

## Original Article

# Pattern of maxillofacial injuries in patients with craniocerebral injuries: a prospective study

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**Abstract – Introduction:** This prospective study highlights the pattern of oral and maxillofacial injuries in patients with associated craniocerebral injuries. **Material and Methods:** This was a prospective descriptive study conducted over a 22-month period. Information was collected using a structured questionnaire and analyzed using Statistical Package for Social Sciences (SPSS) Version 13 (SPSS Inc., Chicago, IL, USA) and Microsoft Office Excel 2007 (Microsoft, Redmond, WA, USA). Test of statistical significance was set at 0.05. **Results:** Three hundred and three consecutive patients were studied and this consisted of 254 males and 49 females. The difference in the gender distribution was statistically significant ( $p=0.008$ ). Road traffic crashes ( $n=262$ ; 86.5%) was the most common cause of injury and soft tissues orofacial injuries accounted for 61.7% of injuries. Le Fort II fractures were the major skeletal injuries. Glasgow Coma Score (GCS) of 13–15 had the highest frequency ( $n=157$ ; 53.4%). Intracerebral haemorrhage was the most common cerebral injury recorded and the commonest complication noted was dysocclusion. **Discussion:** Although middle third facial fractures were the most common skeletal injury, fractures of the upper third facial skeleton appear to be associated with lower GCS. **Conclusion:** Fractures of the facial skeleton are fairly common in craniocerebral injuries.

## Introduction

Injuries to the face have a high frequency of occurrence because the face is the most exposed part of the body with little protective covering. Oral and maxillofacial injuries affect functions such as mastication, swallowing and speech in addition to facial aesthetics. Generally, individuals place a high value on facial aesthetics such that injuries that alter facial appearance may cause severe disability, psychological morbidity, and huge economic loss to the victim(s) and care providers [1].

There is a correlation between facial fractures and cranial injuries, approximately 20% of patients with maxillofacial injuries may have an associated craniocerebral injury [2,3]. Knowledge of these injuries provides useful strategies and a multidisciplinary approach to patient care [4]. Historically, the facial skeleton (particularly the middle third facial skeleton) has been perceived to be a cushion against impact

to the neurocranium and thus protecting it from severe injury [5]. Recent evidences suggest that the face (particularly upper and middle face) may actually transmit forces directly to the neurocranium through the buttresses resulting in more neurological injuries with lower Glasgow Coma Score and increased mortality [6,4]. Different classification systems for craniocerebral injury have been used in assessing patients and these include injury severity, pathoanatomic and pathophysiologic classifications. Classification based on injury severity is the most widely used classification in clinical research to compare patients among centers and for clinical treatment trials [7]. The 15-point Glasgow Coma Scale [8] which assesses patients level of consciousness is the most commonly used neurologic injury severity scale for adults and this is due to its high inter-observer reliability and generally good prognostic capabilities [9]. However, it requires skill and experience in scoring of consciousness and it is a poor predictor of outcome for less severe craniocerebral injuries. This prospective study highlights the characteristic features of oral and maxillofacial injuries in patients with associated craniocerebral injuries.

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## Material and methods

This prospective descriptive cross-sectional study was conducted on both out-patients and in-patients seen at the Accident and Emergency unit, Oral/Maxillofacial, and Neurosurgery clinics of a regional University Teaching Hospital over a 22-month period.

### Inclusion criteria

- Patients who gave informed consent.
- All consecutive patients (including those who died during or after treatment but were included in the study) with hard and soft tissues maxillofacial injuries and associated craniocerebral injuries.
- Patients with maxillofacial injuries and associated craniocerebral injuries of different etiologies.
- Patients with maxillofacial injuries and associated craniocerebral injuries in the presence or absence of other concomitant injuries (such as chest, abdominal, genitourinary, orthopedic injuries).

### Exclusion criteria

- Patients who refused informed consent.
- Patients who had craniocerebral injuries without maxillofacial injuries.
- Patients who had maxillofacial injuries without craniocerebral injuries.
- Patients who were brought to the hospital dead.

