

The facial skeleton: Armor to the brain?

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Abstract

Background: With the development of urban setting worldwide, the major issue of concern is the increase in the mortality rate in the population due to road traffic accidents. The face, being the most exposed region is susceptible to injuries and maybe associated with injuries to the adjacent neuro-cranium. The literature has conflicting views on the relationship between facial fractures and head injuries with some authors opining that the facial skeleton cushions the brain while some other authors claim that the facial fractures act as indicators for head injuries. **Objectives:** To analyze the correlation between the facial fractures and head injuries and to assess if the facial skeleton acts to protect the brain from injury. **Patients and Methods:** A prospective study that included patients who reported to the emergency department of Basaveswar Teaching and General Hospital, Gulbarga, during 2 years, between August 2013 and July 2015 was conducted. A total of 100 patients with facial fractures were enrolled in the study. **Results:** Head injuries were sustained by 51 patients in the study. Maximum number of patients was in the age group of 20–29 with a male to female ratio of 10.1:1. The mandible was the most frequently fractured bone in the facial skeleton followed by the zygomatico-maxillary complex. A majority (96%) of patients with head injuries had fractures of either the upper third or the middle third of the face. Contusions and pneumocephalus were the most common head injury encountered. The Glasgow Coma Scale score was significantly lower in patients with associated head injuries as compared to those patients with facial trauma alone. The mortality rate in the study was 2% with both the victims having sustained middle third and upper third fractures respectively with associated head injuries. **Conclusion:** The facial skeleton does not act to cushion the brain from injury but, in fact, the facial trauma victims should be considered potential head injury patients.

Key words: Facial trauma, head injury, prospective study

INTRODUCTION

The face, the most exposed region of our body, is susceptible to injuries that may range from superficial abrasions to complex fractures of the facial skeleton. The causes of these injuries are also multiple, like, the road traffic accidents, fall from height, interpersonal violence, animal attacks and sports injuries with the road traffic accidents being the most common in developing nations due to the factors such as increased use of automobiles, faulty drivers, and badly laid roads that have all conspired to cause a rise in the number of road accidents. When the flow of such victims in a morbid state into the casualty has

become commonplace, the faculty with which the professionals have to make a precise assessment is a major criterion in the rate of chances for survival, as there may be associated traumatic head injuries in these facial trauma victims. Some authors are of the opinion that the face protects the brain while others opine that the severity of facial fractures is an allusion to the severity of brain injury incurred. This is due to

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the evidence that injuries to the facial skeleton, many a time, cause a concomitant injury to the brain, which may range from a benign concussion to a severe fatal head injury.

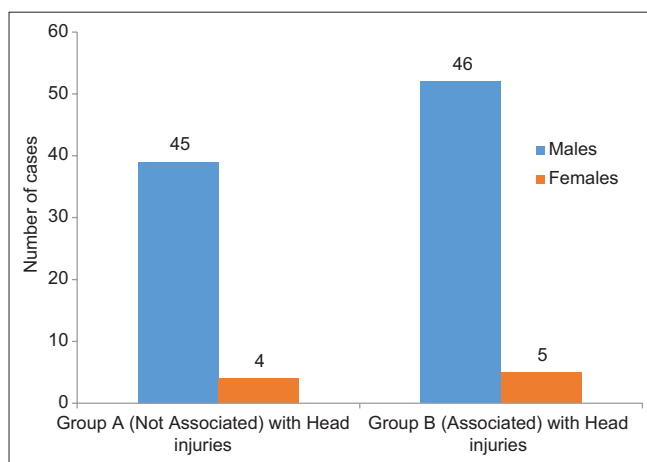
This study intends to evaluate the relationship between the facial fractures and associated head injuries if any and to understand if the face protects the brain from injuries or acts as a marker for probable head injury.

