Original Article

The Pattern of Maxillofacial Fractures in the Traumatic Brain Injury Patients in Songklanagarind Hospital: A Retrospective Study

Orawan Chansanti MD[1], Yaninee Anusitviwat MD[1], Atthawit Mongkornwong MD[1]

[1] Division of Plastic and Reconstructive Surgery, Department of Surgery, Faculty of Medicine, Songklanagarind Hospital, Prince of Songkla University, Songkhla, Thailand

Background: Maxillofacial injuries are commonly associated with brain injuries, with the major etiological factors being traffic collision, violence, and fall from height. The incidence and etiology are important for the development of treatment and for the improvement of patient care in the future.

Objective: To analyze the incidence of patterns of maxillofacial fractures with traumatic brain injuries and to measure the incidence of cause of injury, age, gender distribution, and length of stay in hospital.

Materials and Methods: The present study was a retrospective study in Songklanagarind Hospital. The authors evaluated the patients that presented with a concomitant maxillofacial and traumatic brain injury in Songklanagarind Hospital between 2007 and 2016. The data were assessed using multiple logistic modeling and reported in term of percentage and corresponding 95% confidence intervals.

Results: Eight hundred fifty-nine patients were studied, consisting of 73.3% male and 22.7% female. The mean age was 39.5 years. The severity of the traumatic brain injury was mild and 70.15% with associated alcohol consumption. The maxilla bone fracture was common in 49.9%. The patients with mild to moderate traumatic brain injury were related to the coronoid process of mandible and severe traumatic brain injury was related to Le Fort fracture type II and III.

Conclusion: In the present study, the maxilla bone fracture was the most frequent site involved. In addition, there was an association between the severity of the head injury and the type of maxillofacial injury.

Keywords: Traumatic brain injury, Maxillofacial fracture

Received 1 May 2020 | Revised 15 September 2020 | Accepted 17 September 2020

J Med Assoc Thai 2021;104(2):185-90

Website: http://www.jmatonline.com

Maxillofacial injuries frequently occur among patients with acute traumatic brain injuries. The major etiological factors are traffic collision, violence, and fall[(1)]. Regarding the etiology, patients in Amsterdam mostly suffered from frontal sinus fracture, with mandibular fracture. This was being the most common in the tertiary trauma centers[(2-4)]. Maxillofacial fractures are often associated with multiple injuries to the cranium, especially following high energy trauma[(5)].

Correspondence to:

Mongkornwong A.

Division of Plastic and Reconstructive Surgery, Department of Surgery, Faculty of Medicine, Songklanagarind Hospital, Prince of Songkla University, 15 Karnjanavanich Road, Hatyai, Songkhla 90110, Thailand.

Phone: +66-74-451401, **Fax**: +66-74-451400

Email: Atthawit_sx@hotmail.com

How to cite this article:

Chansanti O, Anusitviwat Y, Mongkornwong A. The Pattern of Maxillofacial Fractures in the Traumatic Brain Injury Patients in Songklanagarind Hospital: A Retrospective Study. J Med Assoc Thai 2021;104:185-90.

doi.org/10.35755/jmedassocthai.2021.02.11330

Understanding of the demographic patterns of maxillofacial injuries will assist health care providers as they plan and manage the treatment of traumatic maxillofacial injuries. Such epidemiological information can also be used to guide future findings and prevention.

The aims of the present retrospective study were meant to evaluate the patterns of maxillofacial fractures in patients with traumatic brain injuries, as well as to identify the prevalence of cause of injury, age, and gender distribution.

Materials and Methods

The study was approved by the Human Research Ethics Committee of the Faculty of Medicine, Prince of Songkla University (REC number 59-293-10-4). The authors evaluated all patients presented with concomitant maxillofacial and traumatic brain injuries in Songklanagarind Hospital, between January 2007 and October 2016. Data collected included history, physical examination, and radiographic evaluation. Data were collected from the medical records

division by using search terms from International Classification of Diseases, Tenth revision (ICD-10) version 2015.

Patients aged over 17 years old with traumatic brain injuries were diagnosed and referred for consultation to a neurosurgeon for evaluation. Therefore, all the neurological data were based on computed tomography (CT) results, performed by neurosurgeons. Exclusion criteria were any head injury with non-skull related injury, such as spine, and patients who were classified as a low risk of mild traumatic brain injuries and medial of orbital wall fracture.