### Classification

Classification of mandibular fracture was based on site while frontal bone fracture was based on anatomic location [10,11]. Classification of craniocerebral injury was according to the 15-point Glasgow Coma Scale (GCS) [8] which is based on the period of loss of consciousness and classified craniocerebral injuries into mild, moderate and severe. For patients less than 5 years, the Pediatric Coma Scale, a modification of the adult Glasgow Coma Scale was used [12].

Following approval from the Human ethics committee, a structured proforma was used to record relevant details of all patients who met the inclusion criteria. These information included bio-data, etiology of injury, Glasgow Coma Score, clinical features, investigations, treatment given, treatment outcome and complications.

Data collected was analyzed using Statistical Package for Social Sciences (SPSS) Version 13 (SPSS Inc., Chicago, IL, USA) and Microsoft Office Excel 2007 (Microsoft, Redmond, WA, USA). Data were presented in the form of tables, figures and cfigures and charts with statistical significance tested using Pearson Chi-square test ( $\chi^2$ ) and set at 0.05.

## Results

During a 22-month period of study, 580 patients presented with oral and maxillofacial injuries. Of these, three hundred and three (52.2%) patients had associated craniocerebral injuries and were included in the study. This consisted of 254 males and 49 females giving a male/female ratio of 5.2:1 with a male dominance in all age groups. The ages of the patients ranged from 3 to 73 years, with mean age of  $28.8 \pm 13.1$  years and a peak age incidence in the third decade. The difference in gender distribution was statistically significant ( $p = 0.008$ ).

Road traffic crash ( $n = 262$ ; 86.5%) was the most common cause of injury, comprising of 144 (55.0%) injuries from vehicular crashes, 117 (44.6%) motorcycle crashes, and only 1 (0.4%) bicycle crash. Of the 144 patients involved in vehicular crashes, 10 (6.9%) alluded to the use of seat belts. Similarly of the 117 patients with motorcycle crashes, only 2 (1.7%) wore helmets. Other causes of injuries were assault ( $n = 16$ ; 5.3%); falls ( $n = 15$ ; 5.0%); occupational injury ( $n = 5$ ; 1.7%), blast injury ( $n = 1$ ; 0.3%) and electrical burns ( $n = 1$ ; 0.3%). There was no statistically significant relationship between etiological factors and facial fractures ( $p = 0.831$ ).

The distribution of patients in the study on presentation according to their Glasgow Coma Scores (GCS) shows that GCS of 13–15 had the highest frequency ( $n = 157$ ; 51.8%), followed by GCS of  $\leq 8$  ( $n = 84$ ; 27.7%) and GCS of 9–12 ( $n = 62$ ; 20.5%). Amongst the nine patients who were five years and below, Pediatric Coma Score (PCS) of  $\leq 8$  (66.7%) had the highest frequency followed by PCS of 13–15 (22.2%). Although most of the patients with GCS  $\leq 8$  had cerebral injuries (67.9%), this was not statistically significant ( $p = 0.305$ ). Similarly, there was no statistically significant relationship between etiological factors and Glasgow Coma Score ( $p = 0.061$ ).

The type of injuries and the anatomic site distribution are represented in Table I. Three hundred and three patients sustained 811 various facial injuries with injuries to the soft tissues having the highest frequency, accounting for 61.7% of all injuries while the remaining 38.3% were to the hard tissues. Severe craniocerebral injury (GCS  $\leq 8$ ) was higher in patients with lacerations (36.1%), abrasions (26.4%) or a combination of both (34.7%).

When associated craniocerebral injuries are considered, there were 60 cranial injuries and 37 cerebral injuries (Tab. II). All the patients had a history of loss consciousness. There was no statistically significant relationship between the age of patients and type of cranial fracture ( $p = 0.790$ ).

