e-CliniC 2024; Vol. 12, No. 2: 157-163
DOI: https://doi.org/10.35790/ecl.v12i2.46477
URL Homepage: https://ejournal.unsrat.ac.id/index.php/eclinic

Pattern of Skull and Facial Bone Fracture in Craniomaxillofacial Trauma Associated with Traumatic Brain Injury: A Retrospective Analysis at Tertiary Hospital

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Received: February 11, 2023; Accepted: December 26, 2023; Published online: December 28, 2023

Abstract: Trauma is one of the primary causes of death during the first four decade. Craniomaxillofacial (CMF) trauma has become a common presentation in emergency departments of hospitals. The most presentation of CMF trauma includes skull and facial bone fracture and traumatic brain injury (TBI). This study aimed to obtain the pattern of skull and facial bone fracture in craniomaxillofacial trauma associated with traumatic brain injury. This was a retrospective study conducted on 501 patients from January 2020 to December 2021. Demographic data included age, sex, length of stay (LOS), and Glasgow coma scale (GCS). The results showed that from the total 501 patients with skull and facial bone fracture with or without traumatic brain injury, 406 (81%) were males and 95 (19%) were females. The age range of the patients was between 2 years and 86 years (mean±SD 33.9±18.2). The most common patient affected age ranged from 21 to 30 years. The average of LOS was 7.2±5.7 days (0-33) and the mean of GCS was 10.2±4.2. Based on types of cases, there were 232 cases (60%) of skull and facial bone fractures accompanied by TBI; 154 cases (40%) of only skull and facial bone fracture; and 339 (59.5%) cases of only TBI. In conclusion, the distribution of TBI increases in those with skull and facial bone fractures. On the other hand, the distribution of TBI is more common without fracture. Hence every skull and facial bone fracture must be carefully evaluated clinically and radiologically to rule out any underlying TBI.
Keywords: skull and facial bone fracture; craniomaxillofacial trauma; traumatic brain injury

INTRODUCTION

Trauma is one of the primary causes of death in humans during the first four decade. Craniomaxillofacial (CMF) trauma has become one of common presentation in emergency departments of hospitals. An isolated injury or multiple injuries may cause serious functional, physical, psychological, and cosmetic disabilities. The incidences of craniomaxillofacial trauma vary according to socioeconomic, cultural, environmental and geographical factors. World Health Organization reported that developing countries had 7.4% - 8.4% craniomaxillofacial injury that required emergency medical care.[1,2]

The craniomaxillofacial area is directly exposed to environment, therefore, this area has a much higher possibility of injury from external force than other parts of body. The trauma on CMF can cause severe functional loss and frequently associate with severe morbidity and loss of function. The outcome of CMF trauma depends on the severity and location of trauma, proper treatment required, evaluation, accurate diagnosis, physician's experience, and complications after injury.[3]

The closeness of cranimaxillofacial bone injuries would suggest that there are chances of intracranial injuries occurring simultaneuously. Historically, the facial architecture has been perceived to be a cushion against any impact to protect the neurocranium from severe injury. However, some recent investigations have suggested that the face may actually transmit forces directly to the neurocranium, resulting in more serious traumatic brain injury.[2,3]

Manado, a city in North Sulawesi, has various cultures and traditions. One of the traditions in North Sulawesi is alcohol consumption which is very popular in Indonesia. The level of alcohol consumption in the community, geographical condition of the roads, crime rate, number of industries around the city, and the diversity of people's characters are some of the factors for CMF trauma in Manado. Therefore, the authors were interested to assess retrospectively the pattern of skull and facial bone fracture due to craniomaxillofacial trauma associated with traumatic brain injury at Manado tertiary hospital.

METHODS

This study was conducted as a single center, cross sectional, and descriptive study for all craniomaxillofacial trauma patients with facial and/or skull fractures and with or without traumatic brain injury from during period 2020 to 2021 presenting to the emergency department. Patient data were obtained from medical record of Prof. Dr. R. D. Kandou Hospital, Manado, North Sulawesi. Demographic data included sex, age, Glasgow Coma Scale (GCS) and length of stay (LOS). The fracture of facial and skull were classified based on the location such as vault of skull fracture, maxilla fracture, mandible fracture, nasal fracture, and skull base fracture which were diagnosed by a primary clinical examination supported with computed tomography (CT) scan. Data were presented in the forms of graphs, numeric with percentage presentations, and tubular presentations.