PATIENTS AND METHODS

A prospective cohort study was designed to assess the incidence of concomitant head injuries in patients, who sustained facial fractures during a period of 2 years between August 2013 and July 2015. The study population comprised the patients reporting to the emergency Department of Basaveswar Teaching and General Hospital. A case proforma to record the details of each patient including the age, sex, etiology of injury, type and number of bones fractured in the facial skeleton, type of associated head injury if present was designed and used for each patient. The findings of the computed tomography were also included. The Glasgow Coma Scale (GCS) was used to assess the neurologic status of each of the patients. The patients were then divided into two groups: Group A including those patients with maxillofacial fractures alone and Group B including those patients with maxillofacial fractures and associated head injuries.

Statistical analysis

The data were analyzed using the SPSS 16.0 Software. Manufactured by SPSS Inc. Chi-square test was the test used as test of significance and $P < 0.005$ and < 0.001 were considered statistically significant.



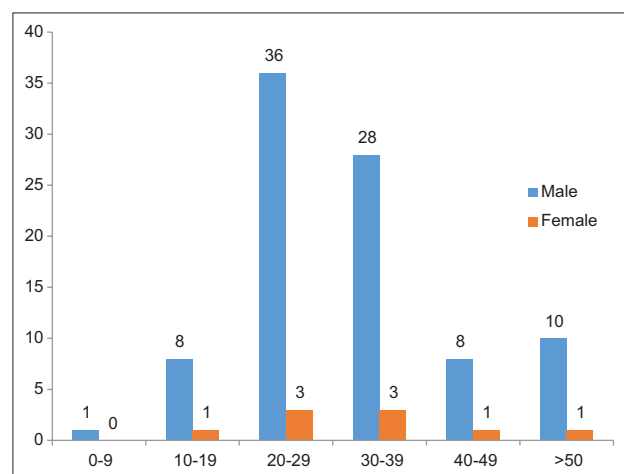
Graph 1: Gender-wise distribution of incidence of associated head injuries

RESULTS

A total of 100 patients with facial trauma were assessed during the study period in which 51 patients have sustained associated head injuries [Graph 1]. Maximum number of patients is in the age group of 20–29 with the number of males outnumbering the females in the study sample [Graph 2]. The major etiologic factor is the road traffic accidents followed by fall from height. The mandible is the most frequently fractured bone in the facial skeleton followed by the zygomatico-maxillary complex. However, it is observed that the majority of the patients with head injuries (97.3%) have fractures of either the upper third or the middle third of the face. Only 7.6% of patients with isolated mandible fracture sustained an associated head injury [Table 1]. Contusions and pneumocephalus is the most common head injury encountered followed closely by the extradural hemorrhage (EDH), subarachnoid hemorrhage (SAH) and subdural hemorrhage (SDH) [Graph 3]. The GCS score was significantly lower in patients with associated head injuries as compared to those patients with facial trauma alone [Graph 4]. The incidence of death among the patients included in this study during the study period is 2% with both the victims having sustained middle third and upper third fractures respectively with associated head injuries.

DISCUSSION

Any injury affecting the maxillofacial skeleton has to be considered as complex because of its proximity to the cranial vault that encloses the brain. While some authors are of the opinion that the facial skeleton protects the brain from injury by acting as an impact absorber, others contradict this by opining that the

