Maxillofacial Injuries Related to Road Traffic Accidents: A Five Year Multi Center Analysis

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Abstract

The purpose of this study was to assess the epidemiological data on maxillofacial injuries related to road traffic accidents from two multispecialty medical centers in India, and then evaluate their incidence and pattern. Data were extracted from the medical records of all road traffic accident victims with maxillofacial injuries who reported to the centers between January 2013 and December 2017. Descriptive statistics and chi-square test were used for statistical analysis; significance was set at \( p < 0.05 \). Out of 1,110 patients, highest incidence of injuries was observed in the males of age group 20 to 29 years with mean age of 25.95 years (standard deviation, 9.35 years). Head injury, laceration, and tooth luxation were the most common forms of associated injuries. The use of protective helmets and seatbelts was extremely low which was associated to higher risk of facial bone fractures. Violation of traffic rules was the most common etiology behind these accidents. These findings were statistically significant ( \( p < 0.05 \)). The ever increasing incidence of maxillofacial injuries related to road traffic accidents suggests the need to deal with them promptly and wisely. Keeping an update on the changing pattern of these injuries by continuous recording and periodic evaluation of epidemiological data is helpful in the primary prevention of trauma by evolving a better trauma care program and effective treatment protocol focused on the target groups. The updated data can guide treating physicians in anticipating and diagnosing maxillofacial injuries.

Keywords

► maxillofacial trauma
► pattern

Injuries to the maxillofacial region are quite common as it occupies the most prominent position in the human body. The alimentary and respiratory tracts which are the two most important components start from this area. Hence, maxillofacial injuries can present serious clinical complications. The victims are not only physically but psychosocially traumatized as even “minor” facial trauma and its management can impact the ability to integrate back into the society, affecting both personal relationships and employment opportunities. Preventing these injuries needs careful analysis of etiological factors and the trauma pattern.

Number of reports on the incidence and treatment of maxillofacial injuries are available. However, knowledge is limited on the patterns of maxillofacial injuries.1 Large variability is seen in causative factors and prevalence of maxillofacial injuries. Interpersonal violence is turning out to be the most common cause in developed countries, whereas road traffic accidents (RTAs) remain the most frequent cause in developing countries.2 Low-income countries have RTA-related fatality rates more than double of those in high-income countries.3

In the developing world, current trends in population growth, industrialization, and urbanization are putting heavy pressure on the transport network in general and on road system in particular.4 A high prevalence of old vehicles...
that often carry many more people than they are designed to carry, lack of safety belt and helmet use, and poor road conditions are other factors that contribute to high rate of accidents. Despite this, road safety has not received enough attention in many developing countries.\(^5\)

The aim of the present study was to assess the epidemiological data on maxillofacial injuries related to RTAs from two medical centers in India and then evaluate their incidence and pattern.

**Materials and Methods**

This retrospective study was conducted at Sardar Patel Post Graduate Institute of Dental and Medical Sciences (SPPGIDMS) and Dr. OP Chaudhary Hospital and Trauma Center, Lucknow, India, after the prior approval from Ethical Review Board following the guidelines of Declaration of Helsinki. Data were extracted from the medical records of all road traffic accident victims with maxillofacial injuries who reported to the centers between January 2013 and December 2017.

Patients whose medical records were missing or incomplete; patients injured on the road without involvement of a vehicle, for example, a person slipping or falling on the road and sustaining injury; and injury involving a stationary vehicle, for example, a person getting injured while washing or loading a vehicle were excluded from the study.

The following patient data were recorded—gender, age, characteristics of facial bone fractures, associated soft tissue injuries, concomitant dental injuries, and other associated injuries. In addition to this, the following information related to the accident was also considered—vehicle involved, location, time, day, month, etiology, and use of protective gear by the patient at the time of accident.

**Statistical Analysis**

Patient characteristics were analyzed using descriptive statistics, qualitative variables (absolute and relative frequencies), and quantitative variables (means and standard deviation [SD]). Relative risk was calculated to associate the use of protective gear and facial bone fractures. The chi-square test was used to evaluate the association between gender, age, month, day, location, vehicle involved, site of facial bone fracture, associated injury, and etiology of RTAs. A p value of less than 0.05 was considered statistically significant.