The primary objective of this study was to identify the pattern of skull and facial bone fracture in craniomaxillofacial trauma patients presenting to the emergency department at Prof. Dr. R.D. Kandou Hospital. The secondary objective was to identify the associated skull and facial bone fracture with the incidence of traumatic brain injury (TBI).

RESULTS

A total of 501 patients were victims of skull and or facial fracture; among them, 406 were males and 95 were females. Table 1 and Figure 1 showed that the age of the studied patients ranged from 2 to 86 years with the majority of them between 21 to 30 years (28.1%) and the mean age of 33.9 ±18.2 years. The mean GCS was 10.2± 4.2 (3-15) and the mean LOS was 7.2 ±5.7 (0-33) days.

Table 2 showed a total of 386 fractures of skull and facial due to craniomaxillofacial injury; all included multiple injuries. The most frequent represented was the fractures of base skull (33.4%) followed by fractures of maxilla (27.3%), skull (19.2%), mandible (13.9%), and nasal (6.2%).

Table 1. Data distribution of patients' characteristics

Characteristics	Frequency	Percentage (%)
Sex		
Male	406	81
Female	95	19
Age (years)	33.9 SD±18.2 (2-86)	
0-10	27	5.3
11-20	108	21.6
21-30	141	28.1
31-40	59	11.8
41-50	59	11.8
51-60	52	10.4
61-70	36	7.2
71-80	14	2.8
>80	5	1
GCS (mean ±SD)	10.2 SD±4.2 (3-15)	
Total LOS (mean range)	7.2 SD±5.7 (0-33)	

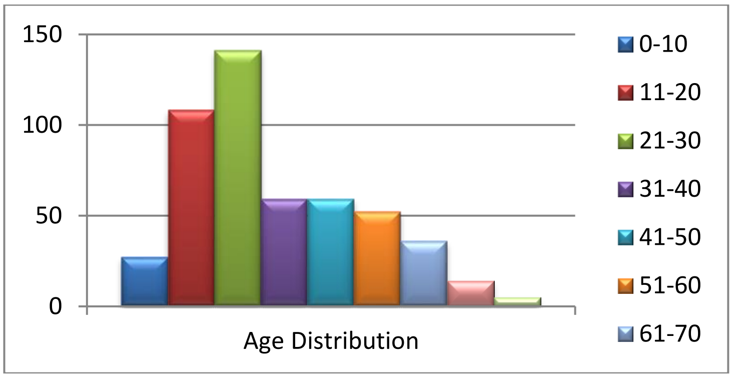


Figure 2. Age distribution of the studied patients

Table 2. Frequency of Fracture of facial and skull

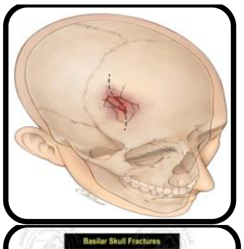
Fractures of facial and skull	Frequency (%) (included mutliple injury)
Vault of skull	74 (19.2%)
Skull base	129 (33.4%)
Mandible	54 (13.9%)
Maxilla	105 (27.3%)
Nasal bone	24 (6.2%)

Table 3 showed that based on types of cases, a total of 570 traumatic brain injuries were reported and all included multiple injury with or without bone fracture. The most frequent represented was epidural haemorrhage (EDH) as many as 129 cases (33.4%), 83 cases (51.8%) were associated with skull and facial bone fractures; followed by subarachnoid haemorrhage 117 (20.5%) and 50 (42.7%) associated with skull and facial bone fractures; traumatic cerebral oedema 94 (16.5%) and 53 (56.4%) associated with skull and facial bone fracture; subdural hematoma (SDH) 77 (13.5%) and 11 (14.3%) associated with skull and facial bone fractures; diffuse brain injury 67 (11.7%) and 23 (34%) associated with skull and facial bone fractures; and intracranial haemorrhage (ICH) 55 (9.7%) and 12 (21.2%) associated with skull and facial bone fractures.

