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CLINICAL PAPER

# Incidence and Pattern of Cranio-Maxillofacial Injuries: A 22 year Retrospective Analysis of Cases Operated at Major Trauma Hospitals/Centres in Pune, India

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**Abstract** This study aims to retrospectively analyze the incidence and pattern of cranio-maxillofacial injuries in the developing world in a hope to emphasize on authorities the need of improvising infrastructural facilities, medical and other. Hospital medical records with available radiographs of 6,872 patients treated for cranio-maxillofacial injuries at major trauma centres in Pune, India over a 22 year period (from July 1989 to June 2010) were reviewed. Relevant data pertaining to patients' age, sex, cause of injury, sites of injury, associated injuries, anaesthesia, various treatment modalities and complications were recorded and analyzed statistically. A total of 6,872 patients sustained maxillofacial injuries of which 5,936 (86.4 %) were caused by road traffic accidents (RTA), followed by fall in 608 cases. Distribution pattern of sex revealed male predominance (M:F-2.5:1) and the third decade age group (2,416) sustained maximum cranio-maxillofacial injuries. Of 12,503 cranio-maxillofacial sites involved, mandible (6,456) predominated, while there was middle third involvement in 5,024 cases. Most of the patients (4,856) were treated with open reduction and internal fixation without maxillo-mandibular fixation and complications were noted in 320 patients. In comparison to similar recent studies reported in the literature, our findings show that RTA remains the most common cause of cranio-maxillofacial injuries with male preponderance. Also RTA remains the major preventable etiological factor of cranio-maxillofacial injuries, which should prompt authorities to take "Herculean effort" to implement rules and educate people.

**Keywords** Facial trauma · Maxillofacial injuries · Road traffic accidents · Retrospective statistical analysis

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## Introduction

Many published studies [1–6] pertaining to the incidence and causes of maxillofacial injuries show that pattern of maxillofacial fractures have changed over the decades and continue to do so. Main causes worldwide are traffic accidents, assaults, falls, sports-related injuries, and civilian warfare [1]. Earlier studies from Nigeria [2], Libya [3], Europe [4], and Pakistan [5] showed that traffic accidents were the most common cause of facial bone fractures.

World Health Organization (WHO) statistics indicate that 1 million people die and between 15 and 20 million are injured annually in road traffic accident (RTA) [6, 7]. It is predicted that by year 2020 RTAs will rank third of all major causes of morbidity and mortality globally, unless technology and knowledge is used for prevention [8].