**Results**

Between January 2013 and December 2017, a combined total of 1,110 patients (823 males, 287 females) with maxillofacial injuries related to RTAs had reported to the centers. The male to female ratio was 2.87:1. Males were significantly more injured than females (p < 0.05). Mean age of the study population was 25.95 years (SD, 9.35 years) with more than half of patients in the age group 20 to 29 years (p < 0.05) (\(\sim\)Table 1).

Motorized two-wheelers like motorcycle, moped, and scooter (n = 682, 61.44%) were significantly more involved in RTAs (p < 0.05) followed by motorized light four-wheelers (n = 229, 20.63%) that included car, jeep, and van. Bicycles, motorized heavy four-wheelers (bus and truck), and motorized three-wheelers (auto rickshaw and tractor) were also involved. The least involved were animal-driven vehicles, for example, bullock carts. Of the combined total, 910 (81.98%) patients were vehicle drivers and occupants while 200 (18.02%) patients were pedestrians.

A total of 586 (52.79%) patients sustained facial bone fractures among which 352 suffered simple facial fractures while 234 suffered multiple facial fractures. Mandible was the most common site of fracture in the facial skeleton (n = 565, 64.45%). Majority of fractures in the mandible were located at the parasymphysis (40.90%) followed by condyle (25.30%) (p < 0.05) (\(\sim\)Table 2).

\(\sim\)Table 3 summarizes the type of associated injuries. Tooth luxation, fracture, and avulsion were the associated dental injuries in the descending order of occurrence. Among concomitant soft tissue injuries, 133 (12%) was contusion while 194 (17.47%) was abrasion. Laceration was noted in

**Table 1** Age and gender of study population

<table>
<thead>
<tr>
<th>Age group (years)</th>
<th>Males</th>
<th>Females</th>
<th>Total number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–9</td>
<td>24</td>
<td>30</td>
<td>54</td>
<td>4.86</td>
</tr>
<tr>
<td>10–19</td>
<td>101</td>
<td>53</td>
<td>154</td>
<td>13.87</td>
</tr>
<tr>
<td>20–29</td>
<td>455</td>
<td>124</td>
<td>579</td>
<td>52.16</td>
</tr>
<tr>
<td>30–39</td>
<td>174</td>
<td>49</td>
<td>223</td>
<td>20.09</td>
</tr>
<tr>
<td>40 and above</td>
<td>69</td>
<td>31</td>
<td>100</td>
<td>9.02</td>
</tr>
<tr>
<td>Total</td>
<td>823</td>
<td>287</td>
<td>1110</td>
<td>100</td>
</tr>
</tbody>
</table>

**Table 2** Characteristics of facial bone fractures

<table>
<thead>
<tr>
<th>Site/type</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandible</td>
<td>565</td>
<td>64.45</td>
</tr>
<tr>
<td>Symphysis</td>
<td>8</td>
<td>1.41</td>
</tr>
<tr>
<td>Parasympysis</td>
<td>231</td>
<td>40.90</td>
</tr>
<tr>
<td>Body</td>
<td>68</td>
<td>12.03</td>
</tr>
<tr>
<td>Angle</td>
<td>98</td>
<td>17.34</td>
</tr>
<tr>
<td>Ramus</td>
<td>10</td>
<td>1.76</td>
</tr>
<tr>
<td>Condyle</td>
<td>143</td>
<td>25.30</td>
</tr>
<tr>
<td>Coronoid</td>
<td>7</td>
<td>1.26</td>
</tr>
<tr>
<td>Midface</td>
<td>226</td>
<td>25.77</td>
</tr>
<tr>
<td>Le Fort I</td>
<td>19</td>
<td>8.40</td>
</tr>
<tr>
<td>Le Fort II</td>
<td>40</td>
<td>17.70</td>
</tr>
<tr>
<td>Le Fort III</td>
<td>6</td>
<td>2.65</td>
</tr>
<tr>
<td>Zygomatic complex</td>
<td>112</td>
<td>49.55</td>
</tr>
<tr>
<td>Nasal bone</td>
<td>49</td>
<td>21.70</td>
</tr>
<tr>
<td>Dentoalveolar</td>
<td>86</td>
<td>9.78</td>
</tr>
<tr>
<td>Grand total</td>
<td>877</td>
<td>100</td>
</tr>
</tbody>
</table>
Table 3 Associated injuries

