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Differences in the kinematics of booster-seated pediatric occupants using two different car seats

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Abstract-

Objective:
The objective of this article is to compare the performance of forward-facing child restraint systems (CRS) mounted on 2 different seats.
Methods:
Two different anthropomorphic test device (ATD) sizes (P3 and P6), using the same child restraint system (a non-ISOFIX high-back booster seat), were exposed to the ECE R44 regulatory deceleration pulse in a deceleration sled. Two different seats (seat A, seat B) were used. Three repetitions per ATD and mounting seat were done, resulting in a total of 12 sled crashes. Dummy sensors measured the head tri-axial acceleration and angular rate and the thorax tri-axial acceleration, all acquired at 10,000 Hz. A high-speed video camera recorded the impact at 1,000 frames per second. The 3D kinematics of the head and torso of the ATDs were captured using a high-speed motion capture system (1,000 Hz). A pair-matched statistical analysis compared the outcomes of the tests using the 2 different seats.
Results:
Statistically significant differences in the kinematic response of the ATDs associated with the type of seat were observed. The maximum 3 ms peak of the resultant head acceleration was higher on seat A for the P3 dummy (54.5 ± 1.9 g vs. 44.2 ± 0.5 g; P =.012) and for the P6 dummy (56.0 ± 0.8 g vs. 51.7 ± 1.2 g; P =.015). The peak belt force was higher on seat A than on seat B for the P3 dummy (5,488.0 ± 198.0 N vs. 4,160.6 ± 63.6 N; P =.008) and for the P6 dummy (7,014.0 ± 271.0 N vs. 5,719.3 ± 37.4 N; P =.015). The trajectory of the ATD head was different between the 2 seats in the sagittal, transverse, and frontal planes.
Conclusion:
The results suggest that the overall response of the booster-seated occupant exposed to the same impact conditions was different depending on the seat used regardless of the size of the ATD. The differences observed in the response of the occupants between the 2 seats can be attributed to the differences in cushion stiffness, seat pan geometry, and belt geometry. However, these results were obtained for 2 particular seat models and a specific CRS and therefore cannot be directly extrapolated to the generality of vehicle seats and CRS.

Index Terms- Frontal impact, ECE-R44, different seats, head displacement, pediatric occupants

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