Brief Report

Pediatric craniomaxillofacial injuries after road traffic crashes: characteristics of injuries and protective equipment use

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Objective: A cross-sectional study to determine the pattern of craniomaxillofacial (CMF) injuries among children involved in road traffic crashes was performed. The association of protective equipment use with the CMF injuries was evaluated.

Methods: Retrospective records of children treated in the University Malaya Medical Centre, Kuala Lumpur, Malaysia, after road traffic crashes between January 1, 2008 and December 31, 2012 were reviewed, and, after that, telephone interviews were made.

Results: Seventy-one children were included in this study. Fifty-two (73.6%) were involved in a motorcycle injury and 19 (23.4%) in a car crash. Their mean age was 6.02 years; SD, 3.46 (range between 0 to 13 years old). More male children were observed (52.1%) compared with females (47.9%). Thirty-nine percent of the children sustained CMF injuries, 33.8% body injuries, and 23.9% had both CMF and other body parts injuries. The highest injury severity score was 26, whereas the lowest was 0. Many children did not use protective equipment during traveling, 44.2% of children among motorcycle pillion riders, and 78.9% among car passengers. The association between helmet use and CMF injuries was shown to be statistically significant ($P < 0.001$).

Conclusion: Craniomaxillofacial injuries could be prevented with the use of motorcycle helmet and seat belt.

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1. Introduction

Road traffic injuries accounted for 12% of death among children aged younger than 14 years with a mortality rate of 7.4 per 100000 children in Southeast Asia [1]. In Malaysia, young motorcycle riders aged 15 to 18 years were reported to be the highest group of children involved in fatal road traffic injuries, whereas child pillion riders were ranked as the third leading group, and this involved children aged between 1 and 14 years [2]. Children riding on a motorcycle without wearing helmet are likely to sustain moderate-to-severe head injury [3,4]. Similarly, children who traveled without proper car restraint system and placed on the front seats are also prone to moderate-to-severe injury [4].

A craniomaxillofacial (CMF) injury is defined as any injury involving the head and/or the face.

The objectives of this study were as follows:

1. to determine the sociodemographic of the children and parents involved in road traffic crashes (RTC),
2. to determine the crash characteristics of the RTC,
3. to determine the pattern and severity of CMF injuries after RTC among children who traveled as car or motorcycle passengers, and
4. to determine the association between use or nonuse of protective apparatus and CMF injuries among car or motorcycle child passenger.

2. Material and method

Ethics approval was obtained from the Research and Ethics Committee, Faculty of Medicine, University Malaya, and Faculty of Dentistry, University Malaya (MEC ref. no.:896.122 and DF OS1205/0018[P]).

2.1. Study design

The design of this study is a cross-sectional study. It comprised 2 stages as follows:

1. Retrospective record review and
2. Telephone interview of the parents of the injured children.

2.1.1. Retrospective record review

Medical records of pediatric passengers of private vehicles who were involved in RTC and treated in the Emergency Department, University of Malaya Medical Centre, were obtained. The patients’ registration...
numbers were manually obtained from the Registry of the Emergency Department, and this was matched with the data from the University Malaya Medical Centre Patients' Record Department.

The selection of subjects was based on the following inclusion and exclusion criteria:

### Inclusion criteria:

- Children who traveled as a car or motorcycle passenger and
- Parents of the injured children agreed to participate in the study and could communicate in Malay or English language.

### Exclusion criteria:

- Children who traveled in vehicles other than cars or motorcycles,
- Children who traveled as driver of the vehicle,
- Fatal RTC, and
- Patients who were discharged from the hospital care before a definitive diagnosis could be made.

Data related to demographic data, brief information on injury mechanism, and other characteristics were obtained from the medical record. The diagnosis of injuries were identified, and severity of associated injury was assessed using the Abbreviated Injury Scale (AIS) 2005 (updated 2008) [5].

