury Using Finite Elements Method

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I. INTRODUCTION

Whiplash injuries are one of the most common injuries reported from automotive rear-impact accidents. Statistical data have shown that females have up to three times higher risk of sustaining whiplash injuries than males in similar crash conditions [1]. Despite advances in whiplash injury research, no simple explanation has been found for this difference. While it is thought that the anatomic dissimilarity of the genders is the main reason, the correlation between some of the neck anatomic features such as neck geometry and the neck response in rear impacts has yet to be firmly established. The objective of this study was to analyze the influence of head mass and neck geometry on cervical facet joint motion in a rear impact.

II. METHODS

The study was conducted using a validated intact head to first thoracic vertebra (T1) computational model from Wayne State University (WSU) (Fig. 1). The model was modified to incorporate head mass and neck geometry variation between female and male which was extracted from the literature. Design of computer experiment (DOCE) was used to assess effects of head mass, facet joint angle, and vertebrae body depth and height on facet joint motion. Rear impacts were simulated by horizontally accelerating the T1 vertebra. Characteristics of the acceleration pulse were based on the horizontal T1 acceleration pulse from a series of simulated rear-impact experiments using full-body post mortem human subjects.

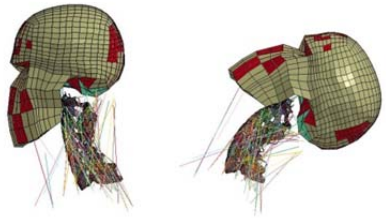

Fig 1. Head and neck model used in the study

III. INITIAL FINDINGS

The facet joint motion was not statically different between female and male models. However, facet joint motion increased with the increase of head mass, increase of facet joint angle and decrease in vertebrae body depth. The facet joint motion magnitudes were greatest at C5-C6. Greater facet joint motion was observed to be mainly attributable to head mass and facet joint angle.

IV. DISCUSSION

These findings indicate that the neck geometry difference influenced the cervical facet joint motion in a rear impact accident. Increase in facet joint motion correlates with female neck geometry features such as bigger facet joint angle and smaller vertebra depth relative to the male. However, the smaller head mass of the female relative to the male seems to counteract both of the previous effects on facet joint motion.

V. REFERENCES

[1] Storvik SG, Stemper BD, Yoganandan N, Pintar FA. Population-based estimates of whiplash injury using NASS CDS data. *Biomed Sci Instrum.* 2009, 45:244–249.

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