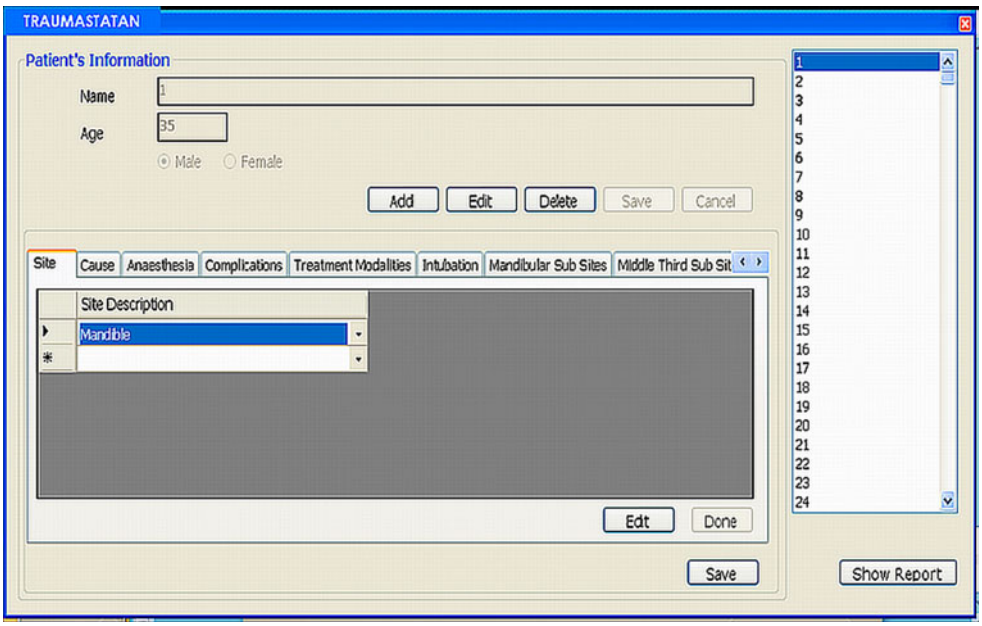


**Fig. 1** Showing data screen of *TRAUMASTATAN* software

Large variability is seen in causative factors and prevalence of cranio-maxillofacial injuries, which is related to the environment, culture, sex, age and socioeconomic status, as well as the mechanism of injury [5, 6]. Whereas RTA remains the most frequent cause of maxillofacial injuries in developing countries [9], recent studies show that assault is turning into the most common cause in developed countries. Due to poorly developed infrastructure, medical and other, at grass root level, the true public health and economic impact due to RTA is probably not estimated in developing countries [8].

This article presents patient demographics, injury profile, anesthetic as well as surgical management, and complications in 6,872 patients treated for cranio-maxillofacial injuries between July 1989 and June 2010 at major trauma hospitals/centers in Pune, India.

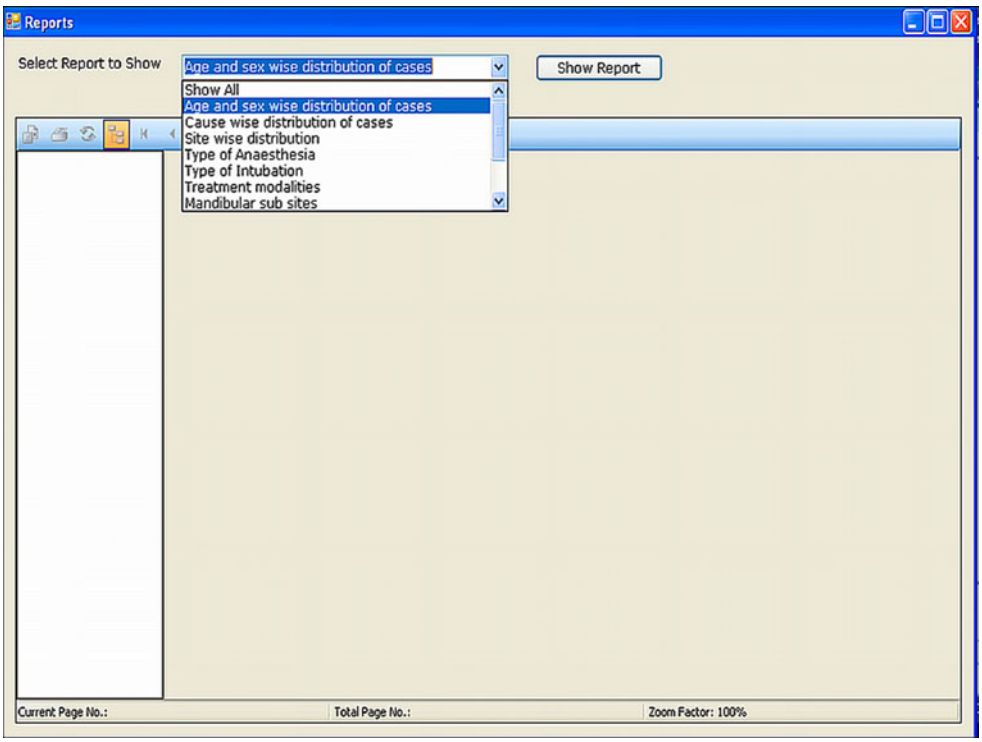


**Fig. 2** Showing report screen of *TRAUMASTATAN* software

## Materials and Methods

The authors and co-authors function as a team of consultant maxillofacial surgeons in many major trauma centres/hospitals in the city of Pune (Maharashtra, India). These centres are referral centres for poly trauma cases, which drain a large area in the west of Maharashtra, India. Hospital records of patients, including radiographs who had undergone treatment for facial injuries during the period July 1989 to June 2010 at these centres/hospitals were reviewed retrospectively to analyze the incidence and the pattern of cranio-maxillofacial injuries.