Ninety two (65.2%) patients were assessed using plain radiography while 39 (34.8%) patients had computed tomography scanning. Of a total of 303 patients, 208 patients had various treatment modalities, namely, surgical (202 patients) and conservative (6 patients). The remaining 95 patients were not treated and the reasons were death; discharged against medical advice; patient request for referral, and inability to afford cost of surgery.

Anesthetic technique used in treating injuries were local anesthesia ( $n = 137$ ; 67.8%), local anesthesia plus conscious

**Table I.** Pattern of oral and maxillofacial hard and soft tissue injuries in patients with associated craniocerebral injury.

Anatomic sites of injury	Frequency (%)	Total number (%)
<b>Soft tissue</b>		500 (61.65)
<i>Laceration</i>		290 (35.76)
Eye lids	19 (2.34)	
Nasolabial	2 (0.25)	
Nose	14 (1.73)	
Tongue	2 (0.25)	
Preauricular	8 (0.99)	
Angle of mouth	4 (0.49)	
Chin	16 (1.97)	
Lips	55 (6.78)	
Submandibular	5 (0.62)	
Cheek	45 (5.55)	
Frontal	97(11.96)	
Labial sulcus	10 (1.23)	
Ear	13 (1.60)	
<i>Abrasion</i>		188 (23.18)
Ear	3 (0.37)	
Frontal	52 (6.41)	
Submandibular	2 (0.25)	
Cheek	54 (6.66)	
Lips	23 (2.48)	
Eyelid	11 (1.36)	
Preauricular	14 (1.73)	
Chin	12 (1.48)	
Nose	17 (2.10)	
<i>Hematoma</i>		3 (0.37)
Frontal	3 (0.37)	
<i>Contusions</i>		3 (0.37)
Cheek	3 (0.37)	
<i>Penetrating</i>		2 (0.25)
Cheek	2 (0.25)	
<i>Avulsion</i>		14 (1.73)
Eyelid	2 (0.25)	
Lips	1 (0.12)	
Cheek	7 (0.86)	
Frontal	1 (0.12)	
Ear	3 (0.37)	
<b>Hard tissues</b>		311 (38.35)
<i>Mandibular fracture</i>		83 (10.23)
Condyle	7 (0.86)	
Ramus	1 (0.12)	
Angle	6 (0.74)	

**Table I.** (continued).

Anatomic sites of injury	Frequency (%)	Total number (%)
Body	21 (2.59)	
Parasymphysis	22 (2.71)	
Symphysis	11 (1.36)	
Dentoalveolar	15 (1.85)	
<i>Middle third fractures</i>		197 (24.29)
Dentoalveolar	23 (2.84)	
Palatal	17 (2.10)	
Zygomatic complex	79 (9.74)	
Zygomatic arch	2 (0.25)	
Nasal bone	3 (0.37)	
Nasal complex	19 (2.34)	
Le fort I	19 (2.34)	
Le fort II	23 (2.84)	
Le fort III	2 (0.25)	
Orbital blow out	10 (1.23)	
<i>Upper third fractures</i>		31 (3.82)
Frontal bone	31 (3.82)	
<b>Total</b>		811 (100.00)

**Table II.** Pattern of associated craniocerebral injuries.

Type on Injury	Frequency (%)	Total number (%)
<b>Cranial injury sites</b>		60 (61.86)
Frontal	31 (31.96)	
Parietal	16 (16.49)	
Temporal	6 (6.19)	
Occipital	6 (6.19)	
Base of skull	1 (1.03)	
<b>Cerebral injury types</b>		37 (38.14)
Contusions	3 (3.09)	
Epidural hematoma	5 (5.15)	
Subdural hematoma	5 (5.15)	
Subdural effusion	1 (1.03)	
Subarachnoid haemorrhage	3 (3.09)	
Intracerebral haemorrhage	12 (12.37)	
Intraventricular haemorrhage	7 (7.22)	
Mesencephalic haemorrhage	1 (1.03)	
<b>Total</b>		97 (100.00)

sedation ( $n=26$ ; 12.9%) and general anesthesia ( $n=39$ ; 19.3%). Eight patients (3.8%) required neurosurgical intervention in the form of craniotomy with duraplasty.

