Crash Performance of Type-G Forward-facing Child Restraints for Older Children

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I. INTRODUCTION

Compared to younger children, older children (6–12 years) are disproportionately injured as occupants in car crashes, sustaining the majority of injuries (55.4%) despite representing only 43.1% of child occupants [1]. The greater risk of hospitalisation and fatalities in older children suggest that traditional restraints for this age group are suboptimal [2]. Seat belts are excellent restraints for adults, but due to the differences in anatomy of children (immature bones and smaller size) they do not provide the same protective benefits to children [3-4]. Booster seats aim to alleviate this issue by aligning seat belts with a child's anatomy and boosting the seated height, but how well they achieve this remains unclear [5]. Conversely, forward-facing child restraints (CRs) are consistently shown to be highly effective, although most studies have analysed forward facing CRs only for younger children. Type-G CRs are forward-facing CRs, introduced in the 2013 version of the Australian/New Zealand standard (AS/NZS 1754), that accommodate children up to approximately 8 years of age in a harnessed restraint. However, their effectiveness specifically for children in this older age range, and relative to booster seats, has yet to be studied. A frontal test of a single Type-G restraint reported excessive forward excursion of the dummy in a sled test compared to a high-back booster [6], but this result has not been replicated and the extent to which this is typical of all Type-G restraints is unknown. The aim of this study is to compare the relative crash performance of Type-G CRs compared to booster seats, when restraining an older child. This was tested through frontal and side-impact crash tests.

II. METHODS

Frontal and side-impact crash tests approximating the AS/NZS 1754 (2013) frontal and side-impact test conditions were conducted using three Type-G CRs and one booster seat. Each test was repeated twice. During frontal testing a Q6 dummy was subjected to a mean peak sled deceleration of 30.3 g and a velocity change of at least 49 km/h. Side-impact testing subjected the dummy to a mean peak sled deceleration of 18.3 g and at least a 32 km/h velocity change with a side-door structure adjacent to the dummy seating position. The setup for these tests is shown in Fig. 1.

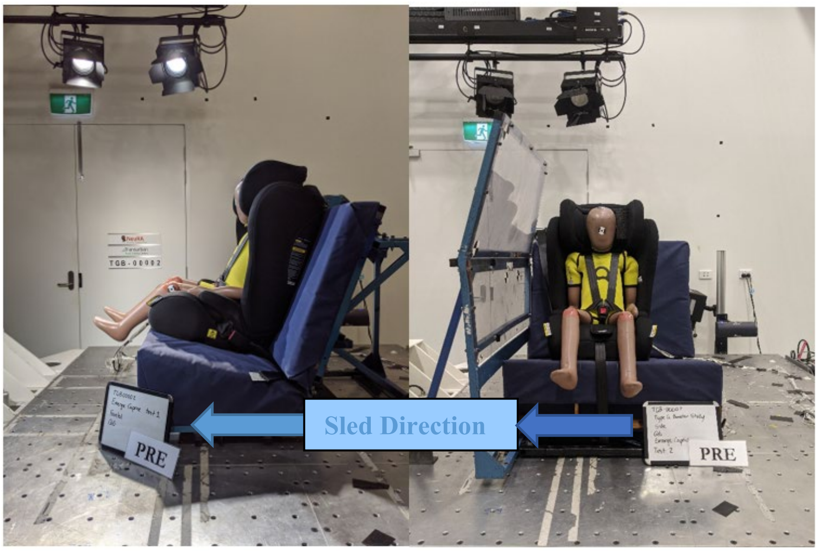

Fig. 1. Frontal and side-impact setup.

The Q6 dummy was equipped with triaxial accelerometers in the head and pelvis, and all data were collected using an onboard data acquisition system, in accordance with SAE J211. The accelerometer data from the head was used to calculate the Head Injury Criterion (HIC). High-speed video was captured (Phantom Miro R111, Phantom C110, Vision Research Inc.) and used to record dummy movement. This video was analysed in ProAnalyst to measure maximum forward head excursion of the dummy in the frontal crash configuration.

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III. INITIAL FINDINGS

Figure 2 shows the mean maximum forward head excursion for each restraint type and indicates a similar excursion for two Type-G CRs compared to the booster, with one Type-G model (769 mm) exceeding the booster excursion (697 mm).

In both frontal tests with new restraints, the Type-G CR-3 sustained significant permanent damage. Side-impact tests were not conducted on this restraint due to the risk of damage to the dummy if similar failures occurred in side impact.

Peak acceleration and Head Injury Criterion analysis is currently being performed.

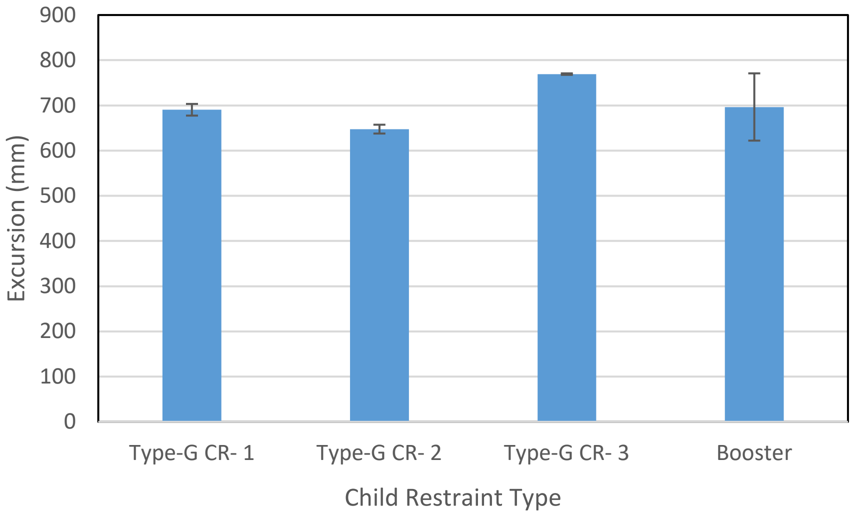

Fig. 2. Head excursion in frontal impacts.

IV. DISCUSSION

These initial findings suggest that Type-G CRs do not confer any significant benefit over a booster seat for older children. Head excursion is important to consider during crash tests as it can indicate the likelihood that a child's head would collide with structures in the car during a crash, which is the leading mechanism for head injury in motor vehicle crashes [7]. The increased average head excursion (72 mm) for one Type-G model was not as large as the increase noted in a previous single full crash test comparison of a Type-G CR and a booster (152 mm) [6]. The design of some Type-G CRs may be more effective than others at limiting head excursion in a frontal crash.

It is important to note that the test performance of Type-G CR-3 was not consistent with the other Type-G restraints. In both frontal tests this CR was permanently deformed. This is believed to be an issue with that design of CR and not with Type-G CRs overall. This restraint was not used in side-impact tests. The deformation of this restraint may have resulted in the higher head excursion in comparison to the other Type-G CRs.

Analysis of all dummy responses is needed before any conclusions can be drawn.

V. REFERENCES

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