Incidence, pattern, etiology of facial fractures among two referral centers (retrospective cross-sectional study)

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Original Article

ABSTRACT

Facial trauma represents a serious public health problem. Although there is an increase in maxillofacial trauma globally, pattern and etiology of these maxillofacial injuries varies between countries due to socioeconomic, cultural, and environmental factors for each country.

The object of this study was to analyze and discuss incidence, pattern, and etiology of maxillofacial fractures. A retrospective cross- sectional study of 350 patients admitted to oral and maxillofacial department during 2016 to 2021. Data were collected for age, gender, etiology , fracture pattern , timing of admission , hospital stay , method of treatment and cost. All data were analyzed using statistical analysis that is chi square test. There is male predominance with the highest incidence in the age group of 20 to 35 years. The most common etiology of trauma is motorcycle accident (34.29%), car accidents (18.57%) followed by falling accidents (14.86%) zygoma (13.71%) is the most common fracture site in the face. Thus, effectiveness of current preventive measures is to be assessed, followed by constructing new guidelines for prevention and inflexible traffic rules shall be raised. More epidemiological surveys can, if encouraged to measure the frequency of fractures, better the world.

Key Words: epidemiology of maxillofacial trauma, postoperative stay , method of treatment .

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INTRODUCTION:

Facial injuries are considered as a part of injuries in human body [1] . Facial injury defined as injury of face including major and minor injuries of the soft tissue , bone , blood vessels and nerves .[1,2] Maxillofacial injuries following trauma to head and neck region could lead to medical emergencies as blood loss and airway obstruction .[1–3] Maxillofacial injuries constitute one of the major health problems worldwide.[4] Each year about 5.8 million people globally die from trauma or may be disabled. It's predicted to become one of the top 20 causes leading to death worldwide by 2030. For people under 44 years of age, trauma is already among the top three causes of death.[5] Maxillofacial injuries may result in loss of function , disfigurement , psychological problems to the extent of disability and death.[6] In addition to facial bones , soft tissue injuries of head and neck and dentoalveolar fractures , maxillofacial fractures can occur isolated or in combination with cranial , spinal , upper and lower body injuries .[7] Major or minor trauma can be assessed using injury severity score (ISS). [8] An ISS of ≥ 16 is the cutoff for major trauma, and this is calculated by summing up the scores of the three most severe injuries a patient sustains. Management of head and neck trauma is a complex procedure because it often requires input from a wide variety of surgical disciplines as maxillofacial surgery, plastic surgery and neurosurgery. [9,10] There are various causes of maxillofacial injuries, road traffic accident and interpersonal violence are the most common causes of maxillofacial injuries. [11–17] It's followed by sports , occupational related injuries , falls , domestic accidents , terrorism and war. [18–23] The mandible is the most primary bone involved in maxillofacial fractures, condyle and para-symphysis are the most commonly affected sites in patients with mandibular fractures.[11] Risk factors of maxillofacial fractures including age, sex and etiology varies depending on geographical , social , cultural , traffic volume , preventive measures , economic and environmental factors.[24,25] Understanding incidence , etiology , pattern helps to evaluate the behavior patterns of people in various countries and different social cultures as well as establish proper prevention and treatment strategy. [26] The management of cranio-maxillofacial trauma include facial bone fractures , dentoalveolar fractures , soft tissue lacerations and associated injuries mainly of head and

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neck. [27] The treatment of maxillofacial fractures includes both conservative and surgical methods. Maxillofacial trauma often leads to morbidity and disability so treatment and rehabilitation should be performed with consideration of the psychological and esthetic effects. [28] Management of maxillofacial trauma must be done in an evolutionary manner. Evaluation of soft tissue and bone injuries must be done precisely through instrumental diagnostic examinations. Coordinated, periodic, and sequential collection of data related to demographic patterns of maxillofacial injuries may help health care officials to know the causes and evaluate effectiveness of previously implemented preventive protocols.[29] The aim of this retrospective study is to analyze the incidence , pattern and etiology of facial fractures in period of 5 years ago from 2016 to 2021 .

MATERIALS AND METHODS:

This retrospective study covered a 6-year time. All data were collected from medical sheets of the patients with facial fractures treated at the Department of Oral and Maxillofacial Surgery of Dental Specialized Teaching Military Hospital, Kobri El-Kobba and the Maxillofacial Department in the Faculty of Dentistry, Ain-Shams University, Cairo, and was centralized electronically using Microsoft Excel Software. Many patients were transferred to the military dental specialist teaching hospital and Ain-Shams University Hospital because of its unique location and perfect medical services. This research sample consisted of 350 patients who had maxillofacial fractures and were treated in our department from 2016 to 2022. A total of 350 patients suffered from maxillofacial trauma and suspected facial bone fractures including the nose, frontal bone, maxilla, zygoma, and mandible presented to the emergency room in two hospitals. All patients were diagnosed clinically and radiographically by computed tomography (axial and coronal slices and three-dimensional reconstructed images). 343 patients were confirmed to have facial fractures necessitating surgical intervention and so admitted to the department and operated upon. This study retrospectively analyzed these medical records and data were collected concerning gender, age, cause of injury, fracture pattern, Annual distribution, operation admission time, hospital residency period, and treatment modality.

This analysis helped us to improve the management and treatment of patients who had maxillofacial fractures. All data were analyzed in relation to maxillofacial fracture. Annual distribution analyzed based on age, gender, cause of injury and fracture pattern as well. Additionally, patients were divided into nine fracture etiology groups: RTA group which was subdivided into five subgroups (motorcycle accident, car accident, pedestrians, bicycle, rick-show accident), interpersonal violence, falling, work-related injuries, gunshot injury, explosive device explosion, sports accidents, extraction of wisdom teeth and animal accidents.