Information concerning age, gender, socio-economic activity, cause of injury, pattern of maxillofacial injury, severity of traumatic brain injury, and hospitalization periods were obtained. The causes of injury were summarized as motorcycle accidents, car accidents, falls, assaults, sport-related injuries, and others. Maxillofacial bone fractures were classified as zygomatic fracture, which included zygomatic arch and zygomatic complex, mandibular fracture, which included condyle, coronoid process, ramus, angle, body, parasymphysis, and symphysis, Le Fort fracture I, II, and III, frontal bone fracture, maxillary bone fracture, nasal bone fracture, and orbital bone fracture. Clinical judgment of neurological injury was dependent on Glasgow coma score (GCS) at admission into the Emergency department. Traumatic brain injury was defined as mild (GCS 14 to 15), moderate (GCS 9 to 13), and severe (GCS 3 to 8) traumatic brain injury. For each mild traumatic brain injury, the authors included only moderate and high risk of mild traumatic brain injury. Moderate risks of mild traumatic brain injury were vomiting with more than two episodes, older than 65 years old, depressed skull fracture, basilar fracture as seen with raccoon eyes, battle sign, cerebrospinal fluid [CSF] rhinorrhea, or otorrhea, or GCS drop of less than 15 at two-hour. High risk of mild traumatic brain injury were GCS scores of 13 or 14, or a GCS score of 15 with acute radiographic abnormalities[5-7].

Statistical analysis

Data were recorded in Epidata version 3.1 software and analyzed using the IBM SPSS Statistics, version 23.0 (IBM Corp., Armonk, NY, USA). For parametric data Student t-test and non-parametric data chi-square tests were performed.

Results

Demographic patterns of the patients

The study population consisted of 859 patients.

Table 1. Demographic characteristics

	No. of patients; n (%)
Age (year); mean±SD	39.5±16.8
Sex	
Male	664 (73.3)
Female	195 (22.7)
Male to female ratio	3.4:1
Socioeconomic activities	
Student[1]	109 (12.7)
Employee	341 (39.7)
Self-employed/business owner	162 (18.9)
Government officer	102 (11.9)
State enterprise employee	6 (0.7)
Unemployed	139 (16.2)
Alcohol consumption	
Yes	380 (44.2)
No	301 (35.0)
Unknown	178 (20.7)
Cause of injury	
Motorcycle	566 (65.9)
Car accident	94 (10.9)
Fall	70 (8.1)
Assault	58 (6.8)
Sport related injury	7 (0.8)
Others[2]	64 (7.5)
Severity of traumatic head injury	
Mild traumatic head injury	602 (70.1)
Moderate traumatic head injury	94 (10.9)
Severe traumatic head injury	163 (19.0)
Hospitalization period; median (P25, P75)	7 (3, 14)

SD=standard deviation

[1] High school, college, university; [2] Suicide, pedestrian injury, blast injury, gunshot injury

There were 664 males and 195 females, with a mean age of 39.5±16.8 years. The youngest patient was 18 years old, whilst the oldest was 91. Most patients (n=506, 59%) were between the ages of 18 and 40 years (Table 1).

As shown in Table 1, the most common cause of injury was motorcycle accident, accounting for 65.9% (n=566), followed by car accident 10.9% (n=94), fall 8.1% (n=70), assaulted 6.8% (n=58), sport related injury 0.8% (n=7), and others, such as suicide pedestrian injury, blast injury, and gunshot injury 7.5% (n=64).