In the follow-up periods, many patients were lost after the removal of suture and intermaxillary fixation wires. Of the 202 patients treated, 36 (17.8%) presented with complications of which malocclusion ( $n=10$ ; 27.8%) and infections ( $n=8$ ; 22.2%) were the most common presentations (Tab. III).

## Discussion

The incidence (52.2%) of maxillofacial injuries in patients with associated craniocerebral injuries reported in this study is higher than earlier reports [13,14]. This higher incidence may be attributed to increased referral of patients from peripheral hospitals to the tertiary hospital where this study was conducted since it is the only facility in the state with a computed tomography machine, and the only health care facility in the state with a neurosurgeon at the time of this study. The unavailability of computed tomography machine and a neurosurgeon in this center prior to the year 2006 is probably responsible for the low (15.7%) incidence reported by an earlier researcher from this center [15].

20–29 years age group accounted for a majority of patients in this study. This is in agreement with previous studies [4,16] and this may be related to their greater involvement in risk related outdoor activities, substance abuse and interpersonal violence. A male to female ratio of 5.2:1 recorded is in line with some global reports of male preponderance [4,17,18].

Road traffic crash was the major etiological factor, similar to the findings from other studies [5,16]. However, a report of 86.5% due to road traffic crashes in this study is higher than

**Table III.** Complications observed during follow-up period.

Type	Frequency	Percentage
Hypertrophic scar	7	19.44
Ectropion	2	5.56
Wound infection	8	22.22
Malocclusion	10	27.78
Resorption of bone graft	2	5.56
Facial nerve palsy	3	8.33
Keloid	3	8.33
Anosmia	1	2.78
<b>Total</b>	<b>36</b>	<b>100.00</b>

previous findings [5,19]. In agreement with other report [2] motorcycle related crashes were the second most common cause of road traffic crashes. In this environment, a number of commercial motorcyclists do not own the motorcycles they ride. Rather they make fixed daily financial return to the owners, a situation referred to as “hire purchase” or “rent-to-own”. In an effort to meet the daily financial targets imposed by the owners, they engage in reckless driving which may result in a crash.

Pedestrian related road traffic crashes (16.0%) were the third frequent type of road traffic crashes noted, and commonly involved the 0–9 and 10–19 year age groups. Children are more predisposed to pedestrian crashes due to their inability to make complex judgment of distance and speed, inefficient peripheral vision and poor directional hearing [20]. This risk is further heightened by the non-existence of speed limit signs in this environment which meant that drivers and motorcycle riders are at liberty to move at any speed deemed reasonable to them irrespective of whether it is a market, residential or school area.

Maxillofacial soft/skeletal tissue injuries constituted 61.7% and 38.3% of cases studied respectively, this is similar to other finding [21]. Therefore, oral and maxillofacial soft tissue injuries may be important markers of craniocerebral injuries. Soft tissue injuries were mainly lacerations and abrasions. This pattern of soft tissue injury observed may be related to the main etiological factor; road traffic crash. Most of the commercial vehicles used in this environment are old and have rough/sharp exposed interior metallic parts as a result of loss of the overlying protective padding's. Thus in an event of a crash, contact between human body parts and such rough/sharp vehicle interior are more likely to produce abrasive and lacerative injury patterns. Similarly, contact between the face and tarred road in vehicular and motorcycle related crashes may easily result in abrasions and lacerations. Overall, the frontal region ( $n = 153$ ; 18.9%) was the most commonly involved site in soft tissue injuries. This is in accordance with previous findings [22]. However, in the general population, maxillofacial soft tissue injuries have commonly been noted in the lower third facial region [23,24]. The frontal region may have been more predisposed due to the forward thrust of unrestrained passengers in a vehicle on sudden application of brake by the

driver or on sudden impact with a stationary or moving object in accordance with Newton's first law of motion (“everyone continues in their state of motion in a straight line unless acted upon by an external force”). The United States of America National Highway Traffic Safety Administration (2008) reported that 48% of crash involved frontal impact. The use of seatbelts and presence of airbags reduces frontal contact between vehicle occupants and vehicle interior [25]. In this study, only 10 (6.9%) patients alluded to the use of seat belts while only 2 (1.7%) patients wore helmets.

