

Comfort accessories for elderly drivers: Influence on occupant injury risk.

Tom Whyte^{a,b}, Nick Kent^a, Lisa Keay^b, Kristy Coxon^c, Julie Brown^{a,b}

^a Neuroscience Research Australia, ^b University of NSW, ^c Western Sydney University

Abstract

The aim of this study was to analyse the effect of various comfort accessories, observed to be used by 26% of elderly drivers, on occupant injury risk. A collection of frontal sled tests using a 5th percentile Hybrid III dummy showed increased sternal deflection when the dummy was seated on cushioning, indicating potential for increased thoracic injury. When a lumbar support roller and cushion were used the dummy submarined under the lap belt which would pose an increased risk of severe abdominal injury.

Background

Twenty-six percent of drivers aged 75 and over have been observed using a comfort accessory, such as cushions, back supports and seat covers in their vehicle (Fong, Keay, Coxon, Clarke & Brown, 2016). The effect of the comfort accessories on occupant injury risk, however, is unknown. In the context of child passengers, similar accessories impair crash protection. Elderly drivers are more fragile and frail than younger vehicle occupants and hence impaired effectiveness of the restraint system can have significant impacts in this population. The primary body regions of concern for three-point seat belt related injury risk are the thorax and abdomen. The aim of this study was to examine the effect of comfort accessories on impact crash protection.

Method

Frontal sled tests were conducted on a deceleration sled at the Transurban Road Safety Centre at NeuRA with a 5th percentile female Hybrid III dummy, intended to represent a small stature older occupant, at a severity of 32 g peak sled deceleration, 43 km/h initial velocity and 70 ms pulse duration typical of a moderate-to-severe frontal crash. Eight identical front seats from 2002-2007 model commercially available Australian passenger car were used with a new seat for the baseline test and each of the following seven accessories: seat wedge cushion, swivel seat cushion, lumbar support roller, lumbar cushion, mesh lumbar support, large lumbar support and a padded seat cover. The dummy was instrumented with a rotational potentiometer in the chest, a 6-axis load cell at the upper neck and triaxial arrays of accelerometers in the head and the chest. Dummy instrumentation therefore measured sternal deflection, upper neck loads, head acceleration and chest acceleration. The Head Injury Criterion (HIC₁₅) was calculated from the head accelerations and the Neck Injury Criterion (N_{ij}) from the upper neck load cell using critical intercept values for the 5th percentile female (Eppinger et al. 1999). The deceleration event was captured by a high-speed camera recording at a sampling rate of 1 kHz. High-speed video was used to assess whether the pelvis of the dummy submarined under the lap portion of the belt.

Results

The peak responses of the dummy are shown in Table 1. Accessories placed on the seat surface under the dummy (seat wedge, swivel seat cushion and padded seat cover) increased the sternal deflection by up to 56% compared to the baseline test. Lumbar support accessories, with the exception of the large lumbar support, were associated with an increase in HIC₁₅ compared to the baseline test by up to 26%. The dummy submarined when the lumbar support roller and the lumbar cushion were used (see Figure 1) whereas no submarining occurred in the baseline test or with the other accessories.

Table 1. Peak dummy responses for each comfort accessory in frontal sled test (32 g, 43 km/h)

Test condition	HIC ₁₅	N _{ij}	Peak chest acceleration (g)	Sternal deflection (mm)
Baseline (no accessory)	694.7	0.589	89.3	30.1
Seat wedge cushion	618.5	0.540	82.1	47.0
Swivel seat cushion	492.9	0.500	82.7	45.1
Lumbar support roller	747.6	0.448	68.4	34.1
Lumbar cushion	843.9	0.457	87.5	33.6
Large lumbar support	597.1	0.590	91.9	31.8
Mesh lumbar support	878.0	0.601	86.1	33.1
Padded seat cover	735.0	0.572	92.6	37.2

**Figure 1. Post-crash belt position for the baseline test (left) and lumbar support roller (right) showing the belt intruded into the abdomen when using the lumbar support roller**

Conclusions

The results indicate comfort accessories have the potential to negatively impact restraint system effectiveness in a moderate-to-severe frontal crash. While the absolute risk of injury to older occupants cannot be calculated due to the unavailability of applicable injury risk curves based on Hybrid III 5th percentile female responses, increased sternal deflection indicates a potential higher risk of chest injury when seated on cushions. Lumbar supports negatively altering the initial position of the pelvis were associated with observed submarining and this also potentially increases risk of injury. Collaboration with clinicians and older drivers is needed to develop appropriate guidelines for the use of comfort accessories in cars.

References

- Fong, C., Keay, L., Coxon, K., Clarke, E., Brown, J., 2016. Seat belt use and fit among drivers aged 75 years and older in their own vehicles. *Traffic Injury Prevention*, 17(2), p142-150.
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