Comparison of Kinematic and Dynamic Behavior of an Obese Dummy and Obese PMHS in Frontal Sled Tests

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Abstract

Study Objective: As previous studies have demonstrated that there is an increasing association between obesity and mortality in automobile collisions, increased attention to injury prevention of obese occupants seems necessary. The purpose of this study is to compare the kinematic and dynamic behavior of a first generation of obese dummy with two obese post mortem human surrogates (PMHS) in matching frontal impact sled tests.

Problem: Assessment of dummy biofidelity requires comparison of dummy kinematics and dynamics with a biological model (in this case, PMHS) in matched test conditions.

Methodology: The obese dummy was built around an existing fiftieth percentile THOR male crash test dummy's skeletal structure but with unique flesh and additional mass added to the upper and lower torso and upper legs. It had a mass of approx.124 kg, stature of 189 cm, and body mass index (BMI) of 35 kg/m2. Four tests, including two 48 km/h PMHS and two 48 km/h dummy were performed with a sled buck representing the rear seat occupant component of a 2004 mid-sized sedan, and with 3-point belt restraint including a retractor pretensioner and a progressive force-limiter.

Results and Data: Forward motion of head and knee of the dummy were within 14 cm and 4 cm, respectively, of the mean PMHS values, and forward motion of pelvis of the dummy was 7 cm greater than the PMHS mean. The mean peak of upper shoulder belt, lower shoulder belt, and lap belt tension in dummy tests were 6.5 kN, 6.7 kN, and 8.8 kN, and in PMHS tests, they were 6.4kN, 6.3 kN, and 8.3kN. Peak head, chest, and pelvis accelerations also tended to be greater with the dummy than with the PMHS.

Summary and Conclusion: The obese dummy exhibited the same kinematic characteristics that have been highlighted previously as potentially challenging for restraint systems design – most notably, both the PMHS and dummy exhibited substantial forward motion of lower body and subsequent backwards rotation of the torso affected by limited engagement of the lap belt with

the pelvis. Although the differences presented suggest that further refinement may be warranted, the similarities suggest that this dummy may prove useful as a research tool to begin investigating the challenges of, and potential strategies for, the safe restraint of obese occupants.