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tooth luxation</td>
<td>313</td>
<td>47.35</td>
</tr>
<tr>
<td>Dental injuries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooth fracture</td>
<td>239</td>
<td>36.16</td>
</tr>
<tr>
<td>Tooth avulsion</td>
<td>109</td>
<td>16.49</td>
</tr>
<tr>
<td>Total</td>
<td>661</td>
<td>100</td>
</tr>
<tr>
<td>Laceration</td>
<td>327</td>
<td>29.45</td>
</tr>
<tr>
<td>Abrasion</td>
<td>194</td>
<td>17.47</td>
</tr>
<tr>
<td>Contusion</td>
<td>133</td>
<td>12.00</td>
</tr>
<tr>
<td>Soft tissue injuries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple superficial injuries</td>
<td>456</td>
<td>41.08</td>
</tr>
<tr>
<td>Total</td>
<td>1110</td>
<td>100</td>
</tr>
<tr>
<td>Isolated maxillofacial injury</td>
<td>414</td>
<td>37.30</td>
</tr>
<tr>
<td>Neurologic</td>
<td>324</td>
<td>29.20</td>
</tr>
<tr>
<td>Orthopaedic</td>
<td>238</td>
<td>21.40</td>
</tr>
<tr>
<td>Ophthalmic</td>
<td>134</td>
<td>12.10</td>
</tr>
<tr>
<td>Total</td>
<td>1110</td>
<td>100</td>
</tr>
</tbody>
</table>

327 (29.45%) whereas multiple superficial injuries was observed in 456 (41.08%) patients.

Out of 1,110 patients, 414 (37.30%) sustained isolated maxillofacial injury while 696 (62.70%) sustained other associated injuries as well. Neurologic (head/brain and spine) injuries showing clinical symptoms like loss of consciousness and vomiting was the most commonly observed associated injury (n = 324, p < 0.05). Also, 238 orthopaedic injuries in other parts of the body (limbs and ribs) and 134 ophthalmic injuries were recorded.

The highest incidence of road crashes was recorded in urban areas (57.20%) compared with rural areas (24.86%) and highways (17.94%). These were common on weekends (► Fig. 1) and more likely to occur between 5 p.m. and 1 a.m. Greater number of accidents was witnessed in the months of May, June, and December while the least in October (► Fig. 2). These findings were statistically highly significant (p < 0.01).

Out of 1,110 patients, majority (n = 490, 44.10%) of them were injured during noncollision accidents; 279 (25.18%) patients were injured during head-on collision and 162 (14.60%) during side-on collision, while 179 (16.12%) patients were hit from behind. Out of 910 riders, drivers, and vehicle occupants, 15.24% of the two-wheeler vehicle riders were wearing helmet and 8.73% of four-wheeler vehicle drivers and occupants had their seat belts tied at the time of accident while none of the vehicles had airbags inside them. Facial bone fractures were sustained by 502 of them among which 96.4% (n = 484) lacked compliance with use of protective gear. Use of protective gear was associated to lower risk of facial bone fractures (relative risk < 1, p < 0.05) (► Table 4).

► Table 5 summarizes the etiology behind RTAs. Violation of traffic rules (24.77%) was the most common etiology (p < 0.05). Driving under the influence of alcohol and other intoxicating substances like amphetamines (16.75%) significantly increased the incidence of RTAs (p < 0.05). Unsafe driving (overspeeding, and inexperienced and reckless driving, 14.50%), poor visibility (10.72%), vehicle congestion (9.43%), poor road condition (8.01%), and use of mobile phones while driving (3.96%) were also recorded.