The middle third of the facial skeleton had the highest frequency (63.3%) in fractures of the facial skeleton, with fractures of the zygoma (40.1%) and Le Fort II (11.7%) fractures being the most frequent, similar to previous reports [18,26]. The prominence of the zygoma and its multiple articulations on the middle facial skeleton may have increased its vulnerability to fractures following trauma. The proximity of the midfacial skeleton to the neurocranium and its tendency to transmit forces of impact directly to it through the buttresses has been attributed to the frequent association between midfacial fractures and craniocerebral injuries [5]. Similarly, the low incidence of seat belt use (only 10 patients used seat belts) noted in this study may have predispose to increased middle third facial fractures and the associated craniocerebral injuries. A significant association between seat belt use and incidence of middle third facial fractures (particularly zygomatic complex fractures) have been reported [25] with an associated reduction in the incidence of zygomatic complex fractures from 49.0% (in unrestrained passengers) to 37.0% with seat belts.

Mandibular fractures, accounting for 13.7% of all skeletal injuries were the second most common fracture of the facial skeleton. Previous studies reported the mandible as the most commonly involved bone in fractures of the facial skeleton in the general population and in patients with associated craniocerebral injuries [4,15,19]. The lower incidence of mandibular fractures reported in this study is may be due to the non presentation of some isolated mandibular fractures to our tertiary hospital particularly those associated with mild craniocerebral injuries (Glasgow coma score of 13–15). Rather, these were managed by general dental practitioners. The low incidence of mandibular fracture may also be as a result of missed diagnosis (particularly in undisplaced fractures where there is no gross occlusal derangement) especially by the accident and emergency doctors who are not skilled in maxillofacial injury assessments or who may have been more focused on the associated craniocerebral injuries. Similarly, because mandibular fractures are indicators of possible potentially serious injuries due to the high energy required to disrupt the mandible [27], non survival from associated severe craniocerebral injury especially in the absence of a good pre-hospital care which is lacking in this environment may also have accounted for the low incidence of mandibular fractures observed. The upper third facial skeleton had the least frequency (10.0%) in fractures of the facial skeleton associated with craniocerebral injuries. In general, the incidence of frontal

**Table IV.** Craniofacial fractures and GCS.

Craniofacial fracture	GCS			Total
	13 and above	9–12	8 and below	
Lower third	16	2	6	24
Middle-third	35	7	14	56
Upper-third	5	2	10	17
Lower and middle-third	25	7	4	36
Middle and upper-third	4	3	0	7
Lower, middle and upper-third	3	3	1	7
Total	88	24	35	147

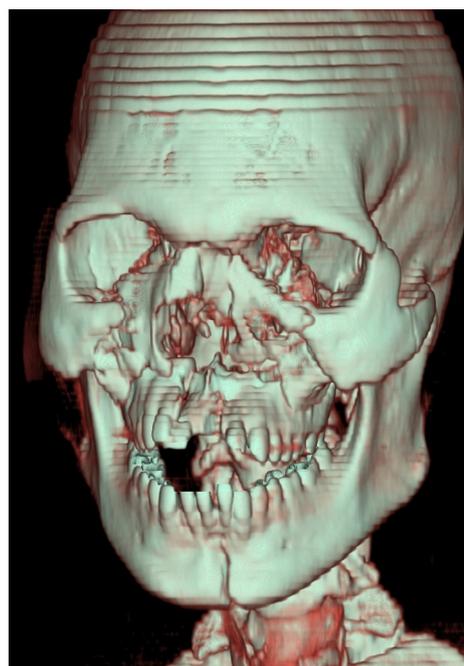
sinus fracture ranges from 5% to 15% [28]. Despite the low use of seat belt and helmet in this study (with the likely frontal impact by passengers in the event of a crash), the low incidence of frontal sinus fracture recorded may be related to its resistance to fracture. Nahum (1975) in his experimental study on cadavers reported that fractures of the frontal sinus were produced by forces in the range of 500–1500 lbs, the highest of all the facial bones. Similarly, because the frontal sinus is closely related to the brain, and its fracture is produced by high velocity impacts such as road traffic crash [28], mortality from the likely associated severe cerebral injuries may have also accounted for the low incidence recorded.