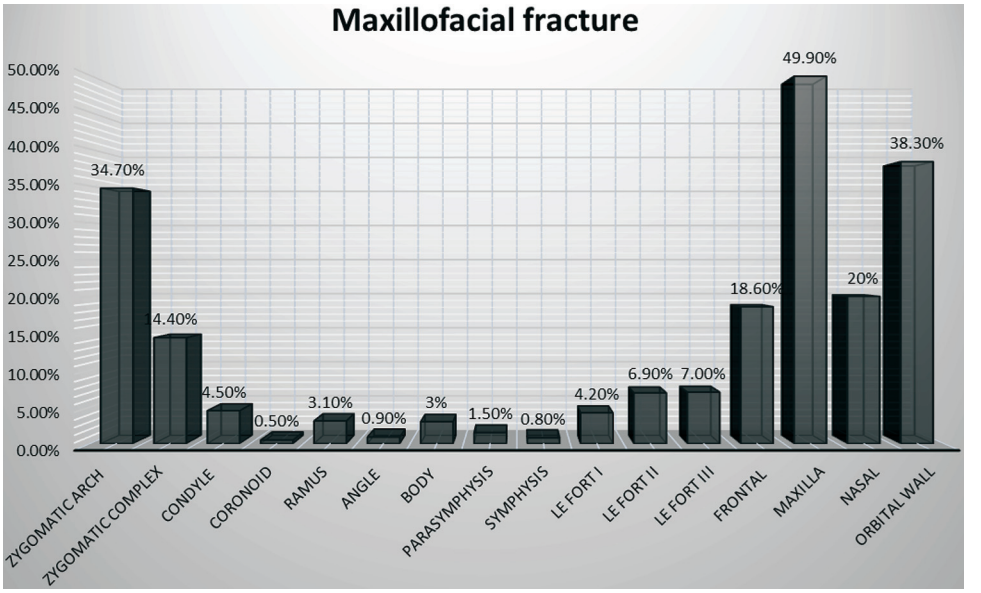

Figure 1. Description of the incidence of maxillofacial fracture in traumatic brain injury patients.

The severity of most traumatic brain injuries was mainly mild traumatic brain injury 70.1% (n=602), followed by severe traumatic brain injury 19% (n=163), and lastly moderate traumatic brain injury 10.9% (n=94), as shown in Table 1.

Alcohol consumption

In concerning to alcohol consumption, the data of 178 patients (20.7%) was missing. Of the remaining 681 patients, 380 (44.2%) had consumed alcohol before injury. As shown in Table 1, alcohol consumption was significantly related to both mild and severe traumatic brain injuries ($p<0.05$).

Overview of maxillofacial fractures and locations

Regarding the fracture type, maxilla bone, orbital bone, and zygomatic arch were the anatomical sites most fractured, representing 429 (49.9%), 329 (38.3%), and 298 (34.7%) of the injuries, respectively. Table 2 and Figure 1 shows the description of maxillofacial fractures in the present study.

Maxillofacial fracture analysis: Patients with mild traumatic brain injury were significantly associated with fracture of coronoid process of the mandible, Le fort fracture type II and type III ($p<0.05$). Whereas patients with moderate traumatic brain injury were significantly associated with fracture of coronoid process of the mandible only ($p<0.05$). Patients with severe traumatic brain injury were significantly associated with Le fort fracture type II and III, respectively (Table 3).

Table 2. Description of maxillofacial fracture

	No. of patients; n (%)
Zygomatic fracture	
Zygomatic arch	298 (34.7)
Zygomatic complex	124 (14.4)
Mandibular fracture	
Condyle	39 (4.5)
Coronoid process	4 (0.5)
Ramus	27 (3.1)
Angle	8 (0.9)
Body	26 (3.0)
Parasymphysis	13 (1.5)
Symphysis	7 (0.8)
Le Fort fracture	
Type I	36 (4.2)
Type II	59 (6.9)
Type III	60 (7.0)
Frontal sinus fracture	160 (18.6)
Maxilla bone/sinus fracture	429 (49.9)
Nasal bone fracture	172 (20.0)
Orbital wall fracture	329 (38.3)

Hospitalization period and treatment: Patients were most commonly hospitalized for only one day (10.6%). With the average period being 12.2 days, 43.8% of patients were hospitalized for more than 10 days, usually for long-term observation, and to receive

Table 3. Correlation of severity of traumatic head injury with maxillofacial fracture area