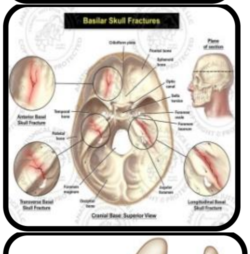
Table 3. Frequency of traumatic brain injury and associated with skull and facial bone fracture

Traumatic brain injury	Frequency (%) (included mutliple injury)	Associated with skull and facial bone fractures
Diffuse brain injury	67 (11.7%)	23 (34%)
Epidural haemorrhage	160 (28.1%)	83 (51.8%)
Subarachnoid haemorrhage	117 (20.5%)	50 (42.7%)
Traumatic cerebral oedema	94 (16.5%)	53 (56.4%)
Subdural hematoma	77 (13.5 %)	11 (14.3%)
Intracranial haemorrhage	55 (9.7%)	12 (21.2%)

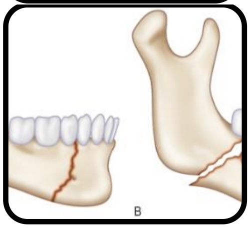
In our study, the distribution of traumatic brain injury from 74 cases of fracture of vault of skull was 67 cases and the most frequent represented was epidural haemorrhage 21 (28.3%) followed by subarachnoid haemorrhage 18 (24.3%), traumatic cerebral oedema 11 (14.8%), subdural hematoma 8 (10.8%), diffuse brain injury 5 (6.7%), and intracranial hermorrhage 4 (5.4%). The distribution of traumatic brain injury from 129 cases of fracture base of skull was 96 cases and the most frequent represented was epidural haemorrhage 39 (30.2%) followed by traumatic cerebral oedema 22 (17%), subarachnoid haemorrhage 20 (15.5%), diffuse brain injury 8 (6.2%), intracranial hermorrhage 4 (3.1%), and subdural hematoma 3 (2.3%). The distribution of traumatic brain injury from 54 cases of mandible fracture was 15 cases and the most frequent represented was subarachnoid haemorrhage 5 (9.3%) and traumatic cerebral oedema 5 (9.3) followed by epidural haemorrhage 3 (5.6%), diffuse brain injury 1 (1.8%), and intracranial haermorrhage 1 (1.8%). The distribution of traumatic brain injury from 105 cases of maxilla fracture was 45 cases and the most frequent represented was epidural haemorrhage 17 (16.1%) followed by traumatic cerebral oedema 12 (11.4%), subarachnoid haemorrhage 6 (5.7%), diffuse brain injury 5 (5.7%), intracranial haemorrhage 3 (2.8%) and subdural hematoma 1 (1%). The distribution of traumatic brain injury from 24 cases of nasal fracture was 10 cases and the most frequent represented was epidural haemorrhage 3 (12.5%), traumatic cerebral oedema 3 (12.5%), diffuse brain injury 3 (12.5%), followed by subarachnoid haemorrhage 1 (4.1%). All data on fractures and traumatic brain injury were included in the overall data and not based on individual fractures and diagnoses.



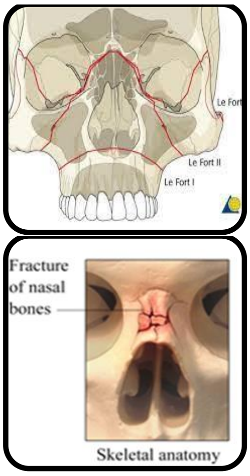
Fracture of vault of skull = 74 (19.2%)
- Subarachnoid haemorrhage = 18 (24.3%)
- Epidural haemorrhage = 21 (28.3%)
- Traumatic cerebral edema =11 (14.8%)
- Diffuse brain injury = 5 (6.7%)
- Subdural hematoma = 8 (10.8%)
- Intracranial haemorrhage = 4 (5.4%)



Fracture of skull base = 129 (33.4%)
- Subarachnoid haemorrhage =20 (15.5%)
- Epidural haemorrhage =39 (30.2%)
- Traumatic cerebral edema =22 (17%)
- Diffuse brain injury = 8 (6.2%)
- Subdural hematoma = 3 (2.3%)
- Intracranial haemorrhage = 4 (3.1%)



Fracture of mandible =54 (13.9%)
- Subarachnoid haemorrhage = 5 (9.3%)
- Epidural haemorrhage = 3 (5.6%)
- Traumatic cerebral edema = 5 (9.3%)
- Diffuse brain injury =1 (1.8%)
- Subdural hematoma = 0
- Intracranial haemorrhage = 1 (1.8%)