The data recorded included personal details, cause of injury, site of injury, type of anaesthesia/intubation, concomitant injuries, modalities of treatment and complications related to cranio-maxillofacial injuries if any.

Whereas cranio-maxillofacial injuries were managed by the consultant maxillofacial team, the associated/concomitant injuries were managed by respective specialists.

The data was entered in MS Excel spread sheet (*Windows Microsoft Office Excel Worksheet 1997*) and then transferred to the Software Programme (*TRAUMASTATAN Version 1.0 2010–2011*) which was designed indigenously and specifically for tabulation and analysis of the obtained data (Figs. 1, 2).

## Results

A 22 year retrospective study evaluated 6,872 patients managed for cranio-maxillofacial injuries from July 1989 to June 2010 at major trauma centres/hospitals. There were 4,912 males and 1,960 females patients (Table 1). The patients ranged in age from 2 to 71 years (mean 32.7), with highest incidence of 2,416 patients in the 3rd decade.

The etiology of cranio-maxillofacial injuries were varied (Table 2); however, the main causative factor was RTA in 5,936 cases, followed by fall in 608 cases and assault in 128 cases. Sports related injuries accounted for only 64 cases. Other causes included animal injury in 32 cases, industrial injury in 64 cases, farm injury in 8 cases, and gunshot injury in 32 cases. Seventy-two per cent of RTAs were noted in two wheeler users.

The total injury sites were 12,503 amongst which mandibular fractures were the highest which accounted for

**Table 1** Age and sex wise distribution of cases

| Age in years | Sex | | Total | |
|---|---|---|---|---|
| | Male | Female | Number | % |
| 1–10 | 120 | 24 | 144 | 2.1 |
| 11–20 | 304 | 216 | 520 | 7.6 |
| 21–30 | 1,744 | 672 | 2,416 | 35.2 |
| 31–40 | 1,154 | 570 | 1,724 | 25 |
| 41–50 | 926 | 340 | 1,266 | 18.4 |
| 51–60 | 470 | 196 | 666 | 9.7 |
| 61–70 | 88 | 40 | 128 | 1.9 |
| >70 | 8 | 0 | 8 | 0.1 |
| Total | 4,912 | 1,960 | 6,872 | 100 |

**Table 2** Cause wise distribution of cases

| Cause | Sex | | Total | |
|---|---|---|---|---|
| | Male | Female | Number | % |
| RTA | 4,192 | 1,744 | 5,936 | 86.4 |
| Assault | 104 | 24 | 128 | 1.8 |
| Fall | 456 | 152 | 608 | 8.9 |
| Sports | 56 | 8 | 64 | 0.9 |
| Animal injury | 32 | 0 | 32 | 0.5 |
| Industrial | 40 | 24 | 64 | 0.9 |
| Farm injury | 8 | 0 | 8 | 0.1 |
| Gun shot | 24 | 8 | 32 | 0.5 |
| Total | 4,912 | 1,960 | 6,872 | 100 |

