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Analysis of paediatric injuries related to child restraint seats: Are children at higher risk of injury outside the vehicle than inside?

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1. Introduction

Motor vehicle crashes (MVC) remain the leading cause of death and injuries among children in North America, Europe, Asia and Australia (Desapriya et al. 2004). The American Academy of Pediatrics (AAP) and the National Highway Traffic Safety Administration (NHTSA) recommend appropriate child restraint seat (CRS) use for children to reduce injury risk (Winston et al. 2004). A major benefit of the proper use of CRS is the reduction in head injuries, potentially attributable to a reduction in the degree of head excursion during MVC (Winston et al. 2000).

With the increased use of CRS, particularly devices with a hand-held baby-carrier that attaches to a base secured within the automobile, clinicians at institutions have noticed an increase in a mechanism of injury: falls and other injuries related to CRS use when the CRS is not in the automobile. This study aims to quantify the frequency of these non-MVC-related CRS injuries among children at the authors’ institution and to compare these with MVC-related CRS injuries.

2. Data and methods

The Canadian Hospital’s Injury Reporting and Prevention Program (CHIRPP) is an emergency department injury surveillance programme operating at 16 hospitals throughout Canada. BC Children’s Hospital (BCCH) is the participating site in British Columbia. Data, including whether or not a CRS was involved in the injury as well as pattern of injury, are prospectively collected for every patient who visits the BCCH emergency department. A retrospective, comparative analysis of 107 children who presented at BCCH for CRS-related injuries between January 1997 and December 2002 was performed in order to describe the epidemiological and background factors related to injury occurrence.

3. Results

There were 12 MVC-related CRS injuries (11.2%) and 95 non-MVC-related CRS injury cases (88.8%) recorded in the CHIRPP data base. Non-MVC injuries were 7-fold higher than MVC-CRS injuries. The mean age for children experiencing MVC-related CRS injuries was 25.33 months (range 2–63 months; SD 19.49), compared to 5.73 months (range 0–49 months; SD 7.08) among children suffering non-MVC-related CRS injuries (t = 6.955, p < 0.001) (table 1).

Table 2 shows the type of injury sustained by children in the non-MVC-related CRS group compared to the injuries sustained by children in the MVC-related CRS group. The odds of sustaining head injury for the non-MVC-CRS vs. the MVC-CRS were 23.3 (odds ratio 23.3; 95% CI 2.49–218.2.). Similarly, the prevalence and risk of fractures, open wounds, superficial and other injuries were all higher in the non-MVC-related CRS group, although these trends were not statistically significant, probably due to the smaller numbers in each of these subgroups.

There were significant differences in the mechanism of injury between the two groups ($X^2$=97.1, p < 0.001). Falls were the most common mechanism of injury for the non-
MVC-related CRS group (65.3%; 62/95). In the non-MVC-related CRS group, falls most commonly resulted in head (59%; 39/62) and superficial injuries (16.1%; 10/62), resulting from poorly placed or unbalanced CRS.

The incidents noted in table 2 are typical of the non-MVC-related CRS injury group and have the following common elements: 1) in many cases the parent or caregiver used the CRS in a way other than intended by the manufacturer; 2) many of the database comments regarding the injuries indicated that there was no strap or other restraint used to secure the CRS or to prevent the child from falling or tipping out of the CRS.

A representative case, seen at the authors' institution, is depicted in figures 1 and 2. This child, aged 4 months, was improperly restrained in a CRS while in the home. The CRS fell off a low piece of furniture, approximately 3 feet off the ground and the child’s head struck the tiled floor.

Table 1. Type of injury sustained by children in the non-motor vehicle crashes (MVC)-related child restraint seat (CRS) group and the MVC-related CRS group.

<table>
<thead>
<tr>
<th>Type of injury</th>
<th>Non-MVC-related CRS group</th>
<th>MVC-related CRS group</th>
<th>Odds ratio</th>
<th>CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head injury</td>
<td>56</td>
<td>1</td>
<td>23.3</td>
<td>2.49–218.2</td>
</tr>
<tr>
<td>Superficial injuries</td>
<td>12</td>
<td>3</td>
<td>1.66</td>
<td>0.32–8.59</td>
</tr>
<tr>
<td>Fractures</td>
<td>8</td>
<td>1</td>
<td>3.33</td>
<td>0.32–34.1</td>
</tr>
<tr>
<td>Open wound</td>
<td>6</td>
<td>1</td>
<td>2.50</td>
<td>0.23–26.4</td>
</tr>
<tr>
<td>Other injuries</td>
<td>1</td>
<td>1</td>
<td>0.41</td>
<td>0.02–8.05</td>
</tr>
<tr>
<td>Total injuries</td>
<td>83</td>
<td>7</td>
<td>4.94</td>
<td>1.34–18.0</td>
</tr>
<tr>
<td>No injuries</td>
<td>12</td>
<td>5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2. Selected cases of the circumstances surrounding non-motor vehicle crash (MVC)-related child restraint seat (CRS) injuries based on patient records.

