

Child restraint misuse and injury outcomes observed in at-scene in-depth crash investigations in South Australia

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Abstract

Twenty-three children aged 0-7 who were legally required to be in a child restraint were involved in accidents investigated as part of CASR's at-scene in-depth crash investigations between late 2014 and 2018. Correctness of child restraint use, injury outcomes and crash severity (Delta-V) were determined. Thirteen (57%) of these children were confirmed to be in an age appropriate restraint that had the top tether attached (if required). Three (13%) were in age inappropriate restraints. Six (26%) were in restraints without the top tether attached to the anchor. In a high Delta-V crash, the injuries were much more severe for a child in an untethered restraint compared to a tethered restraint.

Background

Child restraints have been shown to be highly effective in reducing injuries to child passengers in crashes (Henderson, 1994), but previous studies have found that incorrect use of child restraints is common in Australia (Koppel and Charlton, 2009; Brown and Bilston, 2007; Brown, Hatfield, Du, Finch & Bilston, 2010). An appropriate child restraint is one that is suitable for the size of the child. An appropriate child seat is defined by the age of the child in current South Australian law, but the sitting shoulder height of the child determines if the particular child seat is the appropriate for the child. Even with an appropriate child seat, both securing and installation errors are possible (Brown *et al.* 2010). Securing errors relate to the attachment of the child to the child seat. Installation errors relate to the attachment of the seat to the vehicle. Non-attachment of a top tether is one such installation error, and this error has been previously been observed in 1.5 to 7% of child restraints in vehicles (Brown *et al.* 2010; Koppel and Charlton, 2009).

The Centre for Automotive Safety Research's (CASR's) at-scene in-depth crash investigators immediately attend vehicle crashes that occur on public roads within 100 km of Adelaide, and for which an ambulance has transported at least one person. This paper describes the observations that could be made of child restraint appropriateness and fitment for children travelling in motor vehicles included in the in-depth investigations performed between late 2014 and the end of 2018.

Method

During CASR's routine in-depth crash investigations, if a child was known to be involved, or a child seat is observed, its type and fitment is recorded and photographed. Child 'securing' errors are not able to be observed with this methodology as children have usually been removed from the seat prior to CASR's arrival. In cases where the child restraint was removed prior to the arrival of CASR's investigators, non-attachment of the top tether could be deduced if an anchor was not fitted. Information on observed fitment is also obtained from emergency services and witnesses where possible. Age of the child was obtained from police reports, hospital notes and/or interviews. Hospital and ambulance notes provided injury information. The change in velocity was determined through computer aided simulation and/or downloading from event data recorders (Doecke, 2017).

Results

A total of 23 children aged under 8 years old were passengers in vehicles involved in crashes investigated between late 2014 and the end of 2018. The restraint use, injury data and crash details of these are shown in Table 1. One (4%) was not using any form of child restraint. Only 13 (57%)

of these children were confirmed to be in an age appropriate restraint that had the top tether attached (if required), three (13%) were in age inappropriate restraints, six (26%) were in restraints without the top tether attached to the anchor, and the age appropriateness and anchor status was unknown in one case. There were no cases where the child was in an age inappropriate and untethered child restraint. The proportion of children in untethered child seats in this dataset is much higher than the proportions observed in other studies (Brown *et al.* 2010; Koppel and Charlton, 2009).

Figure 1 shows the change in velocity (Delta-V) and the injury outcome, in terms of Maximum Abbreviated Injury Score (MAIS) is shown for the nine children involved in frontal crashes in this dataset. We observed one high delta V crash (86 km/h) where one child in a tethered child seat had a much lower MAIS than the child in the untethered child seat.