**Table 3** Site wise distribution

| | Sub sites | Sex | | |
|---|---|---|---|---|
| | | Male | Female | Total |
| Mandible | Symphysis | 600 | 224 | 824 |
| | Parasymphysis | 1,248 | 464 | 1,712 |
| | Body | 752 | 312 | 1,064 |
| | Angle | 1,048 | 448 | 1,496 |
| | Ramus | 8 | 0 | 8 |
| | Condyle | 984 | 344 | 1,328 |
| | Coronoid | 0 | 0 | 0 |
| | Dentoalveolar | 24 | 0 | 24 |
| | Total | 4,664 | 1,792 | 6,456 |
| Middle third | | | | |
| | Le Fort I | 416 | 144 | 560 |
| | Le Fort II | 224 | 104 | 328 |
| | Le Fort III | 104 | 16 | 120 |
| | Le Fort I and II | 176 | 64 | 240 |
| | Le Fort II and III | 112 | 16 | 128 |
| | Le Fort I, II and III | 400 | 184 | 584 |
| | ZMC | 1,200 | 576 | 1,776 |
| | FNOE | 368 | 208 | 576 |
| | Blow out | 96 | 52 | 148 |
| | Craniofacial | 296 | 116 | 412 |
| | Nasal bone only | 96 | 40 | 136 |
| | Zygomatic arch only | 16 | 0 | 16 |
| | Total | 3,504 | 1,520 | 5,024 |
| Pan facial | | 592 | 232 | 824 |
| Avulsive injuries | | 132 | 67 | 199 |

**Table 4** Associated injuries

| Associated injuries | Sex | | Total | |
|---|---|---|---|---|
| | Male | Female | Number | % |
| Cervical spine | 84 | 32 | 116 | 2.7 |
| Head injury | 1,544 | 916 | 2,460 | 56.5 |
| Orthopaedic injury | 788 | 352 | 1,140 | 26.2 |
| Abdomen/thoracic | 440 | 168 | 608 | 13.9 |
| Cranial nerve injuries | 24 | 8 | 32 | 0.7 |
| Total | 2,880 | 1,476 | 4,356 | 100 |

**Table 5** Type of anaesthesia and intubation

| | Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| Anaesthesia | | | |
| LA | 168 | 120 | 288 |
| SLA | 288 | 80 | 368 |
| GA | 4,456 | 1,760 | 6,216 |
| Intubation | | | |
| Oro endotracheal | 1,080 | 464 | 1,544 |
| Naso endotracheal | 2,760 | 1,032 | 3,792 |
| Transmylohyoid/submental | 544 | 232 | 776 |
| Tracheostomy | 72 | 32 | 104 |
| Total | 4,912 | 1,960 | 6,872 |

6,456 sites followed by middle third fractures in 5,024 sites. Other injuries included pan facial in 824 and avulsive injuries in 199 cases (Table 3).

Distribution of mandibular fractures was in the following descending frequency; parasymphysis region (1,712), angle (1,496), condyle (1,328), body (1,064), symphysis (824), dentoalveolar (24), and ramus (8) (Table 3).

Distribution of middle third injuries was in the following descending frequency; zygomatic complex (ZMC) (1776), Le Fort I, II and III (584), fronto naso orbito ethmoidal (FNOE) (576) isolated Le Fort I (560), craniofacial (412), Le Fort II (328), combination of Le Fort I and II (240), orbital blow out (148), nasal bones (136), Le Fort II and III (128), Le Fort III (120), and isolated zygomatic arch in 16 cases (Table 3).

Distribution of associated injuries (4,356) was as follows; head injuries (2,460), orthopaedic injuries (1,140), thoraco-abdominal injuries (608), cervical spine injuries (116), and cranial nerve injuries (32) (Table 4).

Distribution of anaesthetic management was in the following descending order; general anaesthesia (GA) in 6,216 cases, LA + sedation (SLA) in 368, and local anaesthesia (LA) in 288 cases (Table 5). Naso-endotracheal intubation was carried out in 3,792 cases, followed by oro-endotracheal intubation in 1,544 cases, transmylohyoid in 776 and tracheostomy in 104 cases.