Table 4 Association between protective gear compliance and incidence of facial bone fractures

<table>
<thead>
<tr>
<th>Incidence of facial bone fractures</th>
<th>Complaint victims</th>
<th>Noncomplaint victims</th>
<th>Marginal row totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>18</td>
<td>484</td>
<td>502</td>
</tr>
<tr>
<td>No</td>
<td>106</td>
<td>302</td>
<td>408</td>
</tr>
<tr>
<td>Total</td>
<td>124</td>
<td>786</td>
<td>910</td>
</tr>
</tbody>
</table>

Note: Relative risk (RR) < 1, p < 0.05.
transferred from the chin along the mandible to the condyle.

The long root of canines make this region weaker compared to the other 
turtles were least common in descending order of occurrence.

condylar fracture. Symphysis, coronoid, and Le Fort III frac- 
tures were most prone to RTAs. This vulnerability of two-
wheelers is due to less enclosed protection portion than other 
vehicles;, ability to gain higher speed over a short 
distance; less stability;, and as a whole, the most common 
mode of transportation. Moreover it is related to more 
serious injuries. Accidents involving bicycles is common in 
mode of transportation. Moreover it is related to more 
distance; less stability;, and as a whole, the most common 

In the present study, males were almost three times more 
commonly injured than females. This discrepancy may be 
due to the fact that males are comparatively more involved in 
outdoor activities and more likely to be chronic alcoholics 
and substance abusers. On the other hand, females are 
involved more into household and indoor activities in this 
part of the world.

This study found the peak incidence of maxillofacial trauma in the 20 to 29 years age group which is the most 
active period of life. High risk-taking behaviors like immaturity, inexperienced, and rash driving during this decade are 
one of the main reasons behind it. Analogous observations 
were made by others.

The present study showed that motorized two-wheeler 
vehicles are most prone to RTAs. This vulnerability of two-
wheelers is due to less enclosed protection portion than other 
vehicle;, ability to gain higher speed over a short 
distance; less stability;, and as a whole, the most common 
mode of transportation. Moreover it is related to more 
serious injuries. Accidents involving bicycles is common in 
built-up cities. Previous studies, however, mentioned 
four-wheeler vehicles being the most commonly involved 
ones.

Table 5 Etiology of accident

<table>
<thead>
<tr>
<th>Cause</th>
<th>Number</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Violation of traffic rules</td>
<td>275</td>
<td>24.77</td>
</tr>
<tr>
<td>Alcohol intoxication and substance abuse</td>
<td>186</td>
<td>16.75</td>
</tr>
<tr>
<td>Unsafe driving</td>
<td>161</td>
<td>14.50</td>
</tr>
<tr>
<td>Poor visibility</td>
<td>119</td>
<td>10.72</td>
</tr>
<tr>
<td>Over vehicle congestion</td>
<td>105</td>
<td>9.43</td>
</tr>
<tr>
<td>Poor road condition</td>
<td>89</td>
<td>8.01</td>
</tr>
<tr>
<td>Use of mobile phones while driving</td>
<td>45</td>
<td>3.96</td>
</tr>
<tr>
<td>Overload on vehicle</td>
<td>43</td>
<td>3.87</td>
</tr>
<tr>
<td>Poor vehicle condition</td>
<td>32</td>
<td>2.88</td>
</tr>
<tr>
<td>Pedestrian on road</td>
<td>29</td>
<td>2.61</td>
</tr>
<tr>
<td>Animal on road</td>
<td>26</td>
<td>2.50</td>
</tr>
</tbody>
</table>

Discussion

Road traffic injuries cause considerable economic losses to individuals, their families, and the nations as a whole. 90% of 
the world’s fatalities on the roads occur in low- and middle-income countries, even though these countries have ~54% of 
the world’s vehicles. Lower levels of protective device 
compliance and older design of vehicles in these countries may contribute to different injury patterns.

In the present study, males were almost three times more commonly injured than females. This discrepancy may be 
due to the fact that males are comparatively more involved in outdoor activities and more likely to be chronic alcoholics 
and substance abusers. On the other hand, females are 
involved more into household and indoor activities in this 
part of the world.