This analysis was conducted for each group: sex, age, fracture pattern (e.g., nasal bone, zygoma, maxilla, mandible, and frontal bone fractures), time of admission, hospital residency period, method of treatment. To make a statistical analysis of this huge sample with multiple fracture patterns, we classified fracture patterns into upper, lower, mixed compound, and complex fractures. Compound fracture exhibited two fracture lines and complex fracture exhibited more than 2 fracture lines. Compound or complex fractures can affect the lower face (mandible), upper face (mid-face, frontal bone), and mixed upper and lower face (mandible, mid-face, frontal bone fractures). Time of admission to surgeries was classified into immediate (the same day of the accident), early (within 2 to 3 days), delayed (more than one week), and no need for surgery. The hospital stay after surgery was divided into short stay (within 2-3 days), long stay (more than one week), and no need for a stay in the hospital. The method of treatment was divided into closed reduction, open reduction, and internal fixation (ORIF), ORIF with ocular enculation, and no need for surgery. The fracture type and patient's condition were considered when choosing the treatment method. After the surgery, the patient received antibiotic treatment and specific oral hygiene cre

Statistical analysis

Statistical presentation and analysis of the present study was conducted, using the mean standard deviation, Chi-square by SPSS V20. Chi-square the hypothesis that the row and column variables are independent, without indicating strength or direction of the relationship. Person chi-square and like-hood ratio chi-square. P-value > 0.05 means non-significant, P- value < 0.05 means significant and P-value <0.01 means highly significant.

RESULTS:

I. Patient data

A total of 350 patients were investigated from 2016 to 2021. One hundred patients' data were collected from Oral and Maxillofacial Department in Faculty of Dentistry, Ain -Shams University and 250 patients' data were collected from Oral and Maxillofacial Department of Dental Specialized Teaching Military Hospital. Among these patients 344 (98.29%) were males and 6 (1.71%) were females. There was a male predominance in all age groups with an overall male and female ratio 5.7 to 1. Regarding patient's age distribution, 24.86% were less than 20 years old, 61.14% were between 20 to 35 years old which was the largest group in both sexes and only 8% were more than 35 years old. Age and sex distribution of patients were shown in (Fig. 1,2). Patients were analyzed from 2016 to 2021. 2019 had the highest incidence of maxillofacial traumatic accidents (Fig. 3). Annual distribution based on gender was shown in (Table 1). There was no statistical difference among individual years. In contrast, in all years the most commonly affected age group was 20-35 years old. P value was <0.001 which highly significant. Annual distribution based on age was shown in (Table 2).

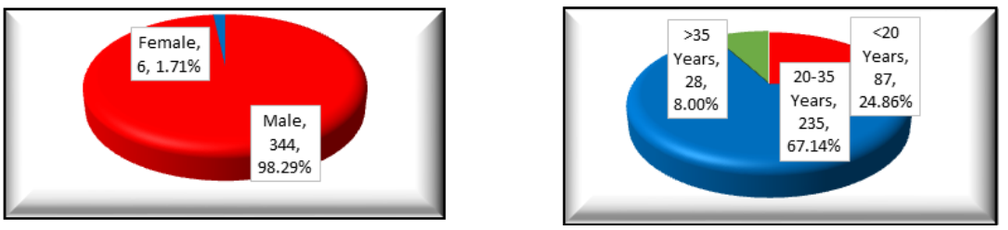

Figure 1, 2. Age and gender distribution of maxillofacial traumatic patients

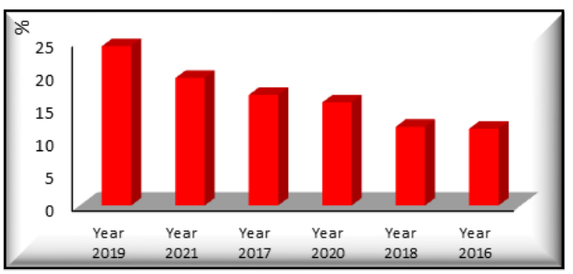

Figure 3. Annual distribution of patients.

Table 1. Annual distribution based on gender.

Year	Gender				Chi-Square	
	Male		Female		X2	P-value
	N	%	N	%		
Year 2016	40	97.56	1	2.44		
Year 2017	57	96.61	2	3.39		
Year 2018	42	100.00	0	0.00	3.937	0.559
Year 2019	85	100.00	0	0.00		
Year 2020	54	98.18	1	1.82		
Year 2021	66	97.06	2	2.94		

Table 2. Annual distribution based on age

Year	Age groups						Chi-Square	
	<20 Years		20-35 Years		>35 Years		X2	P-value
	N	%			N	%		
Year 2017	6	10.17	49	83.05	4	6.78		
Year 2018	4	9.52	34	80.95	4	9.52		
Year 2016	3	7.32	32	78.05	6	14.63	56.951	<0.001*
Year 2019	19	22.35	55	64.71	11	12.94		
Year 2020	20	36.36	35	63.64	0	0.00		
Year 2021	35	51.47	30	44.12	3	4.41		

II. ***Etiology of maxillofacial trauma:***

Regarding etiology of maxillofacial trauma, the most common etiology was motorcycle accidents which occurred in 120 patients (34.29%) followed by car accidents (18.57%, 65 patients) which was the second most common etiology. Fall accidents were the third most common cause of facial fractures (14.86%, 52 patients). This was followed by pedestrians and interpersonal violence which both accounted for 32 patients (9.14%), Sports accidents (14 patients 4%), Work-related accidents (13 patients, 3.71%), rick-show and animal accidents (3 patients, 0.86% for each) and finally improvised device explosion and extraction of wisdom teeth (2 patients, 0.57%) which were the least common. Cause of fracture distribution in patients who suffered from maxillofacial fractures was shown in (Fig. 4). The annual distribution based on etiology of trauma showed that motorcycle accidents were statically significant high in all years (P = 0.028%) as shown in (Table 3)