Severity of traumatic head injury	Maxillofacial fracture area; n (%)																
	Zygomatic fracture		Mandibular fracture							Le Fort fracture			FT	MX	NS	OB	Total
	ZA	ZMC	MC	MCO	MR	MAN	MB	MP	MS	LF I	LF II	LF III					
Mild	199 (23.2)	89 (10.4)	27 (3.1)	1 (0.1)*	18 (21.0)	7 (0.8)	16 (1.9)	7 (0.8)	5 (0.6)	24 (2.8)	30 (3.5)*	31 (3.6)*	106 (12.0)	293 (34.0)	118 (13.7)	229 (26.7)	1,200
Moderate	37 (4.3)	11 (1.3)	3 (0.3)	2 (0.2)*	4 (0.5)	0 (0.0)	3 (0.3)	2 (0.2)	0 (0.0)	7 (0.8)	9 (1.0)	8 (0.9)	19 (2.2)	50 (5.8)	21 (2.4)	33 (3.8)	236
Severe	62 (7.2)	24 (2.8)	9 (1.0)	1 (0.1)	5 (0.6)	1 (0.1)	7 (0.8)	4 (0.5)	2 (0.2)	5 (0.6)	20 (2.3)*	21 (2.4)*	35 (4.1)	86 (10)	33 (3.8)	67 (7.8)	481

ZA=zygomatic arch; ZMC=zygomatic complex; MC=mandibular condyle; MCO=mandibular coronoid process; MR=mandibular ramus; MAN=mandibular angle; MB=mandibular body; MP=mandibular parasymphysis; MS=mandibular symphysis; LF I=Le fort type I; LF II=Le fort type II; LF III=Le fort type III; FT=frontal sinus; MX=maxilla bone; NS=nasal bone; OB=orbital bone

* Statistical significant, p<0.05

either pre- or post-operative treatment.

Among the 859 patients, 291 (33.9%) patients underwent open reduction and internal fixation procedure and were significantly related to mild traumatic brain injury and severe traumatic brain injuries (Table 2). Six (2.1%) patients experienced postoperative complications from plastic procedure. Postoperative infection was the most common, followed by defect and malocclusion.

Discussion

In the present study, the authors assessed the epidemiology of concomitant maxillofacial and traumatic brain injuries from patients that visited the emergency department at Songklanagarind Hospital within the last 10 years. These were then retrospectively analyzed based on the patients' medical records and radiological imaging. The authors' hospital is a level I trauma center in the south of Thailand and receives referrals from all provinces in the south of Thailand.

The etiological factors for maxillofacial injuries are traffic accidents, assaults, falls, and sport related injuries. The main cause in the western world is traffic related, involving male patients[8-10]. Maxillofacial fractures are thought to have an association with the presence of simultaneous brain injury[11]. The causes of a maxillofacial fracture depend on a variety of contributing factors, including environmental, cultural, and socioeconomic factors[12].

The present study described the epidemiology of 859 patients with concomitant maxillofacial and traumatic brain injuries. The male to female ratio was 3.4:1. This can be explained by the fact that men have more exposure to public behaviors, such as drinking, driving, and assaulting more than women. Even in countries with more social freedom for women, for example Greenland, Finland, and Austria, the sexual ratio remains 2.1:1.13.

Traffic accidents remain the most frequent cause in many developing countries, including India. About 50% of fractures were reported due to traffic accidents, and 13% were from assault[13,14]. The results of the present study indicated that the most frequent cause of maxillofacial fractures were traffic accidents. The reports of previous studies, performed by different authors, also showed that maxillofacial fractures are most commonly caused by trauma, such as motor vehicle accidents, assaults, and falls[15]. Traffic accidents are the leading cause of maxillofacial fractures. The reasons for this high frequency are difficult to postulate, but may be due to inadequate road safety awareness, unsuitable road conditions, violation of speed limits, failure to wear seat belts or helmets, entry into opposing traffic lanes, violation of the right, and consumption of alcohol or other intoxicating agents. In the present study, fall related facial injuries were the second most common cause of maxillofacial fractures. This finding is similar to a previous study[16].

According to the severity of traumatic brain injuries, mild traumatic brain injuries was described as the most common, followed by severe and lastly, moderate traumatic brain injury. Additionally, traffic accidents were identified as the most common cause[17] in patients with mild traumatic brain injury concomitant with maxillofacial fracture 29%, and 14% were associated with severe traumatic brain injury.