This study found the peak incidence of maxillofacial trauma in the 20 to 29 years age group which is the most 
active period of life. High risk-taking behaviors like immaturity, inexperienced, and rash driving during this decade are 
one of the main reasons behind it. Analogous observations 
were made by others.

The present study showed that motorized two-wheeler 
vehicles are most prone to RTAs. This vulnerability of two-
wheelers is due to less enclosed protection portion than other 
vehicle;, ability to gain higher speed over a short 
distance; less stability;, and as a whole, the most common 
mode of transportation. Moreover it is related to more 
serious injuries. Accidents involving bicycles is common in 
built-up cities. Previous studies, however, mentioned 
four-wheeler vehicles being the most commonly involved 
ones.

In overall, parasymphyseal was the commonest followed by condylar fracture. Symphysis, coronoid, and Le Fort III frac-
tures were least common in descending order of occurrence.

The long root of canines make this region weaker compared with the rest of mandible whereas, force of the blow that is 
transferred from the chin along the mandible to the condyle 
causes its neck to fracture. However, some mentioned ramus, body, and condyle as the most common site to 
fracture during mandibular trauma. In midface region, the commonest was zygomatic complex fracture while some 
reported nasal complex being the most frequently affected. This noncorresponding finding may be due to the fact that few 
cases of nasal fractures are reported in maxillofacial trauma unit as patients are usually referred to ear, nose, and throat (ENT) surgeons.

The most common concomitant dental injuries were tooth luxation, fracture, and avulsion. Two-wheeler vehicle riders 
represented more than half of the victims sustaining these injuries. Upper teeth are placed prominently, thus invariably 
getting involved during trauma to the midface compared with teeth in lower jaw. Almost one-third of the maxillofacial 
injuries involved soft tissues only as not all RTAs result in facial bone fractures. Laceration, abrasion, and contusion were the 
most common forms of soft tissue injuries. In this study isolated 
maxillofacial injury was noted in most of the victims (37.30%). 
Injuries to neurological components, particularly head injury, 
were the commonest occurring associated injury followed by 
orthopaedic injuries and ophthalmic injuries. Maximum of 
these injuries were observed in two-wheeler vehicle occupants 

Regarding variation according to months of the year, highest 
number of the accidents was recorded in July and August by some which are the months of monsoon season. The road 
becomes muddy and slippery causing more accidents. Also, rain causes visual obstruction to drivers. However, in the present study RTAs were observed comparatively less in July (8.37%) and August (7.47%). The reason behind this may be due to the fact that individuals now drive more cautiously and avoid over speeding or overtaking other vehicles in wet and slippery conditions. It also means less debilitating injuries. Most of the population prefers to stay indoors and enjoy the comfort rather than getting involved in outdoor activities during these conditions.

Highest incidence of RTAs was witnessed in May and June which are the months of summer season. Summer holidays with an added clear weather conditions increase outdoor activities. This is often associated to overspeeding and 
reckless driving resulting in high number of severe injuries. Furthermore, these months is the peak period of marriage ceremonies which means more drunk driving. Similarly in winter months of December and January driving is hampered due to poor visibility in heavy fog and mist resulting in high incidence of RTAs.

Night driving is a potential risk for travelers. At night time 
individuals are more likely to be under the influence of 
alcohol and reckless while driving. Lack of street lights result 
in glare of incoming vehicles especially on high beam which
affects vision. A decade back studies\textsuperscript{20,21} observed higher number of RTAs during the day mentioning more heavy traffic rush on the road compared with night time. In recent years, however, rise in active nightlife has resulted increased traffic during night as well.

Incidence of RTAs also varies according to the location where it took place. Previous studies\textsuperscript{7,10,22,23} observed highest incidence of RTAs on highways. Vehicles travelling at high speeds, less wide roads, and multiple intersections contribute to highway RTAs.\textsuperscript{23} However, in the present study urban victims (57.20\%) outnumbered rural (24.86\%) and highway (17.94\%) victims. The ever increasing gap between the urban and rural areas in terms of available facilities has resulted overcrowding and heavier load of vehicles in urban areas leading to higher number of RTAs. Geographical complexities and difficult terrain with poor road conditions are responsible for RTAs in rural areas.