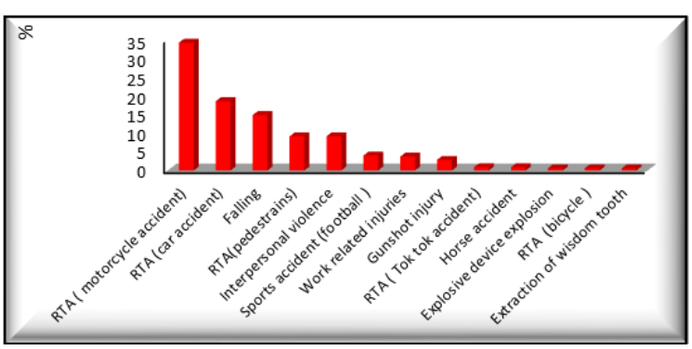

Figure 4. Etiology of maxillofacial trauma

Table 3. Annual distribution based on etiology of trauma

Cause of injury	Year											
	Year 2016		Year 2017		Year 2018		Year 2019		Year 2020		Year 2021	
	N	%	N	%	N	%	N	%	N	%	N	%
RTA (motorcycle accident)	15	36.59	21	35.59	14	33.33	27	31.76	17	30.91	26	38.24
RTA (car accident)	12	29.27	10	16.95	9	21.43	14	16.47	10	18.18	10	14.71
RTA (pedestrians)	1	2.44	4	6.78	1	2.38	7	8.24	11	20.00	8	11.76
RTA (bicycle)	0	0.00	0	0.00	0	0.00	1	1.18	0	0.00	1	1.47
RTA (rik-show accident)	0	0.00	0	0.00	0	0.00	2	2.35	1	1.82	0	0.00
Gunshot injury	4	9.76	3	5.08	0	0.00	2	2.35	1	1.82	0	0.00
Explosive device explosion	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	2	2.94
Falling	4	9.76	9	15.25	8	19.05	15	17.65	5	9.09	11	16.18
Interpersonal violence	3	7.32	6	10.17	5	11.90	11	12.94	4	7.27	3	4.41
Work related injuries	1	2.44	0	0.00	2	4.76	5	5.88	5	9.09	0	0.00
Sports accident (football)	1	2.44	4	6.78	2	4.76	0	0.00	1	1.82	6	8.82
Extraction of wisdom tooth	0	0.00	2	3.39	0	0.00	0	0.00	0	0.00	0	0.00
Horse accident	0	0.00	0	0.00	1	2.38	1	1.18	0	0.00	1	1.47
Chi-Square **X2**	82.604											
P-value	0.028*											

III. Pattern and site fracture

Regarding facial fracture pattern, displaced zygomatic bone and arch fracture were the most frequent (13.17%, 48 patients). The second most frequent fracture pattern was compound fracture lower face (46 patients, 13.14%). This was followed by compound fracture upper face (33 patients, 9.43%). Facial fracture patterns distribution was illustrated in (Fig. 5). Annual distribution based on facial fracture pattern was shown in (Table 4). In 2017, 2020 and 2021, displaced zygomatic bone and arch fracture had the highest incidence. P value was 0.002 which meant high significant.

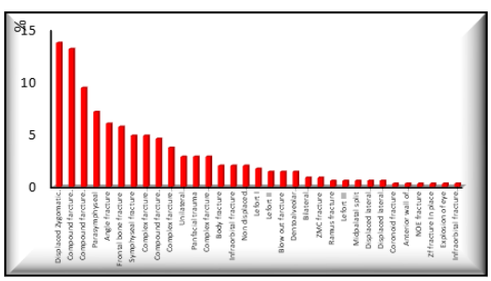

Figure 5. Pattern of maxillofacial fractures

Table (4): Annual distribution based on facial fracture pattern.

Facial fracture pattern	Year											
	Year 2016		Year 2017		Year 2018		Year 2019		Year 2020		Year 2021	
	N	%	N	%	N	%	N	%	N	%	N	%
Symphysis fracture	3	7.32	5	8.47	2	4.76	4	4.71	2	3.64	1	1.47
Parasymphysis	5	12.20	6	10.17	1	2.38	2	2.35	5	9.09	6	8.82
Angle fracture	3	7.32	5	8.47	0	0.00	8	9.41	2	3.64	3	4.41
Body fracture	0	0.00	1	1.69	0	0.00	4	4.71	2	3.64	0	0.00
Unilateral subcondylar fracture	0	0.00	1	1.69	1	2.38	1	1.18	2	3.64	5	7.35
Bilateral subcondylar fracture	0	0.00	0	0.00	2	4.76	0	0.00	1	1.82	0	0.00
Coronoid fracture	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.47
Ramus fracture	0	0.00	0	0.00	1	2.38	1	1.18	0	0.00	0	0.00
Lefort I	2	4.88	0	0.00	0	0.00	1	1.18	1	1.82	2	2.94
Lefort II	2	4.88	0	0.00	1	2.38	1	1.18	1	1.82	0	0.00
Lefort III	0	0.00	0	0.00	0	0.00	1	1.18	1	1.82	0	0.00
Dentoalveolar fracture	0	0.00	0	0.00	0	0.00	1	1.18	0	0.00	4	5.88
Frontal bone fracture	2	4.88	5	8.47	5	11.90	5	5.88	2	3.64	1	1.47
Infraorbital fracture	0	0.00	1	1.69	3	7.14	2	2.35	0	0.00	1	1.47
Displaced Zygomatic arch and bone fracture	3	7.32	11	18.64	4	9.52	9	10.59	7	12.73	14	20.59
Nondisplaced Zygomatic arch and bone fracture	0	0.00	1	1.69	1	2.38	0	0.00	1	1.82	4	5.88
Blow out fracture	0	0.00	0	0.00	1	2.38	0	0.00	0	0.00	4	5.88
Pan-facial trauma	2	4.88	2	3.39	1	2.38	3	3.53	0	0.00	2	2.94
Mid-palatal split	0	0.00	0	0.00	0	0.00	0	0.00	1	1.82	1	1.47
Displaced lateral wall of orbit	0	0.00	0	0.00	0	0.00	1	1.18	0	0.00	1	1.47
Displaced lateral wall of maxillary sinus	0	0.00	0	0.00	0	0.00	0	0.00	1	1.82	1	1.47
Anterior wall of maxillary sinus right side	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	1.47
NOE fracture	0	0.00	0	0.00	0	0.00	1	1.18	0	0.00	0	0.00
Compound fracture upper face	7	17.07	5	8.47	2	4.76	11	12.94	3	5.45	5	7.35