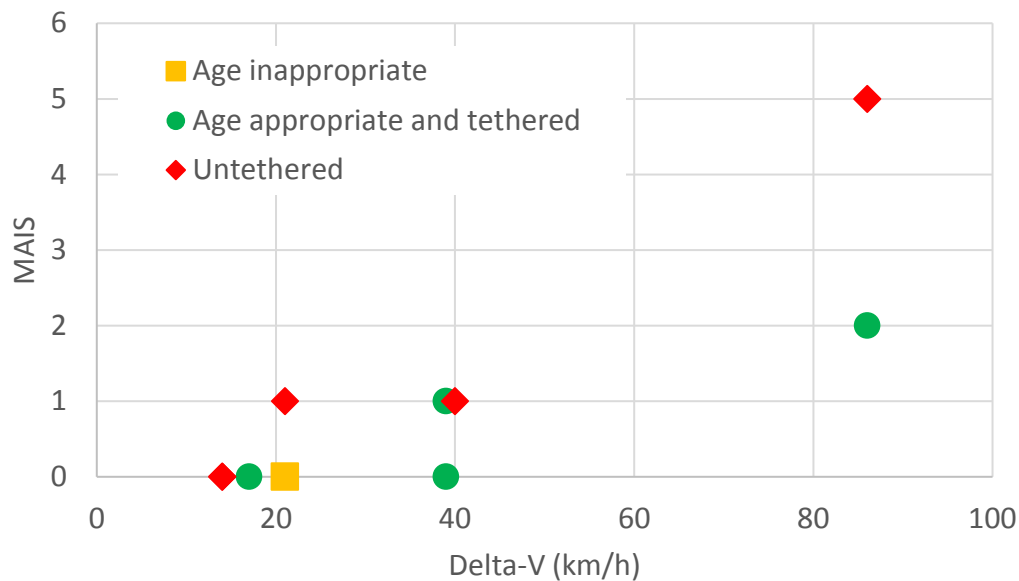


Figure 1. Change in velocity (Delta-V) and injury severity (MAIS) in frontal crashes with child passengers under eight-years-old, by child restraint (mis)use

Conclusion

Data on child restraint use in South Australia from CASR's at-scene in-depth crash investigations suggest that it is common for the top tether to not be attached to the anchor, and in a crash with a high Delta-V the injury outcome was much more severe for a child in an untethered restraint than for a child in a tethered restraint. Using an inappropriate restraint for the child's age was also observed in a number of cases.

References

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- Brown, J., Hatfield, J., Du, W., Finch, C., Bilston, L., 2010. The characteristics of incorrect restraint use among children traveling in cars in New South Wales, Australia. *Traffic Injury Prevention* 11 391 — 398.
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Henderson, M. 1994. An in-depth study of car crashes in which child occupants were injured. Child Accident Prevention Foundation of Australia.

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Table 1. Restraint and injury details for children included in the study

Seat type	Age	Age appropriate?	Position	Tethered	Delta-V (km/h)	Impact direction	Injury severity	MAIS	Injury description
Rear facing CRS	0	Yes	RR	Yes	UK	Multiple	Hospital Admission	UK	Skull fracture with bleeding on brain
Rear facing CRS	0	Yes	CR	Yes	54	Side	Non-injury	0	NA
Rear facing CRS	1	Yes	LR	Yes	34	Rollover	Hospital Treated	1	Abrasion to foot
Forward facing CRS	0	No	CR	Yes	21	Front	Non-injury	0	NA
Forward facing CRS	1	Yes	CR	Anchor	86	Front	Hospital Admission	2	Fractured arm
Forward facing CRS	2	UK	LR	Yes	13	Rear	Non-injury	0	NA
Forward facing CRS	2	Yes	CR	Yes	20	Side	Hospital Treated	UK	UK
Forward facing CRS	3	Yes	LR	Yes	17	Front	Non-injury	0	NA
Forward facing CRS	3	Yes	LR	Ad-hoc	40	Front	Hospital Treated	1	Contusions
Forward facing CRS	3	Yes	LR	Yes	39	Front	Hospital Treated	0	NA
Forward facing CRS	3	Yes	LR	Yes	1	Pedestrian	Non-injury	0	NA
Forward facing CRS	3	Yes	LR	No	8	Side	Hospital Treated	1	Small laceration to lip
Forward facing CRS	4	Yes	RR	Yes	39	Front	Hospital Admission	1	Laceration above right eye
Forward facing CRS	4	Yes	LR	No anchor	86	Front	Hospital Admission	5	Spinal injury resulting in quadriplegia
Forward facing CRS	4	Yes	LR	UK	UK	Multiple	Hospital Treated	1	Seatbelt bruising
Forward facing CRS	UK	UK	LR	No	14	Front	Non-injury	0	NA
Forward facing CRS	UK	UK	RR	No	14	Front	Non-injury	0	NA
Forward facing CRS	UK	UK	LR	Yes	UK	Front	Hospital Treated	1	Contusions
Booster seat	2	No	RR	Unknown	UK	Front	Hospital Treated	1	UK
Booster seat	4	Yes	LR	No	21	Front	Hospital Treated	1	UK
Booster seat	UK	UK	LR	Yes	16	Side	Non-injury	0	NA
None	6	No	RR	NA	UK	Rear	Non-injury	0	NA
UK	1	UK	LR	UK	UK	Side	Hospital Treated	0	NA

2 UK = Unknown, NA = Not applicable