The present study found highest number of injuries associated to noncollision accidents mainly skidding of vehicles hitting face first on the road followed by head-on collision, side-on collision, and hit from behind. Slippery and defective roads, overspeeding, and difficulty in balancing two-wheeler vehicles attributes to high number of non-collision accidents. Similarly, head-on collision with other vehicles, road dividers, trees, and animals is mostly due to driving on the wrong lane in opposite direction.

Use of protective gear was extremely low which explains the severity of injuries in RTA victims. Only 104 (15.24\%) two-wheeler riders were wearing helmets and 20 (8.73\%) four-wheeler occupants had their seat belts tied at the time of accident. None of the four-wheeler vehicles had airbags inside them. Use of protective gears of prescribed standard keeps the drivers as well as occupants intact and safe during accidents. Failure to wear helmets greatly increases the probability of head injury while lack of seat belt use results in forward jerk during collision with higher rate of injury to chest and face. One of the studies\textsuperscript{5} found reluctance among the people to wear helmets believing the myth of hair loss. Helmet and seat belt law obligation could lower the number of RTA injuries. Full-face helmets should be encouraged as they protect the head as well as the jaws whereas half helmets are least effective in avoiding trauma to the jaws particularly mandible.

Violation of traffic rules (24.77\%) was the principal reason behind highest number of accidents followed by driving under the influence of alcohol and other intoxicating substances (16.75\%).

Traffic rules are framed for road safety and to prevent accidents so it should be followed seriously by people across all regions. Drivers and commuters of public vehicles need to respect pedestrians’ right of way. Violation of red lights and rules at road crossings, parking of vehicles in no parking zone, entering the vehicles on one-way lanes in wrong direction, and crossing underneath the barriers with two-wheelers at railway crossings needs to be checked.

Rules are not exclusive for the drivers, but for the pedestrians and vehicle occupants as well. Pedestrians should walk on footpaths which are made exclusively for them. They should avoid crossing the road at wrong places and practice the use of zebra crossings and overhead bridges especially during heavy traffic. Occupants should avoid projecting their body outside the vehicle, talking to drivers, alighting and boarding vehicle from wrong side, travelling on footboards, and catching a running bus.\textsuperscript{24}

Unsafe pattern of driving is closely associated to gender and age of an individual.\textsuperscript{19} In the present study, males of active age group 20 to 29 years were found to be responsible for overspeeding, and reckless and inexperienced driving in most of the cases. Moreover high-speed road crashes result in more severe injuries.

Distraction to the driver can cause loss of concentration and control over the vehicle which can result in major accidents. As the study observed the major distraction nowadays is talking on cellular telephones while driving. It is important to avoid this practice and in cases of urgency, one should pull out beside the road and then attend the call. Animals and pedestrians on road are some of the distractions outside the vehicle that can be controlled by placing road side safety barriers. Children playing on the roads and being hit by speeding vehicles should not be overlooked.

Poor road infrastructure and maintenance is still a common scenario in all regions whether rural, urban, or highways. Rural roads merged with highways, potholes, eroded roads, illegal speed breakers, and diversions have not been managed yet. These were responsible for 89 (8.01\%) cases of the RTAs in the present study. Brakes failure, tire burst, insufficient headlights, projecting loads, and poorly maintained and outdated old vehicles are some of the contributing factors.

**Conclusion**

The ever-increasing incidence of maxillofacial injuries related to RTAs suggests the need to deal with them promptly and wisely. Keeping an update on the changing pattern of these injuries by continuous recording and periodic evaluation of epidemiological data is helpful in the primary prevention of trauma by evolving a better trauma care program and effective treatment protocol focused on the target groups. The updated data can guide treating physicians in anticipating and diagnosing maxillofacial injuries.

**Ethical approval**

This study was exempted from Ethical Review Board in agreement with local regulations, as it consisted of a retrospective review of charts.

**Patient consent**

Not required.

**Funding**

None.

**Conflicts of Interest**

None.
References