Development and Preliminary Validation of Chestband Data from a Full Body Finite Element Model

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ABSTRACT

Post-Mortem Human Subjects (PMHS) and finite element (FE) computer models are often used to examine the biomechanical response of the human body in vehicular crashes. The purpose of this study is to present a methodology for extracting chestband data from a full body FE model, and to compare the model's results in frontal and lateral impacts to experimental results using chest bands. Chestbands provide chest deformation contours in a given plane during impact. PMHS data from two studies were used to compare chestband data from the Global Human Body Models Consortium (GHBMC) mid-sized male model. The GHBMC model was run using LS-DYNA (LSTC, Livermore, CA, R. 4.2.1) to simulate the impacts from both studies [1, 2]. The model was pre-programmed with an upper, middle, and lower chestband each comprised of 32 nodes. The chestbands were placed around the circumference of the chest approximately at the level of the 4th, 6th, and 8th rib, and matched the description of chestband locations in the literature. The nodal data from the GHBMC model were exported to MATLAB (The Mathworks, R 10). One local coordinate system was defined per chestband using nodes on T9, T12, and L1. Node locations on the chestbands at the maximum deflection state for the GHBMC model were plotted. Maximum deflection was determined using the methods of Kuppa and Eppinger [3]. Additionally, an advantage of the virtual chestband is that it cannot separate from the body since it is composed of nodes on the exterior flesh of the model. When comparing the GHBMC model chestband results to both the frontal impact cases (8.1 meters/second(m/s) and 13.3 m/s) [1], there are strong similarities in shape that are clear functions of the belt path. This includes compression in center of the upper chestband for both cases and for the lower chestband compression is seen on the left side for the 8.1m/s case and on the right side for the 13.3m/s case. Also when comparing the GHBMC model to the lateral impact study [2], the upper and middle chestbands exhibit compression on the left side. For the frontal sled data at 8.1 m/s, the GHBMC model predicted peak deflection of the upper chestband to be 9.7%, where as the literature reported a peak deflection 16±5.6%. For the frontal sled data at 13.3 m/s, the GHBMC model predicted the upper chestband peak deflection to be 11.1%, compared to literature which reported a peak deflection of 23±5.6%. Finally, when examining the lateral sled case, the GHBMC model predicted the percent compression of the upper chestband to be 36.7% and of the middle chestband to be 27.1%, compared to literature which reported a 36.0% and 36.8% compression. Minimal differences between the GHBMC model and lateral case were observed, but somewhat larger discrepancies were observed in frontal thoracic loading. While this work was focused on the technique used to extract chestband data from the model, these initial results will also be used to further validate the GHBMC model.