The severity is coded as 0 (no injury), 1 (minor), 2 (moderate), 3 (serious), 4 (severe), 5 (critical), or 6 (nonsurvivable injury). In this study, AIS greater than or equal to 3 indicated severe injury. From the AIS, the injury severity score (ISS) was calculated. It is the sum of the square of the 3 highest AIS scores from 3 different body regions with the highest AIS.

#### 2.1.2. Telephone interview

Parents who agreed to be interviewed were included in the study. The interview took approximately 30 minutes to complete. The variables included in the interview were as follows:

1. sociodemographic data of both children and parents,
2. crash particulars, and
3. protective equipment.

#### 2.2. Statistical analysis

data entry and data analysis were performed using the Statistical Programme for Social Science Software (version 12.0; SPSS Inc, Chicago, IL). The variables of interest were shown as frequency, percentage, mean, SD, median, and interquartile range (IQR) where appropriate.

The association between demographic, crash, and protective equipment use, and CMF were assessed using Pearson $\chi^2$ test. Fisher exact test was used in situations where the expected cell frequency was less than 5. The level of significance was set at 0.05.

### 3. Result

In total, there were 212 child passengers documented to be involved in RTC from January 1, 2008 to December 31, 2012. Eighty-seven were passengers of larger vehicles, so they were excluded from this study. One hundred twenty-five children were passengers of motorcycles and cars. Of the 125 children, 54 parents did not response to our telephone calls. Seventy-one parents were able to be contacted and agreed to participate in this study.

#### 3.1. Sociodemographic characteristic of the children and their parents

The children were between 0 and 13 years old (mean age, 6.02 years; SD, 3.46). Malays made up the largest ethnic group (69.0%). More male children (52.1%) were involved compared with females. Most of the parents interviewed were the father of the child (n = 63, 88.7%). More than half of the parents were between the ages of 30 and 40 years. All parents had at least primary school education, with more than half had secondary education background. Only 15.5% of parents attended tertiary education, they were in the 30 to 50 years age group. The socioeconomic status of the parents was consistent with the type of vehicles drove.

Majority with tertiary education traveled in a car (n = 10 [90.9%]) before the RTC. Only 1 rode a motorcycle. Eighty-five point seven percent of parents with primary and 86.5% with secondary education were on their motorcycles before the RTC.

#### 3.2. Characteristics of the RTC

Table 1 shows the crash characteristics. These involved 52 motorcycle pillions and 19 car passengers. Twenty-nine point six percent of the RTC, which involved 10 motorcycles and 11 cars occurred on a highway. Eighty percent of the crash was self-reported to travel below 80 km/h before the RTC. Eight children were found to be traveling on a motorcycle between 81 and 110 km/h before the RTC.

Most vehicles that were involved in the injuries hit or were hit by a moving partner (50.7%). Approximately half of the crashes were single-vehicle crash (ie, skid and crash with objects).

#### 3.2.1. Protective equipment

Table 2 shows the characteristics and usage of the protective equipment. Among 52 children who rode on the motorcycles with their parents, 38 (73.1%) were seated on the rear. Children who sat in front, sat in between the motorcycle basket and the rider. Altogether, 29 children (55.8%) wore a helmet, and 21 of them (72.4%) sat on the rear.

Among all the helmets, approximately a third (n = 10, 34.5%) were reported between the motorcycle basket and the rider. Altogether, 29 children (55.8%) wore a helmet, and 21 of them (72.4%) sat on the rear. Among all the helmets, approximately a third (n = 10, 34.5%) were reported to be standard helmets (approved by the Standards and Industrial Research Institute of Malaysia [SIRIM]).