Compound fracture lower face	4	9.76	10	16.95	7	16.67	13	15.29	6	10.91	6	8.82
Compound fracture mixed	4	9.76	0	0.00	1	2.38	3	3.53	5	9.09	3	4.41
Complex fracture upper	2	4.88	2	3.39	7	16.67	1	1.18	3	5.45	2	2.94
Zf fracture in place	1	2.44	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Explosion of eye	1	2.44	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00
Complex fracture lower	0	0.00	1	1.69	0	0.00	5	5.88	4	7.27	0	0.00
Complex fracture mixed	0	0.00	3	5.08	1	2.38	6	7.06	3	5.45	0	0.00
Infraorbital fracture, retro bulbar hemorrhage	0	0.00	0	0.00	1	2.38	0	0.00	0	0.00	0	0.00
ZMC fracture	0	0.00	0	0.00	0	0.00	1	1.18	2	3.64	0	0.00
Chi-Square **X2**	215.603											
P-value	0.002*											

IV. Correlation between etiology and facial fracture pattern of maxillofacial trauma

Motorcycle accidents accounted for 120 cases, displaced zygomatic arch and bone fracture was the most common facial fracture pattern (18.33%) and infra-orbital fracture was less common (0.83%). Car accidents accounted for 65 cases, frontal bone fracture and displaced zygomatic bone and arch fracture had the highest incidence (13.85%) for each. The least incidence was unilateral and bilateral sub-condylar fracture (1.54%) for each. Pedestrians accounted for 32 cases, compound fracture of lower face was the most common (18.75%) and non-displaced zygomatic arch and bone fracture was the least common (3.13%). Bicycle accidents had only two cases, compound fracture upper face and compound fracture lower face with equal percentage (50%) for each. Rick-show accidents accounted for 3 cases, mixed compound fracture, mixed complex fracture and compound fracture upper face with (33.3%) for each. Falling accidents constituted 52 cases and the most associated fracture patterns were symphysis fracture of mandible and displaced zygomatic bone and arch fracture with (15.38%) for each. The least common was le-fort III (1.92%). Interpersonal violence represented 31 cases, angle fracture of the mandible had the highest incidence (21.88%) and mixed compound fracture had least incidence (3.13%). Sports accidents accounted for 14 cases, displaced zygomatic bone and arch fracture was the most common (35.71%) and dentoalveoar fracture the least common (7.14%). Work-related accidents constituted 13 cases, the most common one was frontal bone fracture (23.08) and the least one was infra-orbital fracture (7.69%). Gunshot injuries constituted 10 cases, mandibular body fracture had the highest incidence (40%) and le-fort I had the least incidence (10%). Improvised device explosion had 2 cases, associated fractures were pan-facial fracture and compound fracture upper face with (50%) for each. Animal accidents accounted for 3 cases, displaced lateral orbital wall, compound fracture lower face and complex fracture upper face had the same incidence percentage (33.33%). Finally, wisdom teeth extraction which accounted for 2 cases, angle fracture was associated facial fracture with percentage (100%).

V. Time of surgery admission, hospital stay and method of treatment

Most patients admitted early to operations within 2 days of accident occurrence as shown in (Fig. 6). In 293 (83.71%) of patients stayed in hospital for short period (less than one week) as shown in (Fig. 7). Surgical treatment was performed on most of the patients throughout the 5 years. Open reduction and internal fixation were the most common method of treatment used accounting for 90% of all accidents as shown in (Fig.8).

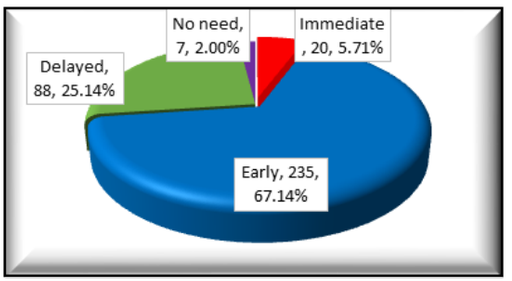

Figure 6. Time of surgical admission

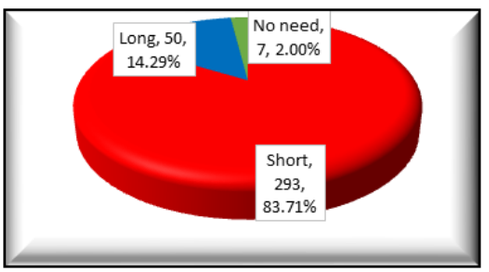

Figure 7. Postoperative hospital stay

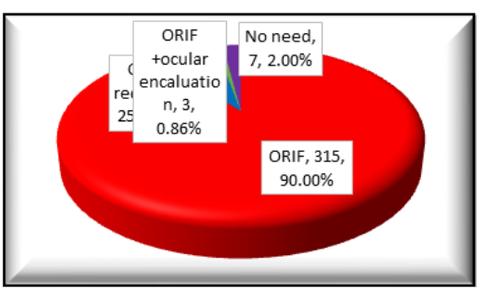

Figure 8. Method of treatment distribution of patients

DISCUSSION:

Major trauma had a major impact on healthcare systems. [30,31] Maxillofacial injuries had a higher death rate than other trauma types because the facial region was unprotected.[32] Maxillofacial injuries affect organs performing essential body functions as respiration, speech, mastication, vision and smell. Therefore, particular attention must be paid to maxillofacial trauma. So Advanced basic life support was used in assessment of all patients who had maxillofacial trauma.[33] Maxillofacial fractures had high percentage of medical services in emergency clinics. In several studies, maxillofacial injuries reported in about 7.4 – 8.4% of emergency clinic cases. [34] Few years ago, there were few studies regarding Egyptian residents with small sample [35], in this study, there were large sample about 350 patients. Many studies were performed globally to assess incidence, pattern, and etiology of maxillofacial injuries. The duration was different in each study. Most of them were presented between 2000 to 2010 [36] In this study, the duration was from 2016 to 2021 which was more recent. Analysis of epidemiological data was an important point for organizing the financial resources, estimating expenses of each type of trauma, and training of oral and maxillofacial surgeons to deal with a certain pattern of patients. Knowing the etiology and epidemiology of each type of trauma was important for approaching its means of prevention. [36] There was worldwide distribution of these studies. For example, five studies from North America[37–41], five studies from South America [42–46], six from Europe [47–52], two from Africa [53,54]and nine from Asia[39,55–62]. There were few studies regarding Egyptian residents with small analyses of the epidemiological data of maxillofacial trauma. Almost all these studies were retrospective as this study except one which was multi-center research with a prospective design.[49]Most of these studies were managed based on national data banks.[40,41,63] In contrast, this study was based on operating rooms, emergency rooms, and other hospital data collection. Most of these articles performed as descriptive statistical analysis except four of them which depended on logistic regression analysis of data.[40,41,50,63] In contrast, this study was a descriptive-analytical statistical analysis study. For example, all these studies revealed that the most common cause of maxillofacial trauma was RTA among children and adults with 34% as the estimated prevalence followed by falling accidents with a prevalence of 31% [13]. Among these studies, only one study did not show several falls. [12] According to these studies, violence was the third mechanism of maxillofacial trauma with a prevalence of 11%. The last mechanism was sports with a prevalence of 4%. [13] When the study region was considered, it was easy to know the most common cause of maxillofacial trauma in each country as RTA was most common in Africa and Asia and lower in Europe which presented a high percentage of fall accidents. North America, Africa, and South America exhibited the highest percentage of violent accidents. Sports and other mechanisms of maxillofacial trauma were similar in etiology distribution. [13] In this study, the incidence, etiology, and pattern of maxillofacial trauma were discussed among the Egyptian population.

I. Age, sex and year distribution:

The rate of maxillofacial trauma increased in recent years worldwide.[64] In this study, the highest percentage of maxillofacial injuries occurred in male which was a universal finding in all previous studies as they were mostly affected because they exposed themselves to risky situations especially in driving and interpersonal violence. [65,66] In contrast, other studies stated above 70 years old facial injuries were dominant in females more than males due to postmenopausal osteoporosis and high incidence of significant falls with increasing age.[67] In this study, the age group that had maxillofacial trauma was 20-35 years old which was consistent with those in previous studies. [14,33,34,64–66,68,69] It reflected that third decade of life represented the main period of activity that was more involved in active transport and outdoor activities.[67] In this study,

there was a high incidence of maxillofacial fractures in 2019 followed by 2021. This may be because enhancement of infrastructures and at the same time non-compliance with traffic rules. The year 2020 had lower incidence of maxillofacial fractures due to the COVID 19 restriction. In this study, there was a correlation between facial fracture pattern and annual distribution. In 2020 and 2021, displaced zygomatic bone and arch fracture was the most common fracture pattern in these years. Motorcycle, pedestrian and falling accidents had more incidences in 2020 and 2021 than other accidents. In these years, there was a COVID 19 pandemic and lockdown to prevent the spread of corona virus so there was a limitation in other activities. Therefore, according to this study the predominant fracture pattern associated with motorcycle, pedestrian and falling accidents was displaced zygomatic bone and arch fracture.

II. Etiology and pattern of maxillofacial trauma:

The etiology of maxillofacial trauma was a very important factor that had a great impact on incidence, clinical picture and treatment protocols of maxillofacial trauma. There were several reasons of maxillofacial trauma such as RTAs, falling, interpersonal violence, work related injuries, sports accident, gunshot injuries, explosive device explosion, animal accidents and wisdom tooth extraction. [70,71] According to this study , the leading cause of maxillofacial trauma were RTAs which was similar to the result of numerous studies in different countries.[72–77] Within category of RTAs, motorcycle accident, car accident, bicycle, rick-show and pedestrian accidents were the most important etiological factors. In this study the most common causes of maxillofacial trauma due to traffic accidents were motorcycle accidents (34.29%) which was in agreement with developing countries studies as in Malaysia, Iran and India.[78–80] because there were inadequate awareness of road safety measures, failure to wear helmets (90% in motorcycles), loss of control and consciousness due to alcohol addiction, non-compliance with the specified speed, low socioeconomic status that resulting in use of motorcycles than cars because it's cheaper but unfortunately, motorcycles lacked safety measures like car occupants as airbags and seatbelts therefore helmets were the only safety measure in motorcycle.[81]

Poor traffic law enforcement by police especially for motorcycles to wear helmets and no specific roads for motorcycles which are consistent with other studies.[79,82] Recent studies were shown that motorcyclists who wear helmets had more protection against facial fractures than un-helmeted motorcyclists..[83–87] In Malaysia, it was reported that motorcycle accidents were three times higher than car accidents and six times higher than pedestrians. [79] In this study, motorcycle accidents were three times higher than car accidents and 4 times higher than pedestrians. These results were different from developed countries results , most of studies concluded that the assault was the most common cause of maxillofacial injuries like in Australia, United states and Bulgaria where the accessibility of weapons had raised and aggressive behavior increased. [82,88,89] In other studies car accidents and pedestrians were the most common causes. [81,90] In developing countries, motorcycles accidents were most common, unlike developed countries had higher incidence of facial trauma among victims of automobile accidents than of motorcycle accidents may be due to the use of airbags, which, despite decreasing the incidence and severity of injuries in general, may contribute to maxillofacial injuries. In contrast to this, increased education and monitoring in regard of protection equipment such as helmets may decrease maxillofacial injuries while driving a motorcycle. [91,92] Regarding this study, the most common facial fracture pattern associated with motorcycle accident was displaced zygomatic bone and arch fracture followed by mandible and mid-face which in agreement with other studies. [93–95] This is because the ability of zygoma to withstand the energy forces was lower than the frontal and mandible. [96]

