Epidemiological Analysis of Zygomatic Bone Fractures in North-Western Romanian Population: A 10-Year Retrospective Study

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Abstract. *Background/Aim: Midface fractures represent a challenge for medical practitioners due to the severe esthetic and functional consequences. This study aimed to determine the causes and to provide a demographic analysis of zygomatic bone fractures in our geographical area, with a view to implementing the necessary prevention methods, training the medical staff for a certain type of patients and decreasing the required costs. Patients and Methods: A retrospective statistical epidemiological analysis of 242 patients with zygomatic bone fractures over a 10-year period was performed. Results: The most affected age group was 20-29 years (27.27%). The most affected were men (n=211, 87.19%) from urban areas (n=140, 57.85%), and without education (n=122, 50.41%). The most frequent cause was interpersonal violence (54.04%), followed by falls (17.36%) and road traffic accidents (16.53%). Conclusions: Interpersonal violence as a cause of zygomatic bone fractures is currently reaching epidemic proportions. Taking legal measures to prevent aggression is a public health emergency that would considerably decrease the incidence of these fractures in our population.*

Zygomatic bone fractures are a pathology that challenges surgeons worldwide, representing the most frequent type of midface fracture in our geographical area (1, 2). This pathology can have severe aesthetic and functional consequences, leading to marked facial asymmetry, visual disorders, associated ophthalmic lesions, limited mouth opening, as well as sensory disorders in the territory of the infraorbital nerve (3). The complexity of these fractures is

directly proportional to the etiology, direction and kinetic energy of the wounding agent, its acceleration speed change, and not least, to the surface of contact and the duration of the impact with the recipient (4, 5). The treatment of zygomatic bone fractures varies from simple conservative methods to complex surgical methods that require high medical costs (6). No allocation of necessary funds for the treatment of this type of pathophysiology can affect the postoperative outcome and favorable evolution over time, which is frequently found in developing countries (7).

The etiology of zygoma fractures is a subject of interest in the literature and is influenced by: i) the geographical region, ii) population density, iii) the level of education and iv) the environment of origin, such as the social, economic, cultural or religious status of patients (2, 7, 8). Knowing the main type of etiology, the demographic pattern and the epidemiology of this condition is extremely important in order to take prophylactic measures and redistribute financial resources in health care (8, 9). Recently, such etiological studies have been conducted both in Europe and internationally, but unfortunately, few of them refer strictly to zygomatic bone fractures, despite the increased incidence and the high resource consumption of these fractures (2, 9-11).

The aim of this study is to determine the main traumatic etiology and the epidemiology of zygomatic bone fractures in order to develop and subsequently implement methods for their prevention, in the context of the absence of studies related to this aspect in our geographical area.

Patients and Methods

For this study, the patients admitted and treated in the Oral and Maxillofacial Surgery Clinic I in Cluj-Napoca over a period of 10 years were available. During this time period, patients admitted and treated for zygomatic bone fractures were selected retrospectively. The study was approved by the Ethics Committee of Oradea University (Nr. 1237/15.10.2018). All patients included in the study signed an informed consent at the time of admission to the clinical service, by which they gave their consent for the use of their anonymized medical data for scientific purposes. The study inclusion

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Figure 1. Distribution of patients by age.

criteria were: i) presence of at least one fracture line in the zygomatic bone or its sutures, ii) an episode of acute trauma in the disease history, iii) paraclinical examinations (radiographic or computed tomographic examination) confirming the clinical diagnosis of fracture and iv) evidencing the location and characteristics of the fracture, as well as its treatment in the study host institution.

Exclusion criteria involved: i) patient without fracture lines in the zygomatic bone or its sutures, ii) zygomatic bone fractures associated with orbital fractures, iii) pathological bone fracture, iv) absence of complementary imaging investigations, v) treatment performed in another service, vi) incomplete data, and vii) presence of factors favoring the development of fractures, such as bisphosphonate treatment, osteopathies *etc.*

The data were extracted from patients' medical records, and the following variables divided into subgroups were monitored: i) sex (male/female), ii) age (divided into 10-year age-groups), iii) environment of origin (urban/rural), iv) level of education (no studies: patients having completed the 1st grade of primary school; primary school: the highest education level completed; middle school: the highest education level completed; high school: the highest education level completed; university studies: patients having graduated from a faculty), and v) traumatic etiology.