### Table 1

<table>
<thead>
<tr>
<th>Characteristics of the RTC</th>
<th>Vehicles</th>
<th>Motorcycle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Car (n = 19), n (%)</td>
<td>Motorcycle (n = 52), n (%)</td>
</tr>
<tr>
<td><strong>Vehicles</strong></td>
<td>Highway</td>
<td>Other roads</td>
</tr>
<tr>
<td><strong>Pre-crash speed</strong></td>
<td></td>
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</tr>
<tr>
<td>0-80 km/h (n = 57)</td>
<td>5 (8.8)</td>
<td>8 (14.0)</td>
</tr>
<tr>
<td>81–110 km/h (n = 14)</td>
<td>6 (42.9)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>12:00-5:59 AM (n = 6)</td>
<td>0 (0.0)</td>
<td>1 (16.7)</td>
</tr>
<tr>
<td>6:00-11:59 AM (n = 18)</td>
<td>2 (11.1)</td>
<td>2 (11.1)</td>
</tr>
<tr>
<td>12:00-5:59 PM (n = 10)</td>
<td>4 (40.0)</td>
<td>2 (20.0)</td>
</tr>
<tr>
<td>6:00-11:59 PM (n = 37)</td>
<td>5 (13.5)</td>
<td>3 (8.1)</td>
</tr>
<tr>
<td><strong>Crash partners</strong></td>
<td></td>
<td></td>
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<tr>
<td>Objects (n = 17)</td>
<td>5 (29.4)</td>
<td>3 (17.6)</td>
</tr>
<tr>
<td>Colliding partners (n = 36)</td>
<td>5 (13.9)</td>
<td>5 (13.9)</td>
</tr>
<tr>
<td>Single vehicle (n = 18)</td>
<td>1 (5.6)</td>
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</tr>
</tbody>
</table>

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Of the 29 children who wore a helmet, 26 (89.7%) of the parents thought that the helmet fitted their children's head well. These parents also claimed that the helmets were properly buckled up before the RTC. Two parents admitted that their children's helmets were unbuckled, and 1 parent was not sure of the helmet status.

Nineteen children traveled in a passenger car. All the cars were equipped with front and rear seat belts. However, only 14 (74.0%) cars were equipped with airbags. Eleven (57.9%) children were seated on the front seat belts, whereas 8 (42.1%) sat on the passenger seat in front. Majority (n = 23) did not wear a seatbelt (front, 8; rear, 7).

The CMF injuries were divided into facial and head injuries. The facial injury was subdivided into focal and diffuse brain injuries (further subclassified into focal and diffuse brain injuries).

### 3.3. Pattern of CMF injuries

The CMF injuries were divided into facial and head injuries. The facial injury was subdivided into smaller zones, that is, the upper facial injuries, middle facial injuries, and lower facial injuries. The head injury was classified into head (scalp and skull fractures) and brain injuries (further subclassified into focal and diffuse brain injuries).

#### 3.3.1. Motorcycle pillion riders

Of those involved in the motorcycle RTC, 19 (36.5%) children sustained non-CMF injuries, whereas 18 (34.6%) children sustained CMF injuries only and 15 (28.8%) with both CMF and non-CMF injuries. This pattern was observed irrespective of their seating position.

The following injuries were observed among the motorcycle child pillion riders:

**Head injury:**

1. with protective equipment: 42.9% (3 of 7 children) sustained brain injury, 66.7% (2 of 3) with cerebral concussion, and 25% (1 of 4) with focal brain injuries; and
2. without a protective equipment: 100% children (n = 4) with scalp injuries, 100% children with skull fractures (n = 2), 33.3% (1 of 3) with cerebral concussion, and 33.3% (1 of 3) with focal brain injuries.

**Facial injury:**

1. with protective equipment: 23.5% (4 of 17) sustained upper face soft tissue injuries, 44.4% (8 of 18) sustained middle face injury (1 child...
Table 4
Association between protective equipment use and CMF injuries

