Comparison of ATD and Human Body Models for Side Impact Scenarios

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Introduction
- In 2012, side impact accounted for 38% of fatalities during passenger car collisions (IIHS, 2013) with thoracic injuries being significant.
- Anthropometric Test Devices (ATD) are used to evaluate vehicle safety through virtual simulations followed by physical testing.
- Detailed Human Body Models (HBM) are used to investigate omni-directional loading scenarios and predict the potential for injury at the tissue level.

Objective
- To compare the kinetic and kinematic response of an ATD model and HBM for various loading conditions (concentrated load, distributed load and full vehicle scenario).

ATD and Human Body Model V&V
- The ES-2re finite element model (Dynamore, Version 6.0) met the calibration tests and response requirements used for the physical ATD (rib certification and thorax certification tests).
- HBM validated using pendulum (front, lateral, oblique) and side sled impact tests (Forbes 2005; Campbell 2009; Yuen 2009).

Methods
- HBM and ATD models were subjected to three loading scenarios: lateral pendulum impact, side sled and vehicle side impact. Predicted responses were compared to the PMHS data available in the literature. ATD and HBM responses were compared using cross-correlation (CORA).

Methods Cont’d
Vehicle Side Impact
Response: chestband deflection
- The ATD and HBM were integrated with a seat, restraint system and vehicle model (2001 Ford Taurus, NCAC). The vehicle was impacted by a moving deformable barrier model.
- Component and integrated model validation undertaken using NHTSA impact data (Watson et al., 2011; Campbell 2014).

Results

Discussion and Conclusions
- The HBM model response was in good agreement with the available PMHS response corridors.
- Pendulum impact: The ATD exhibited higher force response compared to the HBM. The response was sensitive to variations in the pendulum impact location.
- Sled impact: Deformation of the HBM thorax during impact distributed the load over multiple force plates, compared to the ATD thorax model. Interaction with the struck HBM arm was noted to have a significant effect on the HBM response.
- Vehicle impact: The kinematic results were generally similar between the ATD and HBM. Alternate arm or occupant positions were found to affect the kinematic response.
- Local differences in response (e.g. chest compression) have been identified between the HBM and ATD and were attributed to the engagement of different tissues/structures in the models. Future work will focus on understanding these local differences using a larger set of impact scenarios.

Limitations
- One impact condition for the three loading scenarios was considered. Ongoing research will include additional impact velocities.
- Future work will investigate the effect of occupant position on response.