

Chest injuries of elderly Post Mortem Human Surrogates (PMHS) under seat belt and airbag loading in frontal sled impacts. Comparison to matching THOR tests

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Abstract-

Objective:

The goal of the study was to develop experimental chest loading conditions that would cause up to Abbreviated Injury Scale (AIS) 2 chest injuries in elderly occupants in moderate-speed frontal crashes. The new set of experimental data was also intended to be used in the benchmark of existing thoracic injury criteria in lower-speed collision conditions.

Methods:

Six male elderly (age ≥ 63) postmortem human subjects (PMHS) were exposed to a 35 km/h (nominal) frontal sled impact. The test fixture consisted of a rigid seat, rigid footrest, and cable seat back. Two restraint conditions (A and B) were compared. Occupants were restrained by a force-limited (2.5 kN [A] and 2 kN [B]) seat belt and a preinflated (16 kPa [A] and 11 kPa [B]; airbag). Condition B also incorporated increased seat friction. Matching sled tests were carried out with the THOR-M dummy. Infra-red telescoping rod for the assessment of chest compression (IRTRACC) readings were used to compute chest injury risk. PMHSs were exposed to a posttest injury assessment. Tests were carried out in 2 stages, using the outcome of the first one combined with a parametric study using the THUMS model to adjust the test conditions in the second. All procedures were approved by the relevant ethics board.

Results:

Restraint condition A resulted in an unexpected high number of rib fractures (fx; 10, 14, 15 fx). Under condition B, the adjustment of the relative airbag/occupant position combined with a lower airbag pressure and lower seat belt load limit resulted in a reduced pelvic excursion (85 vs. 110 mm), increased torso pitch and a substantially lower number of rib fractures (1, 0, 4 fx) as intended.

Conclusions:

The predicted risk of rib fractures provided by the THOR dummy using the Cmax and PC Score injury criteria were lower than the actual injuries observed in the PMHS tests (especially in restraint condition A). However, the THOR dummy was capable of discriminating between the 2 restraint scenarios. Similar results were obtained in the parametric study with the THUMS model.

Index Terms- Elderly, frontal impacts, post mortem human surrogate, THOR, airbag

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