Evaluation of Head and Cervical Spine Kinematics of a GHBMC M50 Occupant Seated in a Production Seat in a Moderate Rear Impact Scenario

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Background – Studies on moderate-speed rear impacts are gaining importance due to higher incidence of cervical spine injuries (Maximum Abbreviated Injury Scale 3+) than in low-speed rear impact studies (Kang et al., 2012). Evaluating head and cervical spine kinematics of vehicle occupants in a moderate-speed rear impact scenario would help understand the injury mechanism and improve seat designs for better protection of vehicle occupants. Previous studies by Kang et al. (2014, 2015) investigated the responses of head and cervical spine of two PMHS seated in a production seat in a moderate-speed rear impact scenario. Finite element (FE) human body models (HBM) could be used to supplement experimental studies and investigate occupant responses in detail. Therefore, the current study focused on evaluating biofidelity of the Global Human Body Models Consortium (GHBMC) M50, by comparing the head and cervical spine kinematics to those from studies by Kang et al. (2014, 2015).

Objective – The objective of the study was to investigate differences in the head and cervical spine kinematics between the GHBMC M50 occupant model and post-mortem human subjects (PMHS), seated in a production seat and subjected to a moderate-speed rear impact.

Methodology – Simulations were performed using the GHBMC 50th male simplified (M50-OS) FE model in LS-Dyna. The GHBMC M50-OS was positioned on the production seat such that the horizontal distance between the head and the head restraint of the seat was set to 50 mm, based on the positioning information in the PMHS experiments. Shoulder and lap belt segments were added to the seated model. Contacts were defined between the model and the head restraint, seat back, and seat pan. A moderate rear impact pulse (10.3 g, 24 kph) was prescribed to the sled floor. Head, cervical spine and 1st thoracic vertebra (T1) kinematics were measured in global and local coordinate systems (SAE-J211).

Results and Current Conclusions – Kinematic parameters with notable differences in outcomes between GHBMC and the two PMHS are presented here. The peak rearward rotation of T1 about the y axis from the GHBMC (29.6°) was lower than those from the PMHS (39.8˚ and 41.7°). The peak forward relative head rotation to T1 about the y axis was also lower for the GHBMC (-12.0°) than those for PMHS (-20.2˚ and -30.8˚). The peak rearward rotations of the intervertebral levels C2-C3 through C5-C6 about the y axis ranged from 1.3˚ to 5.6˚ for the GHBMC, whereas no rearward rotation about the y axis was observed in the case of the PMHS. The peak acceleration of head in the x direction was much higher from the GHBMC (25.2 g) than those from the PMHS (16.4 g and 17.7 g). The results suggest that there might be a need to improve the GHBMC model to better replicate vehicle occupant kinematics in moderate speed rear impact.

References –

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