Glasgow Coma Score (GCS) of 13 and above (52.5%) had the highest frequency. This is in agreement with previous findings [18,29]. Upper third facial fractures were more likely to result in severe craniocerebral injury (GCS 8 and below) (Tab. IV) similar to other finding [17].

Plain radiograph was the most frequently used imaging technique, accounting for 65.2% of all imaging techniques used while 34.8% of patients had Computed Tomography (CT) scan (Fig. 1). Although CT is currently the gold standard for the evaluation of craniocerebral injury, it was not widely used in this study because most of the patients had mild craniocerebral injury in the presence of certain factors outlined by the Canadian CT head rule such as depressed skull fractures and more than two episodes of vomiting. Secondly, most patients could not afford the cost of CT.

None of the patients with facial fractures had early treatment under general anaesthesia. This was as a result of factors such as logistic problems, poor communication between the different surgical teams and inability of patients to pay for surgical fees early. Skeletal injuries were treated conservatively or surgically (using closed reduction or open reduction plus transosseous wiring with or without intermaxillary fixation). Because of the unavailability of osteosynthesis armamentarium in this centre, rigid fixation was not used. Craniocerebral injuries (Tab. II) were mostly managed by the neurosurgery unit and majorities (96.2%) of the patients were managed non-operatively, similar to other report [18].

Most of the patients in this study fail to keep up with their post treatment review as soon as sutures and intermaxillary



**Fig. 1.** Computed Tomographic findings of a patient with extensive facial fracture with loss of consciousness following road traffic crash.

wires were removed and these patients could not be reached on cell phone due to the absence of telecommunication services in their areas of residence, or the inability to afford a cell phone. Cost of transportation, feeling of wellbeing following resumption of daily pre-trauma activities and ignorance may have resulted in low compliance to follow up review appointments.

About 17.8% of patients had complications, and this is similar to report of 14.0% complication rate [5]. Malocclusion was the most common finding during post treatment review. This may be related to delayed treatment of most of the fractures. Delayed treatment has been associated with increased likelihood of malocclusion [29]. However, infections have been noted as the most common complication following treatment of maxillofacial injuries in the general population [30]. The overall complication rate of facial fracture repair in patients with craniocerebral injury is variable and prolonged surgical procedures, delays in surgical repair were often

associated with higher complication rates [18]. Common complications include malnutrition, wound infection, malocclusion and post head injury syndrome. The lower infection complication rate recorded in this study may be related to the fact that orofacial soft tissue wounds were managed by doctors in the maxillofacial unit rather than by doctors/nurses in the accident and emergency unit.

### Limitations of the study:

- Some injuries (both oral and maxillofacial, and craniocerebral) may have been missed since not all the patients had a Computed Tomography scan. This may have affected the pattern of injury.
- The type of treatment modality (early *versus* late) used was influenced by factors such as logistic problems in the theatre, inadequate operating theatre sessions and lack of finance. Thus outcome and formulation of a treatment protocol could not be firmly established.

### Conclusion

Fractures of the middle third facial skeleton are more common in skeletal injuries, although, fractures of the upper third facial skeleton appear to be associated with lower GCS.

**Conflicts of interests:** The authors declare that they have no conflicts of interest in relation to this article.

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