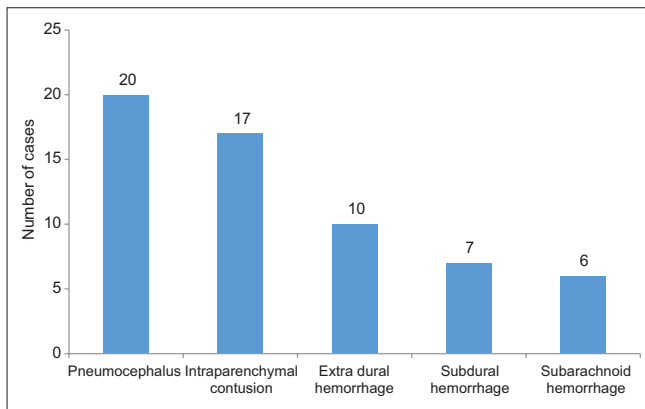


Graph 2: Age- and gender-wise distribution of patients

Table 1: Risk of head injuries in association with maxillofacial fractures

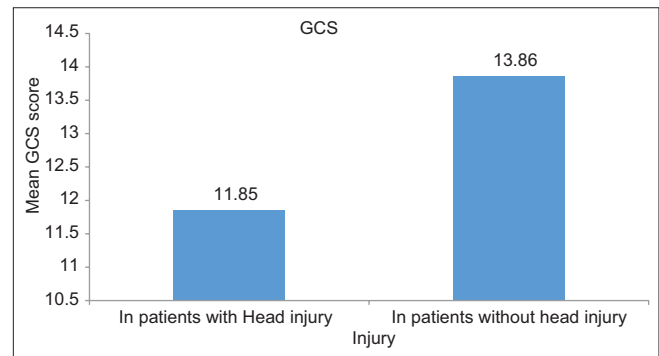
Site of fracture	Head injury present (%)	Head injury absent (%)	Total	Test of significance
Isolated maxilla fracture	17 (70.8)	7 (29.2)	24	$\chi^2=4.97, P<0.05 (S^*)$
Frontal bone fracture+zygomatic bone fracture	12 (85.7)	2 (14.3)	14	$\chi^2=8.31, P<0.001 (VHS^+)$
Zygomatic maxillary complex fracture+mandible fracture (combined midface, lower face)	20 (67)	10 (33)	30	$\chi^2=4.21, P<0.05 (S^*)$
Isolated mandible fracture	2 (7.6)	24 (92.3)	26	$\chi^2=23.15, P<0.001 (VHS^+)$
Isolated nasal bone fracture	0 (0)	6 (100)	6	-
Total	51	49	100	

*Significant, +Very highly significant

**Graph 3:** Incidence of head injuries in patients with maxillofacial fractures

facial injuries should in fact be considered as indicators for a head injury as they observed more number of facial fractures in association with head injuries.

In this study, it is observed that there is a male predominance in the victims, indicating the cultural norms of the small towns in which the males are more involved in outdoor activities than the conservative females. This finding is similar to the observations of several other authors.^[1-4] Road traffic accidents involving two-wheeler crashes were the most frequent cause of trauma accounting for 91% of cases. Keita *et al.*, found road traffic accidents to be the etiology in 93% of cases, attributing to the fact that many civilians are not responsible enough to follow the paramount traffic rules.^[5] The most common age group involved in the study is between 20 and 29. This pattern is similar in almost all other studies studying the relationship between facial fractures and head injuries.^[6,7] From the most common etiology and the most common age group involved, it can be inferred that the youngsters of the society tend to exhibit a lack of restraint and do not adhere to the traffic rules. This is in contrast to the literature of the western nations wherein the road traffic accident is not the leading etiology of trauma. This may be because of the enforcement of stringent traffic rules and sensible driving.

**Graph 4:** Comparison of mean Glasgow Coma Scale in patients with associated head injuries and in those without associated head injuries

In this study, the mandible was the most common bone to be fractured followed by the zygomatico-maxillary complex. This pattern of fractures is similar to the findings of several other authors who observed the mandible to be the most frequently fractured bone in trauma.^[8-10] This may be due to the prominent size and position of the mandible making it more susceptible to injury.

It is observed through this study that though the mandible is the most commonly fractured bone in the facial skeleton, the incidence of associated head injury in these cases is only 7.6% (2 cases) when fractured in isolation. This is consistent with the findings of several other authors.^[7,11-13] Our observation that the middle third facial fractures in isolation or combination with other facial fractures are more associated with head injuries is similar to the findings of Haug *et al.*, who stated that the mid-facial fractures had more than twice the chance of sustaining head injuries.^[9] Hampson attributed this to the low tolerance of the mid-facial bones to force^[14] as compared to the frontal and mandibular bones, allowing the force transmission to the cranium.^[9,11] In contradiction, Chang *et al.* suggested that the maxilla, together with the neighboring bones, is capable of absorbing considerable impact force, thus protecting the brain from the direct collision. They further concluded that there should be a direct correlation between the severity of the maxillary fracture and that of the initial