Fracture of maxilla = 105 (27.3%)
- Subarachnoid haemorrhage = 6 (5.7%)
- Epidural haemorrhage = 17 (16.1%)
- Traumatic cerebral edema =12 (11.4%)
- Diffuse brain injury = 6 (5.7%)
- Subdural hematoma = 1 (1%)
- Intracranial haemorrhage = 3 (2.8%)

Fracture of nasal bone = 24 (6.2%)
- Subarachnoid haemorrhage =1 (4.1%)
- Epidural haemorrhage =3 (12.5%)
- Traumatic cerebral edema =3 (12.5%)
- Diffuse brain injury = 3 (12.5%)
- Subdural hematoma = -
- Intracranial haemorrhage = -

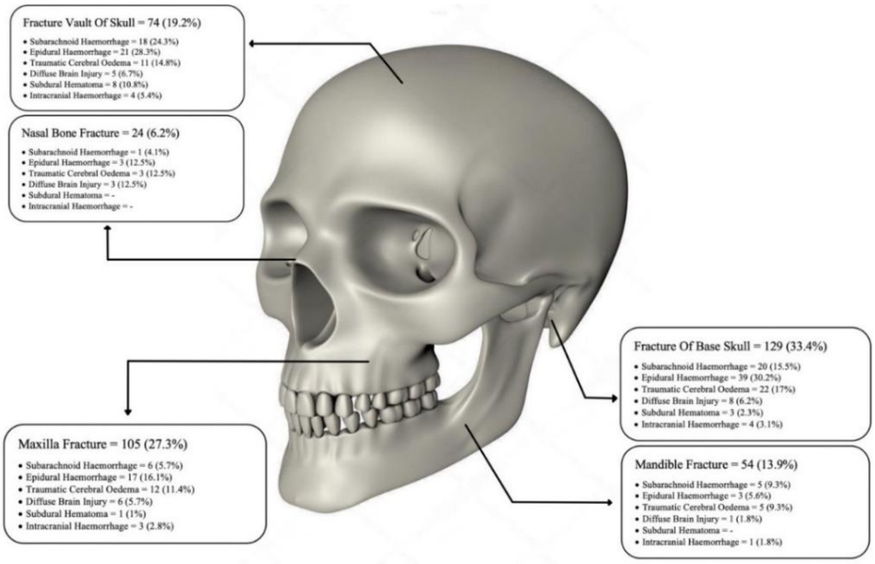


Figure 4. Distribution of traumas

DISCUSSION

Craniomaxillofacial traumas are commonly encountered in the practice of emergency medicine. More than 50% of patients with these injuries have multiple traumas and multiple pathologies. Coordinated management between emergency physician and surgical specialist is very importance. Injuries can be incurred in situations such as road traffic accidents, fall from height, interpersonal violences, animal attacks, and sports.[3,4]

Craniomaxillofacial injuries presenting in the trauma unit ranges from fracture of vault of skull, mandibular fracture, maxillary fracture, nasal fracture, base of skull fracture, etc.[5,6] TBI is defined as damage to the brain resulting from external mechanical forces, such as rapid acceleration and deceleration impact or blast waves. The brain function is temporarily or permanently impaired and structural damage may or may not be detectable with current technologies. patients with craniomaxillofacial fracture may have concomitant traumatic brain injuries and patients with traumatic brain injury may have concomitant craniomaxillofacial fracture.[4]

This study showed that the age of the studied patients ranged from 2 to 86 years with the majority of them between 21 to 30 years (28.1%) and the mean age of 33.9 ±18.2 years. These results agree with the results of a study conducted by Hasnat et al,[7] in which the age of studied patients ranged from 5-64 years with the majority of them between 21 and 30 years (51.7%) and the mean age was 29.63 ± 12.07. The other study conducted by Elbaih et al,[8] in which the age of the studied patients ranged from 2 to 70 years with majority of them between 21 and 30 years and the mean age of 30.7 ± 13.09.

The possible explanation for this is that people in this age group take part in dangerous road traffic accidents which drive motor vehicles carelessly, take part in dangerous exercise and sports, and more likely to be involved in violence.

The present study showed that majority of patients were males (81%), while females were 19% of them. The results were similar to the study by Latifi et al,[9] in which 72% of the studied patients were males and 28% were females. Study of Elbah et al[10] showed similar results in which 63.3% patients were males and 36.7% patients were females.