This study was approved by the Territorial Ethics Commission and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki and its later amendments (12).

The data were centralized in electronic format using Microsoft Excel software. Descriptive statistics analysis of the evaluated cases was performed with a two decimal percentage accuracy. Statistical processing was performed using the MedCalc Statistical Software version 17.2 (MedCalc Software bvba, Ostend, Belgium). Continuous data were expressed as mean and standard deviation, while nominal data were expressed as frequency and percentage. The frequencies of a nominal variable among the categories of another nominal variable were compared to one another using the chi-square test. The comparison of a continuous nominal variable between two groups was performed using the *t*-test for independent variables. A value of $p < 0.05$ was considered statistically significant.

Results

Of all patients admitted with fractures located in the zygomatic bone over the 10-year period, 242 patients met all

Figure 2. Distribution of patients depending on traumatic etiology.

the study inclusion criteria. The most affected age group was 20-29 years, followed by 30-39 years (Figure 1). The incidence of zygomatic bone fractures was higher among men (M) ($n=211$, 87.19%) compared to women (F) ($n=31$, 12.81%). The M/F ratio was 6.8:1. Patients living in urban areas ($n=140$, 57.85%) were more affected by zygomatic bone fractures than those living in rural areas ($n=102$, 42.15%). Zygomatic bone fractures had the highest incidence among patients without education ($n=122$, 50.41%), while patients with various education levels were less affected: i) primary school ($n=20$, 8.26%), ii) middle school ($n=40$, 16.53%), iii) high school ($n=41$, 16.94%), and iv) higher education ($n=19$, 7.85%). The most frequent cause of zygomatic bone fractures in our geographical area was due to interpersonal violence (IPV), followed by falls and road traffic accidents (RTA) (Figure 2).

Statistical correlation of the etiology of zygomatic bone fractures with the sex, the environment of origin and the education level of patients was performed. Men were more predisposed to zygomatic bone fractures than women, regardless of the type of etiology ($p=0.002$) (Table I). Patients from rural areas were more predisposed to fractures through interpersonal violence, animal attacks and domestic accidents, while in urban areas, patients were more predisposed to fractures through interpersonal violence, road traffic accidents or falls ($p=0.005$) (Table II). Patients without education were more predisposed to zygomatic bone fractures of all etiological categories, except for road traffic accidents, where high school graduates were predominant ($p=0.000$) (Table III). These results are statistically significant.

Discussion

Zygomatic bone fractures were found in the highest proportion in the 20-29 age group, in accordance with the

Table I. Distribution of the types of traumatic etiology depending on gender.

Gender	Etiology							Total
	IPV	RTA	Domestic accident	Sports injury	Work accident	Fall	Animal attack	
Female	6	13	1	0	1	7	3	31
	5.7%	32.5%	6.3%	0.0%	20.0%	16.7%	15.0%	12.8%
Male	101	27	15	12	4	35	17	211
	94.3%	67.5%	93.8%	100.0%	80.0%	83.3%	85.0%	87.2%
Total	107	40	16	12	5	42	20	242
p=0.002	100%	100%	100%	100%	100%	100%	100%	100%

IPV: Interpersonal violence; RTA: road traffic accident.

Table II. Distribution of the types of traumatic etiology depending on the environment.

Environment	Etiology							Total
	IPV	RTA	Domestic accident	Sports injury	Work accident	Fall	Animal attack	
Rural	40	15	11	2	2	18	15	103
	36.8%	37.5%	68.8%	16.7%	40.0%	42.9%	75.0%	42.6%
Urban	67	25	5	10	3	24	5	139
	63.2%	62.5%	31.3%	83.3%	60.0%	57.1%	25.0%	57.4%
Total	107	40	16	12	5	42	20	242
p=0.006	100%	100%	100%	100%	100%	100%	100%	100%

IPV: Interpersonal violence; RTA: road traffic accident.

results from other studies (3, 4, 9, 13-19). This is due to the fact that during this period of life, individuals are more socially, culturally, and physically active, making them more exposed to risks factors through their actions (13-19). Another favoring factor, which cannot be neglected and is specific to this age group, is alcohol consumption (20). Additionally, high-speed driving by young and inexperienced drivers, often predisposed to overlooking or deliberately disregarding the traffic rules, can result in higher numbers of road traffic accidents (21).