**Table 6** Treatment modalities

| Treatment | Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| Closed reduction MMF/splints/elastics | 382 | 146 | 528 |
| Craniomandiblar suspension wiring | 208 | 72 | 280 |
| ORIF without MMF | 3,408 | 1,448 | 4,856 |
| ORIF with MMF | 376 | 136 | 512 |
| Observation only | 16 | 0 | 16 |
| ORIF and elastics for 15 days | 384 | 88 | 472 |
| Golden hour reconstruction | 138 | 70 | 208 |
| Orbital excenteration | 16 | 0 | 16 |
| TE | 8 | 0 | 8 |
| Condylectomy | 8 | 0 | 8 |
| Autografts | 128 | 56 | 184 |
| Synthetic grafts | 24 | 24 | 48 |
| Soft tissue transfer | 8 | 2 | 10 |
| Total | 5,122 | 2,024 | 7,146 |

**Table 7** Complications

| Complications | Sex | | Total |
|---|---|---|---|
| | Male | Female | |
| Infection | 40 | 16 | 56 |
| Malunion | 104 | 16 | 120 |
| TMJ dysfunction | 8 | 0 | 8 |
| Mortality | 24 | 0 | 24 |
| Partial vision loss | 24 | 16 | 40 |
| FN duct disturbance | 8 | 0 | 8 |
| Facial nerve palsy | 8 | 8 | 16 |
| Hemorrhage | 16 | 0 | 16 |
| CSF rhinorrhoea | 24 | 0 | 24 |
| Retrobulbar hematoma | 8 | 0 | 8 |
| Total | 264 | 56 | 320 |

Majority of the patients (4,856) were treated with open reduction and rigid internal fixation (ORIF) without any maxillo-mandibular fixation (MMF). Various other treatment options are displayed in Table 6.

Complications (320 cases) were in the following descending order; malunion (120), infection (56), partial vision loss (40), CSF rhinorrhoea (24), mortality (24), facial nerve palsy (16), hemorrhage (16), TMJ dysfunction, frontonasal (FN) duct disturbance and retrobulbar hematoma (8 each) (Table 7).

## Discussion

The results of epidemiological studies on the causes and incidence of cranio-maxillofacial injuries tend to vary with

geographic location, socioeconomic status, culture, religion of the region, and era [5]. The predominance of men is a relatively consistent finding in most studies including the present [3, 5, 10].

In our series we were able to treat 9.5 % cases under LA + SLA which reduced the risk and cost of treatment. Also usefulness of transmylohyoid/submental intubation is highlighted by using this method in 11.29 % cases in whom tracheotomy and complications associated with it were avoided.

Reported ratios of males (M) to females (F) ranged from 2:1 to 5.4:1 [7, 10, 11]. The M:F ratio in the present study was 2.5:1 which compares to the previously reported series. This very well correlates with the nature of the Indian society, where males usually carry outdoor work including military and defense services, as a result are exposed to external unprotected environment while females are majorly occupied as homemakers and/or employed in protected indoor environment like teaching, information technology, health and other professions. Also few females tend to drive motorized vehicles.

Many authors have reported motor vehicle accidents as a major cause of facial injuries [12], whereas others have reported assault as the main causative factor [7, 10, 13, 14]. Our study concurs with the findings of the previous investigators, where motor vehicle accidents were the single most frequent cause of facial bone injuries (86.4 %), whereas fall was common only in the elderly and pediatric age group [15].

Insignificant representation of sports injuries in our series may be attributed to the fact that smaller proportion of population are involved in sports which are likely to cause major trauma, and minor sports injuries are more likely to cause dental injuries which are generally managed at outpatient dental clinics and smaller hospitals.

Earthquake is a rare cause of maxillofacial injury (not seen in our series), but if any, zygoma is the more commonly affected site along with extremity injuries [16].

Most facial bone injuries involve the mandible and this is related to the direction and quantity of force that the mandible is exposed to. Our study also concurs with reported epidemiological studies that, in automobile crashes condylar injuries were more common, while two wheeler injuries are more the common cause for parasymphysis fractures and assault shows highest incidence of angle fracture.