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Injuries (n = 71)</th>
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<tr>
<td></td>
<td>Non-CMF, n (%)</td>
<td>CMF, n (%)</td>
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<td>All vehicle (n = 71)</td>
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<tr>
<td>Protective equipment use (car &amp; motorcycle)</td>
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<tr>
<td>No</td>
<td>6 (23.1)</td>
<td>32 (71.1)</td>
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<td>Pearson $\chi^2 (1) = 15.28, P &lt; .001$</td>
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<td>20 (76.9)</td>
<td>13 (28.9)</td>
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<td>Motorcycle users (n = 52)</td>
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<td>Helmet use</td>
<td></td>
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<td>23 (69.7)</td>
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<td>Pearson $\chi^2 (1) = 23.75, P &lt; .001$</td>
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<td>19 (100.0)</td>
<td>10 (30.3)</td>
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<td>Standard helmet (SIRIM sticker)</td>
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<td>13 (68.4)</td>
<td>6 (18.2)</td>
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<td>Fisher exact test = 27.64, P &lt; .001</td>
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<td>4 (12.1)</td>
<td></td>
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<tr>
<td>Not applicable (not using a helmet)</td>
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<td>23 (69.7)</td>
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<tr>
<td>Helmet fit</td>
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<td>No</td>
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<td>2 (6.1)</td>
<td></td>
<td>Fisher exact test = 28.92, P &lt; .001</td>
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</tr>
<tr>
<td>Yes</td>
<td>18 (94.7)</td>
<td>8 (24.2)</td>
<td></td>
<td></td>
<td></td>
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<tr>
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<td>0 (0.0)</td>
<td>23 (69.7)</td>
<td></td>
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<tr>
<td>Helmet buckled up</td>
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<tr>
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<td>2 (6.1)</td>
<td></td>
<td>Fisher exact test = 28.92, P &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>18 (94.7)</td>
<td>8 (24.2)</td>
<td></td>
<td></td>
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<tr>
<td>Not applicable (not using a helmet)</td>
<td>0 (0.0)</td>
<td>23 (69.7)</td>
<td></td>
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<tr>
<td>Helmet fixation (during crash)</td>
<td></td>
<td></td>
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<tr>
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<td>1 (3.0)</td>
<td></td>
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</tr>
<tr>
<td>Yes</td>
<td>18 (94.7)</td>
<td>9 (27.3)</td>
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</tr>
<tr>
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<td>23 (69.7)</td>
<td></td>
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<tr>
<td>Car passengers (n = 19)</td>
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<tr>
<td>Seating position</td>
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<tr>
<td>Front</td>
<td>1 (14.3)</td>
<td>7 (58.3)</td>
<td></td>
<td>Fisher exact test, $P = .15$</td>
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</tr>
<tr>
<td>Rear</td>
<td>6 (85.7)</td>
<td>5 (41.7)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Use of seat belt/child seat</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>No</td>
<td>6 (85.7)</td>
<td>9 (75.0)</td>
<td></td>
<td>Fisher exact test, $P = 1.00$</td>
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<tr>
<td>Yes</td>
<td>1 (14.3)</td>
<td>3 (25.0)</td>
<td></td>
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</tr>
</tbody>
</table>

with orbital fracture), and 25% (1 of 4) with lower face soft tissue injury; and
2. without protective equipment: 76.5% (13 of 17) sustained upper face soft tissue injuries, 55.6% (10 of 18) sustained middle face injury (1 child with nasal bone fracture), and 75% (3 of 4) with lower face soft tissue injury.

3.3.1.2 Car passengers. Five (26.3%) children sustained non-CMF injuries, whereas 10 (52.6%) children sustained CMF injuries only and 2 (10.5%) with both CMF and non-CMF injuries and 2 (10.5%) without any injury. Head injury:
1. with protective equipment: 1 child sustained base of skull fracture and
2. without a protective equipment: 1 child with cerebral concussion.

Facial injury:
1. with protective equipment: 22% (2 of 9) with middle face and 50% (1 of 2) with lower face fracture; and
2. without protective equipment: 100% children [n = 3] sustained upper face soft tissue injury, 77.8% (7 of 9) sustained middle face soft tissue injury, and 50% (1 of 2) with lower face injury

3.4. Association between sociodemographic, crash characteristics, and use of protective apparatus and CMF injuries

The association between sex, ethnicity, age, and education level of the parents, type of transport, precrash speed, and type of crash did not show significant difference with the CMF injuries ($P > .05$) Table 4.

