C37 An Experimental Investigation Into the Proper Installation of Child Belt Positioning Booster Seats

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The goal of this presentation is to compare two different methods for installing a belt positioning booster (BPB) and the effects each installation method may have on a child occupant. After attending this presentation, attendees will understand what a belt positioning booster seat is and the difference between an automatic locking retractor (ALR), an emergency locking retractor (ELR), and a switchable retractor. Using anthropomorphic child dummies, the effect of these different retractors on head and neck kinematics in a frontal crash is demonstrated.

The presentation will impact the forensic science community by demonstrating how ALR restraints provided the best protection for the booster positioned child.

Field accident studies indicate that, with the exception of a rear impact, the rear seat area of a motor vehicle is the safest location for placement of children, provided the child is securely restrained in a properly designed child restraint system. BPBs are one such system that position the child on a vehi- cle seat to improve the fit of the vehicle's lap and shoulder belt system. These booster seats do not have any attached or integrated components such as a belt system or a structural element designed to restrain the forward move- ment of the child's torso in a frontal impact. The vehicle belts provide the forward restraint. The National Traffic Safety Administration (NHTSA) Child Passenger Safety Technician Manual indicates two correct methods for using vehicle restraints for BPBs. According to the manual, if a vehicle is equipped with a switchable retractor, the retractor can be left in the emergency locking retractor mode or placed in the automatic locking mode if a child is "wiggly" or more active.

Previous sled tests by Bidez, et al., have examined the effects of using a retractor-mounted pretensioner to reduce torso rollout on both a Hybrid III 6-year-old and a Hybrid III 5th percentile female.[1] The purpose of the pretensioner is to reduce the slack in the belt system. Her findings were that the pretensioner prevented torso rollout of the 6-year-old dummy. Engaging the ALR will also eliminate the slack in a belt system utilizing equipment al- ready available in most vehicles.

Two 48 kph frontal sled-buck impact tests, with 3 and 6 year-old child ATDs in BPBs, were run to compare the injury responses between the ELR and ALR modes. A model year 2000 4-door sedan body-buck sled system was towed into a crushable honeycomb barrier to simulate a frontal impact condition. The results of these tests were compared to the Federal Motor Vehicle Safety Standard (FMVSS 213) criteria.

Pitching forward, torso rollout, and head rotation can create dangerous neck stretch in young children. Cervical spine distraction injuries resulting in paralysis and death can result when neck tension exceeds tolerance levels. Axial neck tension force magnitude, the force creating spinal distraction, is directly related to the maximum head acceleration in the Z direction (A_Z). A comparison of dummy head A_Z and dummy head motion using the ALR and ELR belt systems is presented. The comparison reveals that the ALR restraint provided the best protection for the booster positioned child. This study further compares the results from the sled tests to injuries in real world situations.

Reference:

[1] Bidez MW, Hauschild HW, Mergl KM, and Syson SR, "Small Occupant Dynamics in the Rear Seat: Influence of Impact Angle and Belt Restraint Design," SAE Technical Paper Series, Paper No. 2005- 01-1708, SAE International, Warrendale, Pennsylvania, April 2005.

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