Maxilla, zygomatic and orbital bone fractures were the main fractures, accounting for 80% of all fracture sites. Assault was also the commonest cause of maxillofacial fracture in the countries, such as Jordan (16%), Canada (41%), Turkey (19.4%), and developing countries like Nigeria (13%)[18-20]. The present study revealed assault as the third commonest cause of maxillofacial injury. Fractures that occurred most frequently, following assault, are the nasal

bones, the mandible, the zygoma, and the mid face. This finding is in contrast to the authors' findings, in which, assault related injuries resulted in fractures of the maxilla, nasal bone and followed by orbital bone fractures. Maxilla bone fractures were the most common (40%), which resulted from traffic accidents.

Intoxication was documented in 45% of patients, usually associated with alcohol. The involvement of substances, other than alcohol, was probably under-reported as physicians may have been unaware, or simply failed to document in the medical records. A further prospective study could ensure complete documentation on substance use. Alcohol consumption was a reason for maxillofacial fractures, leading to violence and careless driving, in addition to that, intoxicated patients are usually difficult to examine and small fractures in intoxicated patients can easily be misdiagnosed. Prevention, such as the obligatory wearing of a helmet and seat belts, better enforcement of the traffic law regarding "drinking and driving", educating people about the dangers of all-terrain injuries, and providing proper safety guidelines, before the purchase of a vehicle, have been shown to significantly reduce the number of road traffic accidents.

In the present study, the most common hospitalization period was one day (10.6%). The average period of hospitalization was 12.2 days, which contrast with another study wherein the hospitalization period was three days (19%)[1]. The operation rate was 34%, and incidence of complications after maxillofacial bone fracture surgery is reported to be about 6%. Complications included infection, malocclusion, and defect. Some studies reported that ophthalmologic complications account for almost half of all complications[21,22].

The present study was retrospective and focused on all traumatic brain injuries with maxillofacial fracture from patients that visited the authors' hospital. In so saying, as it used data from one hospital, the generalizability may be reduced. Therefore, further epidemiological studies that integrate all data from nearby hospitals are required.

Conclusion

The results of the present retrospective study provide important data for the design of future planning for injury prevention. In this study of 859 patients that visited Songklanagarind Hospital, between 2007 and 2016, the most common cause found was from traffic accidents. The second most common cause was a fall from height, followed by assault. The most common of the severity of traumatic brain injuries was mild, and most fractures occurred in the age range of 18 to 40 years, with maxilla bone fracture being the most frequent site. Patients with mild traumatic brain injury were associated to coronoid process of the mandible, Le fort fracture type II and type III. Patients with moderate traumatic brain injury were only associated to coronoid process of the mandible, whereas severe traumatic brain injury were associated to Le fort fracture type II and III. Citizen awareness programs should be initiated coupled with legislation on preventive measures enforced and followed by every citizen.

What is already known on this topic?

Previous studies from King Chulalongkorn Memorial Hospital were published on 21 March 2018 reported the most common cause of maxillofacial injury was from traffic accidents and the most common type was zygomaticomaxillary complex (ZMC) fractures. Additionally, alcohol consumptions were reported more than half of cases.

What this study adds?

This study evaluated the associated maxillofacial injury with traumatic brain injury and found that the pattern associated between severity of traumatic brain injury with type of maxillofacial injury.

The result from this study is useful for maxillofacial surgeon to be concerned about mandibular fracture in mild to moderated traumatic brain injury and Le fort fractures in severe traumatic brain injury.

Acknowledgement

The authors wound especially like to thank the International Affairs Office, Faculty of Medicine, Prince of Songkla University for their language editing services.

Conflicts of interest

The authors declare no conflict of interest.

References

1. Park KP, Lim SU, Kim JH, Chun WB, Shin DW, Kim JY, et al. Fracture patterns in the maxillofacial region: a four-year retrospective study. J Korean Assoc Oral Maxillofac Surg 2015;41:306-16.
2. Salentijn EG, Peerdeman SM, Boffano P, van den Bergh B, Forouzanfar T. A ten-year analysis of the traumatic maxillofacial and brain injury patient in Amsterdam: incidence and aetiology. J Craniomaxillofac Surg 2014;42:705-10.