Significant associations were observed in protective helmet use and CMF injuries among motorcyclists ($P < .001$). This involved independent variables such as helmet use, standard helmet, helmet fit, helmet buckled up, and helmet fixation.

No significant association between protective equipment use among car passengers and CMF injuries ($P > .05$) was found.

4. Discussion

Road traffic crashes are the main cause of pediatric CMF injuries in Malaysia [6,7]. In this study, the CMF area was shown with the most injuries, that is, 55% of total body injuries. The most severe injury also occurred in the CMF area: AIS 5.

Between a car and a motorcycle, a car offers more protection than a motorcycle [8]. This study is in agreement with the statement, that is, less number of passengers, injuries, and severities were observed among car passengers compared with the motorcycle pillion.

In relation to motorcycle crashes, children without a helmet were more susceptible to scalp injuries, skull fractures, and focal brain injuries compared with those with a helmet. Nevertheless, a helmet did not protect a person from cerebral concussion. This is in agreement with many research including sports and researchers who concluded that the current helmet designs are not able to prevent cerebral concussion [9-11].

In general, the most common facial injury was soft tissue abrasion. This was in accordance with the literature [6,12,13]. The upper face and middle face were more susceptible for injuries in both the car and motorcycle passengers particularly those without protective equipment.

This study showed that 44.2% of children did not wear a helmet, and among those using a helmet, only 19.2% were SIRIM certified. In addition, 78.9% of the children did not wear the seat belt or placed on a child seat with a seat belt. A population study performed in Klang Valley showed low seat belt and helmet use: 11.8% among front seat child passengers; 5.8% among rear seat child passengers, and only 4 children were observed in child seats among 364 front-seat and 462 rear-seat child passengers; and among motorcycle child pillion passengers, only 30.5% wore a helmet [14].
Further evaluation on the association between protective equipment use with the outcome of CMF injuries was performed. A strong association was shown between helmet use and other helmet characteristics and CMF injuries. The association between seat belt/child seat and seating position involving car passengers and CMF injuries, however, was not significant.

Malaysia Helmet Law was first implemented in 1973 and had been revised twice, all addressing helmet use for riders as well as pillions[15]. In 1979, the Seat belt Law was introduced and from January 1, 2009, the law for rear passengers was implemented[16]. However, to date, there is no legislation on child or baby seat use in the passenger vehicle.

In relation to the helmet, a survey conducted by the Malaysian Institute of Road Safety Research showed that child-size helmets are available in most motorcycle sales and service outlets[17]. However, the helmets are only available in selected sizes. Children younger than 5 years do not have proper protective headwear possibly because of rapid head change in size and shape[18]. Due to the unavailability of the right size and shape helmets, many children in this country wear a “toy” or nonstandard helmet.

4.1. Limitation

This study is not without a limitation. The main limitation was the sample size particularly involving car passengers. We reported earlier that 125 (43.2%) eligible parents were not able to be contacted. These parents have similar sociodemographic characteristics with the research participants.

Another limitation is related to parents’ interview. The best approach was the face-to-face interview particularly for description of the protective equipment use, but due to difficulty to get the parents to attend the scheduled appointment, a telephone interview option was selected.

4.2. Recommendation

One of the National Key Result Areas for Malaysia before becoming a high-income nation in 2020 involves the public transport. With easier accessed, wider place-to-place coverage, and reasonable fees, there is no necessity for children to travel on a motorcycle. An age limit must be introduced for motorcycle travel. Children aged younger than 5 years should not be traveling on the motorcycles. In addition, the number of children traveling on a motorcycle should be limited to only 1 passenger.

Enforcement of the existing seat belt law needs to be emphasized. Everyone sitting on the passengers or rear seats must use a seat belt. Introduction of a child seat law is also timely.

5. Conclusion

Many children traveled without using proper safety equipment. Craniofacial injuries were the most common injuries sustained in RTC. Helmets significantly reduce CMF injuries among motorcycle pillion riders.

Acknowledgment

The authors thank the University Malaya Medical Centre Emergency Department and Records Department for allowing us to access the patients’ records.

References