The current study indicates a low incidence of zygomatic bone fractures in the first decade of life. This result is confirmed by other studies and explained by the fact that at this age, parental supervision is greater and the anatomical particularities of children, such as bone suture elasticity and incomplete pneumatization of paranasal sinuses make the bone more malleable and allow it to better absorb traumatic shocks (14, 21-23).

The predominance of the male sex among patients with zygomatic bone fractures is also found in other studies (3, 9-11, 13, 15, 16-19, 22, 24). From a behavioral point of view, it is known that men are more aggressive and more conflicting than women, and as a consequence they are more predisposed to trauma (25). Professionally and socially, men are more frequently involved in physical, agricultural work

or extreme sports (21, 22). In this context, they are more susceptible to experience maxillofacial fractures following work accidents, sports injuries or animal attacks compared to women (21-25). This is precisely why increased male:female ratios are noteworthy in regions such as Saudi Arabia [7.7:1 (11) or 8:1 (26)], where women are forbidden from participating in many social activities, as well as driving (27). In contrast, in countries, such as Norway (15) or Switzerland (9), where women are not banned from participating in social activities, the sex ratios in the case of zygomatic bone fractures decrease.

Regarding the environment of origin, our results are in accordance with those of the literature, as increased incidence of zygomatic bone fractures in urban areas are also reported by other authors (2, 3, 28-30). The elevated population density in cities, the advanced infrastructure with highways allowing high-speed circulation of vehicles, the marked discrepancies between social classes compared to a rural environment are concurrent factors that increase the risk of trauma in urban areas (28-31). Contrary to our studies, Smith H. *et al.* (32) have reported a higher frequency of zygomatic bone fractures in rural areas. However, the authors confirm that the unit where the study was conducted serves multiple rural regions. It should be noted that in our study there was a high incidence of interpersonal violence in

Table III. Distribution of the types of traumatic etiology depending on the level of education.

Level of education	Etiology							Total
	IPV	RTA	Domestic accident	Sports injury	Work accident	Fall	Animal attack	
No education	59	15	10	5	2	24	7	122
	46.7%	38.5%	71.4%	41.7%	40.0%	63.2%	36.8%	48.1%
Primary school	8	1	0	0	0	2	9	20
	6.7%	2.6%	0.0%	0.0%	0.0%	5.3%	47.4%	8.6%
Middle school	19	5	3	3	1	7	2	40
	18.1%	12.8%	21.4%	25.0%	20.0%	18.4%	10.5%	17.2%
High school	17	16	0	2	1	4	1	41
	17.1%	41.0%	0.0%	16.7%	20.0%	10.5%	5.3%	18.0%
University studies	12	2	1	2	1	1	0	19
	11.4%	5.1%	7.1%	16.7%	20.0%	2.6%	0.0%	8.2%
Total	107	39	14	12	5	38	19	242
$p=0.000$	100%	100%	100%	100%	100%	100%	100%	100%

IPV: Interpersonal violence; RTA-road traffic accident.

both urban and rural areas. This is quite rarely found in the literature (14, 28).

The majority of zygomatic bone fractures were registered for patients without education, which has been reported by other authors as well (33-35). The lack of education or a higher qualification predisposes to unemployment, a low social status, material deficiencies, and limited access to health care services (33). All this leads to frustration, predisposing this category of patients to conflicts or interpersonal violence and implicitly, to cervicofacial trauma (36). Higher education can provide, in addition to a superior social status, health education for the prevention of diseases through an adequate diet, a balanced lifestyle and an awareness of social, cultural and legislative norms (34-37). All these contribute to a decrease in the risk of exposure to trauma (36). The literature reports extremely low incidences of zygomatic bone fractures due to interpersonal violence among patients with higher education (34, 36).