It's believable that not only the prominence in facial skeleton of zygoma which make it more prone to fracture but also the articulation of zygoma with other bones make it more fragile than other facial bones. [97,98] In other studies, mandible was considered as the strongest facial bone so that mandible can resist energy forces from motorcycle than other facial bones.[86,97,98] This study revealed that car accident is the second most common etiology of maxillofacial fractures due to traffic accidents which is similar to some studies.[78,79] This can be explained by high speed driving, loss of control of steering wheel, bad weather conditions, car driver errors, prolonged submission to heat waves, old vehicles without safety measures as airbags, and car occupants were not required to wear seat belts that was resulting in high incidence of car accidents in our country. [95,96,98–100] The car structures responsible for severity of facial injuries were the windscreen and the steering wheel followed by the interior rearview mirror. Therefore, the protection effect of seat belts of a passenger with seat belt occurred by preventing or at least decreasing the extent of movement away from the seat. [99] Hogg et al., [101] showed that car drivers who didn't wear seat belts were 5 times more likely to have maxillofacial injuries than those who used seatbelts. In some countries as KSA, seatbelt legislation made seat belt wear by front passengers obligatory. [100] Despite recent achievements in road networks that was made within few years in Egypt including widening and expansion of roads within and between cities, placing traffic lights and placing radars on highways to determine the speed, increased awareness of traffic rules is essential which was in agreement with other studies in developing countries.[26,102,103] In this sample ,there was equal predilection between zygomatic bone fracture and frontal bone fracture. These results were in accordance with the other major studies. [104–107] In this study frontal bone fractures were equal to zygomatic bone fractures in number of car accident victims. Only a study in Helsinki University Hospital, Finland, stated that comminuted frontal bone fractures were common associated with Lefort I. [108]

This was because the great negligence of our citizens in wearing seat belts so immediately at the start of collision unrestrained driver and front seat passenger continues to move horizontally without stoppage so diver come in contact with steering wheel, A-pillar and dashboard resulting in increasing incidence of maxillofacial frontal bone fractures. However, seat belts wearing prevents the free flight of drivers within the vehicle and contact with the interior of the vehicle, some authors stated that restrained drivers exposed to maxillofacial fractures because head's driver still be thrown against steering wheel. [74] Pedestrians are the only group of RTAs who were not guarded in crash with cars, motorcycle and bicycle. [73,109–111] It constituted 9.14% from our study sample.

Pedestrian accidents usually occurred due to high number of pedestrians and car volume , non – compliance with traffic regulations by both pedestrians and motorists ,lack of specific lanes and fly-overs at high risk road crossing roads for pedestrians so our community need more awareness of traffic regulations of pedestrians and specific lanes must be constructed for them. [112] Excessive heat exposure also resulting in lack in focus while crossing the road or systemic pathological conditions.[113] Mandible is the most common fracture site in pedestrian accidents which is similar to several studies.[114–116] In pedestrian accidents ,double and triple fracture lines in the mandible are occurred as a result of high-velocity impact collisions and while hitting the ground as a result of these collisions. [110] Bicycle and rick-show accidents had a small number in our sample. High and low percentage of bicycle accidents was depending on geographic areas. For example, Italy had the lowest percentage of bicycle accidents which is similar to our study and in contrast, the Netherland had the highest percentage of bicycle accidents. [117,118]

In Cairo , there was no specific cycle lanes and paths to separate cycles from other motor vehicles so bicycle accidents has low incidence in this study.[119] In this study, Mandible and mid-face fractures were patterns associated with bicycle accidents which is similar to other studies. [11,111,116,120] The cyclist was leaped over the handlebars in a circular arc of motion about the axis of rotation of the front tire, directly impacting the face with the head in a neutral position. The cyclist's lower and middle face strike the ground and maxillofacial fractures were sustained. [121] In literature , there was a little research concerning incidence of facial fracture patterns related to cycle Rick-show accidents.[122] In this study, rick-show accidents are few because our study was done in Cairo which it is the capital. Rick-shows mostly used in narrow lanes of small cities in which they were only method to travel from one area to another as in India, cycle rick-show were a major method of transportation which parents used to ferry their children to school. [122]

The most common causes of rick-show accidents were that drivers didn't follow the traffic rules, driving in high speed without any safety measures as the rick-show had no safety measures at all, Poor vehicle design and overloading of rich-shows.[123] Rickshaw Crashes with multiple vehicles were found to be associated with more complicated injury as compared to the single vehicle injury. Mortality rates and the frequency of ICU admission was also more in the multiple vehicle crashes. [122] In these results, mandible, midface and frontal bone fractures were common in rickshaw accidents. The second most common cause of maxillofacial fractures was falling accidents according to these results which was as in Melbourne Australia, China and Pakistan. [124–126] Fall accidents occurred mostly in specific circumstances such as a workplace or disease .People hit the ground in any direction and affect various parts of the face.[127] Zygomatic bone, arch and mandible fractures were mainly fracture patterns occurred with falls which was the same results of previous studies. [114,127] In fall accidents, people lose their control or are unconscious while falling, and they may hit the ground with any part of the face. In these types of accidents, the magnitude of traumatic force is high enough to make a fracture in strong bones, such as the mandible and zygoma.. [127] Yamamoto et al., [114] said that nearly two thirds of facial fractures caused by falls occurred in the mandible and only one third in the midface which was different from our study, mandible and zygomatic bone fracture were affected equally. Yamamoto et al.,[114] did not find any remarkable difference in the rate of mandibular and midface fractures between simple falls and falls from height. Other studies have shown that the incidence of midface fractures was higher in falls from a height than falls from standing level. [128,129]