In our study, 386 cases of fracture skull and facial bone were reported and 570 cases of multiple brain injury were reported. There were 232 cases of fracture skull and facial bone accompanied by traumatic brain injury cases (60%). These results agree with the study conducted by Grant et al[11] and Joshi et al,[12] in which the most distribution of traumatic brain injury were associated with maxillofacial trauma. There were 154 cases of only skull and facial bone fracture (40%) and 339 (59.5%) cases of only traumatic brain injury. All data included multiple diagnoses in individual patient.

This study demonstrates the relationship between skull and facial bone fracture with traumatic brain injuries. From 74 cases of fracture of vault of skull, in 67 cases, the most frequent represented was epidural haemorrhage (21 cases; 28.3%) followed by subarachnoid haemorrhage (18 cases; 24.3%), traumatic cerebral oedema (11 cases; 14.8%), subdural hematoma (8 cases; 10.8%), diffuse brain injury (5 cases; 6.7%), and intracranial haemorrhage (4 cases; 5.4%). The distribution of traumatic brain injury showed that from 129 cases of fracture base of skull, in 96 cases, the most frequent represented was epidural haemorrhage (39 cases; 30.2%) followed by traumatic cerebral oedema (22 cases; 17%), subarachnoid haemorrhage (20 cases; 15.5%), diffuse brain injury (8 cases; 6.2%), intracranial haemorrhage (4 cases; 3.1%), and subdural hematoma (3 cases; 2.3%). The distribution of traumatic brain injury from 54 cases of mandible fracture, in 15 cases, the most frequent represented was subarachnoid haemorrhage (5 cases; 9.3%) and traumatic cerebral oedema (5 cases; 9.3), followed by epidural haemorrhage (3 cases; 5.6%), diffuse brain injury (1 cases; 1.8%), and intracranial haemorrhage (1 case; 1.8%). The distribution of traumatic brain injury from 105 cases of maxilla fracture, in 45 cases, the most frequent represented was epidural haemorrhage (17 cases; 16.1%) followed by traumatic cerebral oedema (12 cases; 11.4%), subarachnoid haemorrhage (6 cases; 5.7%), diffuse brain injury (5 cases; 5.7%), intracranial haemorrhage (3 cases; 2.8%), and subdural hematoma (1 c ase; 1%). The distribution of traumatic brain injury from 24 cases of nasal bone fracture, in 10 cases, the most frequent represented was epidural haemorrhage (3 cases; 12.5%), traumatic cerebral edema (3 cases; 12.5%), diffuse brain injury (3 cases; 12.5%), followed by subarachnoid haemorrhage (1 case; 4.1%). All data on fractures and traumatic brain injury were included in the overall data and not based on individual fractures and diagnoses.

In our study, mandible fracture in distribution with traumatic brain injury was mostly associated with normal brain study (27.8%) from the other fractures.[13] These results agree with the results of a study conducted by Joshi et al,[12] in which the distribution of mandibular fracture has lower risk of brain injury.

There are several limitations of this study which should be discussed. There are no data on the mechanism of injury, death, and specific anatomic abnormalities due to trauma. This study was performed retrospective, introducing the possibility of selection or recall bias. However, because the data collector retrieved these data from the medical records without knowledge of the primary endpoint, the results were less likely to be affected by data collection bias. The limitations of taking complete data in the medical record so that the data summarized are incomplete. There is no statistical test because the data collected does not meet the statistical test requirements so that the data presented is in descriptive form. Moreover, this study only involved one center which reduced the generalization of our results. Therefore, inaccurate information could skew the results in study.

CONCLUSION

In our study, skull and facial fractures in craniomaxillofacial trauma were a life threatening risk due to facial fracture alone is usually absent. On the other hand, the distribution of brain injury is more without fracture. Among all patients, the distribution of traumatic brain injury increases in those with skull and facial bone fractures. Hence every skull and facial bone fracture must be carefully evaluated clinically and radiologically to rule out any underlying traumatic brain injury and to decrease the distribution of mortality rate. To increase the awareness of potential incidence of traumatic brain injury in fracture of skull and facial bone.

Conflict of Interest

The authors affirm no conflict of interest in this study.

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