The increasing number of RTAs in developing countries like India may be attributed to many factors besides narrow roads and heavy traffic, people driving twenty-first century vehicles on eighteenth century roads; sharing of un-segregated roadways by pedestrians and animals, fast and slow moving vehicles in same lane; the large number of old and poorly maintained vehicles; more two wheelers than the road can accommodate; low driving standards; large numbers of overloaded vehicles; widespread disregard for traffic rules; defective roads; poor street lighting and defective layout of cross roads and speed breakers [15, 17]. Additionally, ever increasing volume of traffic as a result of rapid economic expansion, urbanization, active night life in metros, may also be contributory factors. The increased interpersonal violence in the recent times can be attributed to the alcohol acceptance by society, which was previously held as taboo. Adding to this rapid modernization, unemployment due to mechanization and population explosion contributes to increased RTA.

The unstable nature of two wheelers, which are easily available due to liberal bank loan facilities in India and mostly driven by competitive energetic youngsters (in 3rd decade) engaged in outdoor activities, offer little protection to riders in comparison to cars. Other contributors to increased RTA involving two wheelers include lack of uniform regional rules pertaining to helmet usage.

Reluctance to use helmets due to myth of causing hair loss [18] and fear of theft of helmets, and lack of tolerance contribute to the higher Indian ranking in RTA. According to Liu et al. [19], though helmets were found to reduce the risk of death and head injuries in motorcyclists who crashed, prevention of facial and neck injuries by helmets needs further studies.

Increasing awareness of public about safety measures and enforcement of strict laws like mandatory use of seat belts and total head guard (with chin protector) rather than the conventional helmets can reduce most of the mandibular and middle third injuries.

Many studies have revealed that, use of air bags combined with use of seat belts results in decreased incidence and severity of maxillofacial injuries [20].

The higher involvement of mandible compared to other facial bones in cranio-maxillofacial injuries may be attributed to its prominence and exposed anatomical position on the face [17–21]. Most of the victims of RTA by reflex try to avoid their head at the time of accidents thus receiving maximum impact to the mandible.

Mandible is inherently weak at the neck of condyles, parasymphysis due to long roots of canine and angle due to abrupt change in direction between strong body and thin ramus and presence of thirdmolars, is found to be susceptible for fractures in most of the studies [17, 20–25]. The involvement of nasal bone in most of the middle third fractures may be attributed to its prominent location on the face and relative structural weakness [26–29]. But in our series ZMC injuries superseded nasal bone and FNOE injuries.

Interestingly, the study by Biju and Mohan [30] reveals that central midfacial fractures were most commonly associated with head injury, and hence, one must have high

suspicion index of unsuspected cranial injuries to decrease morbidity and mortality associated with craniofacial trauma.

The choice of treatment may differ regionally due to socioeconomic status, health insurance awareness, hospital infrastructure, consultant's skill and discretion, and patient's willingness governed by religious beliefs.

Facial bone fractures in younger age groups sometimes may lead to permanent deformity if not addressed timely and appropriately leading to national loss in terms of man hour and man power.

The increasing number of RTA related cranio-maxillofacial injuries suggests the need for immediate attention from the concerned authorities, to enforce strict laws like mandatory use of seat belts and total head guard (that suit climatic conditions) rather than the conventional helmets. Restricting the use of mobile phones and head phones while driving may lead to decrease in the incidence of RTA.

If RTA is considered an epidemic of modern times, then prevention is its vaccine. Increasing public awareness towards voluntary use of safety measures for their own safety rather than merely obeying the rules can reduce most of the cranio-maxillofacial injuries.

The present study had some limitations in terms of obtaining the complete data as it was a retrospective analysis from the hospital records. The valuable information regarding the literacy status of the patients and motor vehicle drivers, use of protective devices like helmets, seat belts at the time of injury were not available.

Rapid action by the authorities related to transportation and making public aware of importance of following the rules and regulations will go long way in reducing the morbidity and mortality associated with RTA. Prospective studies in this regard with complete information status of the patients and drivers, preferably with uniform and standardized proforma are recommended to statistically validate the data.

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**Conflict of interest** None declared

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