Comparison of the Knee-Thigh-Hip Response in Small Female ATDs With Female PMHS

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Introduction
There is a lack of PMHS data that can separate and quantify the effects of sex and size at the KTH complex. Further, enhancing the biofidelity of female ATDs requires matched PMHS data to compare to. Previous work performed by the authors looked at the force transfer along KTH in female PMHS through new testing and the development of lumped parameter models. This study evaluates the force transfer along KTH for two ATDs and compares it with the results derived from PMHS data.

Objective
The current study is aimed at comparing the knee-thigh-hip (KTH) response in both the THOR-5F and the Hybrid III 5th Female ATDs with testing performed using female PMHS. The objective of the study includes examining differences in force transfer along KTH between the various subjects.

Methodology
The THOR-5F and the Hybrid III 5th Female ATDs were placed onto a low friction surface and tested under bilateral whole-body KTH impact conditions. The impactor was driven using a pneumatically driven linear actuator that was controlled with active feedback. The impactor was padded with an energy absorbing polymer mounted onto multi-axis load cells that measured the impact forces applied to the knee. Subjects were tested at impact velocities of 2.5, 3.5, and 4.9 m/s, and the results were then compared to four female PMHS that were impacted under matched conditions.

Results and Conclusion
The dataset provided in this study includes the force transfer along KTH (knee, femur, and hip) for the four PMHS and the THOR-5F, and Hybrid III 5th female ATDs. Velocities at impact include 2.5, 3.5, and 4.9 m/s, which produced loading rates similar to those observed in automotive crash conditions. All subjects were compared in the whole-body condition.

Mean PMHS force transfer from knee to femur and knee to hip were estimated as 68% and 58%, respectively. Mean force transfer for the THOR-5F ATD knee-to-femur was 82%, and 43% for knee-to-hip. Mean force transfer for the Hybrid III 5th Female was 80% from knee to femur with the hip data to come later. Current results would indicate that the force transfer is greater in the ATDs than the PMHS for the femur, but lower for the hip, suggesting that more force is lost between the femur load cell and the hip for small female ATDs compared to the female PMHS. Possible reasons for this include the presence of deformable elements in the ATDs or more rigid coupling at the hip.