head injury.^[15] Rahman and Chandrasala observed that when the severity of head injury increased as per the GCS score, the number of facial injuries decreased. This also means that the more severe facial injury, the less severe the head injury indicating that facial injury dissipates forces so that a less serious cranial injury would be sustained by the victim.^[7] Lee *et al.*, also suggested that facial bones act as a protective cushion for the brain, explaining the fact that injuries that crush the facial bones frequently cause no apparent brain damage.^[16] However, Keenan *et al.*, in their study found that the risk of intracranial injury increased almost 10-fold in patients with facial injuries.^[17] It is stated in the literature that the mid-facial complex is admirably equipped to withstand impact infero-superiorly through the vertical struts, the canine buttress, zygomatic buttress and pterygoid pillars, but it is poorly constructed to withstand lateral and frontal impacts.^[18] In due course, the lateral antrum, medial nasal wall, bony nasal septum, and zygomatic arch have been proposed as the horizontal struts of the midface. When the midface was subjected to experimentally induced trauma, and when of sufficient magnitude, it was observed that the facial struts failed and ultimately transmit or transfer the impact to the adjacent neuro-cranium. These investigations have shown that impact to the midface and upper face, when sufficient, causes disruption of the anterior and middle cranial fossae and the dura mater and thus causes brain injury.^[19] No such association between the mandibular fracture and cranial injuries could be established.^[20] Recently, Zhou *et al.*, hypothesized that the mandible possibly acts as a cushion that protects the cranium and its contents as they observed that the patients who sustained isolated mandible fracture were at the lowest risk of having associated head injuries.^[21]

Scarce information has been reported in the literature regarding the correlation between pan-facial fractures and head injuries. Isik *et al.*, stated that the risk of head injuries is increased significantly in multiple facial bone fractures.^[22] A significant increase in intracranial hemorrhage risk was observed in pan facial fractures by Kanno *et al.*^[23] During our study period, it was observed that head injuries were prone to occur in patients with multiple bone fractures. This is similar to the findings of Zhou *et al.*, who observed that the risk of traumatic head injuries increased in patients with pan-facial fractures and attributed it to the vigorous impact force in traumatic events such as those in a road traffic accident.^[20]

In our study, we observed that the contusions and pneumocephalus are the most common associated head injuries followed by EDH, SAH and SDH. This

is similar to the findings of a retrospective study in which contusions were the most common intracranial problem followed closely by pneumocephalus. Rahman and Chandrasala, in a prospective study observed SAH to be common in patients with facial fractures.^[7] Keenan *et al.*, observed more concussion than intracranial injuries.^[17]

The incidence of death during the study period was 2%. Incidentally, both the patients had sustained severe mid-facial and upper facial fractures with associated head injuries in the form of multiple contusions. Plaisier *et al.*, in their retrospective study of relationship between facial fractures and death from neurologic injury, observed that the nonsurviving patients had a dramatic predilection for mid- and upper-facial fracture patterns and death of neurologic injury and proposed that when the energy of impact to the midface and upperface is great enough, potentially lethal injury to the neuro-cranium can be expected.^[19] They also observed that, when only the mandible is fractured, the forces involved in most cases are either not directed to the brain or are of such relatively low energy that the brain parenchyma is not damaged.

The patients with concomitant head injuries had a lower GCS score as compared to the patients of facial trauma alone. Martin *et al.*, observed a similar pattern of GCS score in a retrospective review of patients with facial trauma and associated head injuries.^[24]

CONCLUSION

From the observations of this study, it can be affirmed that the facial skeleton does not act as an armor to the brain but may, in fact, act as an indicator for a risk of head injury. Any patient with facial fractures, especially involving the middle third and upper third of the face should be considered a patient with associated head trauma until the head injury is ruled out.

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Conflicts of interest

There are no conflicts of interest.

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