3. van den Bergh B, Karagozoglu KH, Heymans MW, Forouzanfar T. Aetiology and incidence of maxillofacial trauma in Amsterdam: a retrospective analysis of 579 patients. J Craniomaxillofac Surg 2012;40:e165-9.
4. van Hout WM, Van Cann EM, Abbink JH, Koole R. An epidemiological study of maxillofacial fractures requiring surgical treatment at a tertiary trauma centre between 2005 and 2010. Br J Oral Maxillofac Surg 2013;51:416-20.
5. Panjaisri S, Phuenpathom N, Veerasarn K. Introduction. In: Phuenpathom N, Srikijvilaikul T, editors. Clinical practice guidelines for traumatic brain injury. Bangkok: The Royal College of Neurological Surgeons of Thailand; 2019. p. 1-30.
6. Arslan ED, Solakoglu AG, Komut E, Kavalci C, Yilmaz F, Karakilic E, et al. Assessment of maxillofacial trauma in emergency department. World J Emerg Surg 2014;9:13.
7. Arabion H, Tabrizi R, Aliabadi E, Gholami M, Zarei K. A retrospective analysis of maxillofacial trauma in shiraz, iran: a 6-year- study of 768 patients (2004-2010). J Dent (Shiraz) 2014;15:15-21.
8. Calderoni DR, Guidi Mde C, Kharmandayan P, Nunes PH. Seven-year institutional experience in the surgical treatment of orbito-zygomatic fractures. J Craniomaxillofac Surg 2011;39:593-9.
9. Bogusiak K, Arkuszewski P. Characteristics and epidemiology of zygomaticomaxillary complex fractures. J Craniofac Surg 2010;21:1018-23.
10. Naveen Shankar A, Naveen Shankar V, Hegde N, Sharma, Prasad R. The pattern of the maxillofacial fractures - A multicentre retrospective study. J Craniomaxillofac Surg 2012;40:675-9.
11. Haug RH, Adams JM, Conforti PJ, Likavec MJ. Cranial fractures associated with facial fractures: a review of mechanism, type, and severity of injury. J Oral Maxillofac Surg 1994;52:729-33.
12. Al Ahmed HE, Jaber MA, Abu Fanas SH, Karas M. The pattern of maxillofacial fractures in Sharjah, United Arab Emirates: a review of 230 cases. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:166-70.
13. American College of Surgeons. Advanced trauma life support. 9th ed. Chicago: American College of Surgeons; 2012.
14. Jeon EG, Jung DY, Lee JS, Seol GJ, Choi SY, Paeng JY, et al. Maxillofacial trauma trends at a tertiary care hospital: a retrospective study. Maxillofac Plast Reconstr Surg 2014;36:253-8.
15. Zachariades N, Papavassiliou D. The pattern and aetiology of maxillofacial injuries in Greece. A retrospective study of 25 years and a comparison with other countries. J Craniomaxillofac Surg 1990;18:251-4.
16. Down KE, Boot DA, Gorman DF. Maxillofacial and associated injuries in severely traumatized patients: implications of a regional survey. Int J Oral Maxillofac Surg 1995;24:409-12.
17. Ansari MH. Maxillofacial fractures in Hamedan province, Iran: a retrospective study (1987-2001). J Craniomaxillofac Surg 2004;32:28-34.
18. Schön R, Roveda SI, Carter B. Mandibular fractures in Townsville, Australia: incidence, aetiology and treatment using the 2.0 AO/ASIF miniplate system. Br J Oral Maxillofac Surg 2001;39:145-8.
19. Pappachan B, Alexander M. Correlating facial fractures and cranial injuries. J Oral Maxillofac Surg 2006;64:1023-9.
20. Czerwinski M, Parker WL, Chehade A, Williams HB. Identification of mandibular fracture epidemiology in Canada: Enhancing injury prevention and patient evaluation. Can J Plast Surg 2008;16:36-40.
21. Lee JH, Mun GH, Bang SI. A clinical & statistical analysis of the facial bone fractures: 7 years survey. J Korean Soc Plast Reconstr Surg 1998;25:1046-52.
22. Kwon HJ, Han J, Kim JH, Jung HY, Kim JY, Yoon SH, et al. Clinical Epidemiologic Study of Facial Bone Fractures in Daegu. J Korean Soc Plast Reconstr Surg 2007;34:365-70.