

Analysis of occupant kinematics and dynamics in nearside oblique impacts

F.J. López-Valdés, O. Juste, M. Maza, B. Pipkorn, C. Sunnevang, A.I. Lorente, A. Aso Vizán, J. Davidsson

Abstract-

OBJECTIVE:

The objective of this article is to analyze the kinematics and dynamics of restrained postmortem human surrogates (PMHS) exposed to a nearside oblique impact and the injuries that were found after the tests.

METHODS:

Three male PMHS of similar age (64 ± 4 years) and anthropometry (weight: 61 ± 9.6 kg; stature: 172 ± 2.7 cm) were exposed to a 30° nearside oblique impact at 34 km/h. The test fixture approximated the seating position of a front seat occupant. A rigid seat was designed to match the pelvic displacement in a vehicle seat. Surrogates were restrained by a 3-point seat belt consisting of a 2 kN pretensioner (PT), 4.5 kN force-limiting shoulder belt, and a 3.5 kN PT lap belt. The shoulder belt PT was not fired in one of the tests. Trajectories of the head, shoulder, and hip joint (bilaterally) were recorded at 1,000 Hz by a 3D motion capture system. The 3D acceleration and angular rate of the head, T1, and pelvis, and the 3D acceleration of selected spinal locations was measured at 10,000 Hz. Seat belt load cells measured the belt tension at 4 locations. PMHS donation and handling were performed with the approval of the relevant regional ethics review board.

RESULTS:

Activation of the shoulder PT reduced substantially the peak forward excursion of the head but did not influence the lateral displacement of the head center of gravity (CG). In all 3 subjects, the lateral excursion of the head CG (291.1, 290, 292.1 mm) was greater than the forward displacement (271.4, 216.7, 171.5 mm). The hip joint excursion of the PMHS that was not exposed to the shoulder PT seat belt was twice the magnitude observed for the other 2 subjects. The 3 PMHS sustained clavicle fractures on the shoulder loaded by the seat belt and 2 of them were diagnosed atlantoaxial subluxation in the radiologist examination. Avulsion fractures of the right lamina of T1, T2, T3, and T4 were found when the PT was not used. The 3 PMHS received multiple fractures spread over both aspects of the rib cage and involving the posterior aspect of it.

CONCLUSION:

In this study of nearside oblique impact loading, the PMHS exhibited kinematics characterized by reduced torso pitching and increased lateral head excursion as compared to previous frontal impact results. These kinematics resulted in potential cervical and thoracic spinal injuries and in complete, displaced fractures of the lateral and posterior aspects of the rib cage. Though this is a limited number of subjects, it shows the necessity of further understanding of the

kinematics of occupants exposed to this loading mode.

Index Terms- Oblique impacts; Post Mortem Human Surrogates (PMHS); kinematics; nearside; thoracic injuries

Due to copyright restriction we cannot distribute this content on the web. However, clicking on the next link, authors will be able to distribute to you the full version of the paper:

[Request full paper to the authors](#)

If your institution has an electronic subscription to Traffic Injury Prevention, you can download the paper from the journal website:

[Access to the Journal website](#)

Citation:

López-Valdés, F.J.; Juste, O.; Maza, M.; Pipkorn, B.; Sunnevang, C.; Lorente, A.I.; Aso Vizán, A.; Davidsson, J.; "Analysis of occupant kinematics and dynamics in nearside oblique impacts", Traffic Injury Prevention, vol.17, no.Sup 1, pp.86-92. September, 2016.