According to our analysis, symphysis fracture had high incidence in fall accidents which is contrast to Iida et al.,[128] and Yamamoto et al.,[114] which said that condyle was most common fracture site due to fall accidents. This difference in results may be due to sample size difference, age of patients, and methodology of studies. Other important causes of maxillofacial trauma in this study were interpersonal violence or assaults. In this study, Assaults were the third common cause of maxillofacial trauma which was in agreement with study in China.[125] This may be due to low level of education which was a predisposing factor to lack of job opportunities, unemployment, low social status, decreasing of material things and limited accessibility of healthcare service. All these points led to annoyance, depression and drug addiction which resulting in conflicts and interpersonal violence. [130–134] In developing countries interpersonal violence was not the dominant cause of maxillofacial fractures as in developed countries may be due to alcohol consumption was restricted or prohibited by law as in Arab countries, so incidence of interpersonal violence was low. [135,136] There are several European studies approve the shifting of maxillofacial fractures etiology from RTA and sport accidents to interpersonal violence. [137–139]

The culture, social and educational patchwork of different cities in developed countries was an important factor in interpersonal conflicts resulting in maxillofacial injuries. [32,37,133,134,139-148] Assault accidents can be with sharp weapons , drinking glasses , blunt instruments or fists and feet attacks.[149] In this study, interpersonal violence mostly be done with fists and feet attacks than blunt objects. [149,150] Violence was unrepressed and the attacker used whatever body part as the attack manners. [150] Mandible was the most common fracture site which was compatible with other studies. [151,152] This is because mandible was easily reachable object. The most repeatedly location of fracture line in mandible was angle fracture which was in agreement with several authors' findings.[152–154] This is because the mandibular angle had the direct effect of attack.[150] In this study, Combination of fracture sites were common in mandible especially compound fractures as a result of the clash at the mandibular body causing fractures at vulnerable sites because of the presence of canine and wisdom tooth especially in younger patients.[150] Fractures of condyle as well as alveolar bone fractures were less frequent in interpersonal violence. Condylar fractures were less frequent due to setting of victim teeth in their position during clash. Alveolar bone fracture also were less common, may be because victim turned his face away involuntary as a defensive mechanism. [150]According to several studies from different countries, the incidence of maxillofacial fractures occurred due to sports was from 5.6% to 33%.[155–161] However, in our study, 4% was only sports – related fractures. This may be due to variations of participation level in sports activities.[162] Football was the most common game associated with maxillofacial fractures in our study as in Australia, Ireland and united kingdom.[155,157,163] In this study , zygomatic bone fractures had high incidence in football accidents which was in agreement with several studies. [155,157,164] Players in sports-related accidents had facial fractures when they clashed heads with another player so midface fractures were more common than mandibular, upper and panfacial fractures. This follows the commonsense that zygomaticomaxillary complex fracture result from a direct impact on the malar eminence, which result from clash of heads with a player at a similar height. [165] However, other studies reveled that mandible was the most common facial fracture followed by zygomatic bone fracture. [158,159,166] These differences occurred due to nature of each sport.[162] The vectors of mandibular fractures are from low to high, as in the case of face against shoulder or forearm where the mandible is usually the first point of contact. Collisions of the face against the head or elbow often originate from a higher or parallel position, where the midface is usually the first point of contact. The higher incidence of mandibular fractures seen in league may be explained by the lower position from which the tackler normally starts compared with the player carrying the ball. The higher incidence of fractures of the midface in Australian rules and soccer may be explained by the contest for the ball being above the player's head, and the elbow comes down into the facial area. [167] According to this study there were 0 % of Pan-facial injuries and head injuries which is similar to united kingdom study. [168] This is mostly occur due to low impact mechanism of injury especially in football and this low impact lead to high incidence of infraorbital fracture than orbital rim fracture because orbital floor is weaker than orbital rim. [169] Work related injuries were another cause of maxillofacial injuries. In literature, there were few studies discussed work related maxillofacial trauma.[18,101,115,170–174] Work related accidents had different types as construction, farm, forestry workers accidents which were the most common causes of facial fractures[171–173,175]. In this study, construction workers had high risk of facial fractures than other jobs. Lizuka et al., [170] stated that construction workers had 15 times higher incidence of facial fractures than office and service workers. This can be explained by high physical effort in job of construction and use of tools and machines in construction work.[171,173,175] Injuries can be either by falling objects or errors in using industrial machines. Improper use or human error were the key role in construction injuries. Rasmussen's SRK model,[176]classifies human error into 3 subtypes: skill-based errors, rule based errors and knowledge-based errors. Examples of skill-based errors are slipping from one routine to another without noticing, returning to a routine at the wrong step, or a conscious control that disturbs the rhythm of the action. Rule-based errors include a failure to recognize situations, and being unable to remember a procedure. Knowledge-based errors include using inadequate mental models, tending to shift back to the routine level too soon and focusing attention on specific aspects of the problem. In the case described, the accident was caused by skill-based error. The classification can also be applied to incidents that occur in the operating theatre. Facial injuries due to work related accidents occurred anywhere but fractures due to manufacturing and construction had high severity. In our study, serious fractures happened with this type of accidents as frontal bone fractures and pan-facial fractures that involve skull base, orbital fractures or even traumatic brain injury which were similar to united kingdom study.[174] In addition, bruising, laceration and grazing were associated with facial fractures causing aesthetic problems. [174] Gunshot and explosive device injuries occurred during wars and revolutions. In our study, these injuries occurred during terrorist attacks in Sinai, and other areas of Egypt as a result of the Egyptian people overthrowing the Muslim brotherhood. There were confrontation between the army and terrorist elements. In Libya 2011, gunshot and explosive injuries had high incidence when a revolution started in Libya against old regime. There were armed quarrel between army and rebels. [177] In addition , United states had high incidence of gunshot injuries due to different reasons as easy weapon accessibility and highly civilian violence.[178] Mandible was most commonly affected facial pattern because improvised explosion devices buried within the clay so when it exploded, tiny pieces and debris were directed upward making face projections as mandible at high risk of injury.