The great number of zygomatic bone fractures through aggression can be explained by the prominence of the zygomatic bone, which is exposed to direct blows to the face (2). Interpersonal violence as a main etiological factor has been identified in other epidemiological studies conducted in: Brazil (27), Bulgaria (2, 37), Norway (2, 14), Sweden (38), Italy (3), and USA (10). Boffano P *et al.* (2) have reported in their EURMAT study, in collaboration with multiple centers in Europe, that interpersonal violence is the main etiology among zygomatic bone fractures in Serbia, Ukraine, Estonia and UK (2). Hallmer F. *et al.* (38) have also reported that the number of interpersonal violence injuries exceeds that of road traffic injuries. Some authors maintain that the predominance of zygomatic bone fractures in developed countries can be caused by interpersonal conflicts resulting from frustration secondary to the great differences between social classes or

by the wide access of the population to alcohol (2, 3, 10, 38). Many literature studies consider that there is an interrelation between alcohol consumption and aggression (2, 15, 39, 40). A proof is represented by Arab countries, where the wide limitation of access to alcoholic beverages leads to a reduced number of interpersonal violence injuries (11, 13). According to the EURMAT study (2), in other European countries, such as France, Netherlands and Croatia, the main etiology of zygomatic bone fractures is represented by falls. This etiology is also found in other regions, such as Switzerland (9), Brazil, the Sao Paulo area (41, 42), and Israel (43). The incidence of zygomatic bone fractures through falls can be attributed to population aging (2-4). Another aspect that should not be overlooked is the possibility that injuries from falls may be secondary to undeclared aggression, or the possible deliberate misreporting of aggression as a fall for various personal reasons or out of fear (2, 3, 10, 11, 13-14, 25-31).

In contrast, zygomatic bone fractures due to road traffic accidents are predominant in other regions: Saudi Arabia (11, 12), Malaysia (23), South Korea (16), India (17), China (4), Iran (19), Nigeria (44), Uganda (45). Road traffic accidents are predominant in developing countries where there are no well-defined traffic rules, such as the obligation of wearing a seatbelt, special equipment for motorcycles or a helmet for bicycles (11, 13-17, 44-47). However, road traffic accidents are also predominant in developed countries with a high population density and a great number of vehicles, leading to a statistically higher risk of road traffic accidents (4, 16, 17, 44, 45). The well-defined traffic rules in Romania are responsible for the limited zygomatic bone fractures caused by road traffic accidents. One thing to mention concerning our results is the fact that here we excluded patients with associated orbital wall fractures, as it is known that the high kinetic energy in the case of road traffic accidents

predisposes to complex zygomatico-orbital or panfacial fractures (4, 16, 17, 44, 45). The exclusion of these patients from the study explains the low rate of road traffic accidents. Zygomatic bone fractures from animal attacks or domestic accidents were found in low numbers in our study and were representative of the rural environment. This is also in line with the literature (14, 28).

Demographic and epidemiological analyses are extremely important in a given territory, providing vital indicators for the organization of financial resources pertaining to a particular type of trauma, the estimation of expenses for collaboration with national health insurances, the training of ambulatory care staff to collaborate with a certain type of patients and, most importantly, the implementation of norms for the prevention of the pathology concerned. We consider this study to be extremely important in the context of the absence of data in Western Romania regarding the epidemiology of zygomatic bone fractures and maxillofacial injuries in general. In this context, the data obtained are representative and have a scientific and clinical impact.

Nevertheless, the current study has a series of limitations. The most important limitation results from the retrospective nature of the research, the data collected from medical records depending on the accuracy with which they were registered and under the standard that they were presented at the time. Another limitation is derived from patients' ability or wish to report incorrect data in order to avoid legal consequences.

In conclusion, the main cause of zygomatic bone fractures in Western Romania is interpersonal violence. The distribution area of interpersonal violence is large, reaching epidemic proportions in both urban and rural environments. The major risk category is represented by men without education, during the third decade of their life. Implementing laws to increase the criminal liability of the aggressor, as well as educating the population would rapidly decrease the number of zygomatic bone fractures in Romania.

Conflicts of Interest

The Authors declare no conflicts of interest.

Authors' Contributions

Conceptualization, research, methodology and writing of the original draft was done by TPA; Formal analysis and data curation was done by RIJ; JM validated the data, reviewed and edited the manuscript and supervised the study.

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