1. Being carried in CRS by mother; fell out of the seat onto asphalt (child was not restrained by straps)
2. Being carried in CRS; handle slipped out of mum’s hands; child landed on pavement (child was not restrained by straps)
3. Being lifted out of the car in CRS; child accidentally dropped on to the concrete (child was not restrained by straps)
4. Brother pulled him off counter as he sat in CRS; child flipped over face first onto the floor
5. The CRS she was seated in tipped off a chair and onto the floor
6. The child fell forward out of the CRS, which was on the stroller; child landed on the concrete
7. The CRS fell from a shopping cart on to the floor (child was not restrained by straps)
8. The child was sitting in the CRS; the CRS fell off a table on to the floor
9. The child was sitting in the CRS; the CRS fell off a kitchen counter on to the floor
10. The child fell on to a hard tile floor when she stood up in her CRS while playing
11. The child was sitting in the CRS; the CRS fell off a bed on to the floor
12. The child was sleeping in CRS; the restraint and straps were pulled too tightly and that caused the injury
13. The child was playing in the CRS and fell backward hitting his head on the concrete floor
14. The CRS was placed on the car trunk with the baby in it; the baby wriggled and landed on the concrete
15. Shortly after the child was fed, the CRS he was in fell off kitchen table
16. The child was sitting in the CRS; the CRS fell off a couch on to the floor
17. The child was sitting in the CRS; the CRS fell off a toilet seat on to the floor

Figure 1. Lateral photograph of the head, depicting a depressed parietal skull fracture.

Figure 2. Axial computed tomography scan, demonstrating a depressed parietal skull fracture.
Figure 1 demonstrates the clinically apparent depressed skull fracture and figure 2 shows the fracture on an axial computed tomography scan. The child had the fracture elevated via a small craniotomy and has made an excellent recovery.

4. Discussion

This analysis shows that emergency department visits for head injuries are more common in non-MVC-CRS events than in MVC-CRS events. The odds ratio for non-MVC head injuries was 23.3, a statistically significant finding suggesting that an infant in a CRS is far more likely to sustain a head injury outside the vehicle than in an actual MVC. This is a startling finding and one that should be publicized by injury prevention agencies focusing on CRS usage. Aggressive encouragement in the use of CRS for infants and young children should be continued, but with the caveat that improper use when not in the vehicle may represent a significant risk. This report supports the notion that prevention of falls, in this case related to improper CRS-use, remains a priority, as suggested by a recent report on paediatric falls in general (Lallier et al. 1999).

The fact that victims of non-MVC-CRS injuries were significantly younger than MVC-CRS injuries is likely explained by the use of hand-held carrier-type CRS systems. Once children are over 9 kg in weight (20 lbs), these devices are no longer used and the CRS for heavier/older children stay secured in the car at all times. Once the child is not being carried in the CRS or rested in the CRS outside of the vehicle, falls become markedly less likely.

Many previous studies have shown that a major benefit of the appropriate use of CRS is a reduction in head injuries, potentially attributable to a reduction in the amount of head excursion during a crash (Winston et al. 2000, Desapriya et al. 2004). This benefit and the effectiveness of the appropriately used CRS in an actual MVC could explain the disparity in the prevalence of head injuries between the two groups in this study. In the MVC-related CRS group, head injuries were significantly lower, suggesting appropriate use of the CRS and the effectiveness of the CRS in the crash event. Further, this study revealed that the majority of non-MVC-related CRS injuries occurred at home. The American Academy of Pediatrics and other injury experts recommend injury prevention education for parents and caregivers as a priority area for counselling during routine health maintenance home visits for young children (Winston et al. 2004).

5. Conclusions

This study suggests than an unintended by-product of the widespread use of CRS is injury related to falls out of CRS. This represents a previously unreported public health issue that may be amenable to primary prevention efforts.

References