Other fractures as Lefort I, II, frontal bone fracture also present which was similar to Boston medical center study. [178] There are various techniques of gunshot injuries which can be understood by knowing the complex interaction between different missiles and tissues. [179] When kinetic energy of missiles hits the target, it describes the maximum energy available. The energy damage within the target depends upon the velocity of missile, it's deformation ability, it's deflection and its exist velocity. Fragments of missiles lead to larger size of wound and crushed injury. [180,181] In high velocity ballistic injuries, pan-facial trauma occurred. High velocity ballistic injuries had profound impact on the face because the absorbed energy created extensive zones and contaminated areas so they produced extensive soft tissue avulsions, progressive necrosis and tissue loss which were highly complicated in reconstruction. [182,183] Miscellaneous causes of maxillofacial injuries as animal accidents or extraction of wisdom teeth were present in this study. They were extremely rare which accounted 0.86% and 0.57% respectively which were consistent with other studies. [184–186] Facial injuries occurred after coming across the animals. In this study, animal accidents affect teenagers < 20 years old because children's height, uncontrolled actions, their approach to animals. In addition, most of animals rearing were done by young boys which expose them to possible attacks from animals, which was in agreement with several studies. [185,187–191]

However, in other studies reveled that most of animal accidents occurred in second and third decade of life because of increasing participation in farming and animal agronomy in this period. [192,193] Animals were categorized according to their sizes into small and large sized animals. In Small or medium - sized animals as cats and dogs, the mechanism of injury was bite or scratch which resulting in infection transmission. On the other hand, large – sized animals associated with kicking, knocking and trampling that resulting maxillofacial fractures. [194] In this study, large sized animals as horses were the predominant cause of the facial fractures. Fracture patterns associated with animal accidents were midface, fontal bone and orbital fractures which were very serious fracture because of horse kicking with its famous hind legs. These results were in agreement with other reports. [191,194] The last cause of maxillofacial fractures in this study was extraction of wisdom teeth. Mandibular fractures associated with wisdom tooth removal were very rare which accounted only 2 cases (0.57%) in this sample. This was in agreement with several studies as in India and UK. [195–198] According to literature, the etiology of mandibular fracture during wisdom tooth extraction was multifactorial as decrease in bone elasticity by aging, ankylosis of wisdom tooth in old patients because its removal needs excessive bone gutter resulting in mandible weakening and excessive biting forces in patient with complete dentition which were transmitted to the mandible during mastication. Other reasons include fully impacted wisdom teeth that require excessive bone removal resulting in weakening of the mandible, presence of pathological lesions and prolonged healing phase. These reasons made the fracture occurred postoperatively. [199–204] In contrast, this study revealed that the mandibular fracture occurred due to improper instrumentation and application of intemperate forces to the bone during tooth removal which made the fracture occurred intra-operatively and in the angle of the mandible. This result was in agreement with a study made in Department of Oral and Maxillofacial Surgery, University of Tubingen, Germany. [200]

III. Time of admission, hospital stay and method of treatment:

In this study, most of patients (67.14%) who had maxillofacial trauma were admitted early within 2 days of incidence to operation theater to prevent fracture malunion and spread of infection. About (25.14 %) of patients had delayed admission. There were several factors affecting delayed admission as posttraumatic swelling, post traumatic edema, presence of gross infection and medical condition un-stability. Failure to resolve posttraumatic swelling and edema resulting in repair complications. Presence of gross infection increased the morbidity rate. Un stability of medical condition was the most common reason for delaying in repair. GCS which is measurement of neurologic status less than in case of le fort III or pan facial trauma. In these cases, patients suffer from vomiting, dementia, disorientation, CSF rhinorrhea to the extent of loss of consciousness which were the most common signs after facial injuries.[205–207] Therefore, delay in repair was mandatory till medical condition stability. These results were in agreement with previous studies.[76,,208] Weider et al,[209] stated that excessive posttraumatic Swelling and edema, intracranial injuries, and unstable medical condition were the greatest causes for delayed admission. In addition, patients with trauma may undergo emergency surgeries, which may lead to a delay in the treatment of facial fractures.[208] On investigating the data of hospital stay, most of our patients had short stay in hospital which was 2-3 days (83.71%) which means minimal postoperative hospital care of patients and minimal risk of infection. Long stay in hospital which was more than one week mostly present in gunshot and explosive device injuries with facial fracture patterns as panfacial trauma and lefort III fractures. These results were contradictory to study made in India where long stay was more prominent than short stay due to high incidence of panfacial and lefort III trauma.[210] In this study, most of fractures were using open reduction and internal fixation (90%) and remaining with closed reduction methods. ORIF method was used to prevent poor oral hygiene and speech difficulties. The main purpose of this approach was to restore occlusal function and esthetic appearance with maxillofacial injury patients. These results were compatible with previous studies. [210,211] In our study, miniplates were used for fixation. Behcet et al., [69] stated that miniplates enhanced early mobilization of the jaws and increased mouth opening and had less morbidity compared to closed reduction method.

IV. Study limitation and challenges

 Nasal bone fractures were limited in this study as the ENT department handles the management of these fractures according to hospital policy.

 All data from the present study were collected from different places as operating rooms, emergency rooms, and different hospitals to which they referred that needed additional effort.

 Irregular follow-up in some cases because the patient did not come to his follow-up appointment.

CONFLICT OF INTEREST

This clinical study was self-funded by the authors, with no conflict of interest.

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