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EPIDEMIOLOGICAL STUDY OF ZYGOMATIC BONE FRACTURES: A FIVE-YEAR RETROSPECTIVE ANALYSIS OF A SINGLE-CENTER EXPERIENCE

EPIDEMIOLOŠKA STUDIJA PRELOMA ZIGOMATIČNE KOSTI: PETOGODIŠNJA RETROSPEKTIVNA ANALIZA U OKVIRU JEDNE INSTITUCIJE

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Summary
Introduction. Zygomatic bone fractures are prevalent in the maxillofacial region. This study aims at analyzing the epidemiology and clinical presentation of isolated zygomatic bone fractures. **Material and Methods.** The retrospective study, conducted at the Clinic of Maxillofacial Surgery of the University Clinical Center of Vojvodina, included 128 patients diagnosed with isolated zygomatic bone fractures. The following parameters were taken into consideration: gender, age, trauma etiology, clinical presentation, computed tomography analysis of the fracture localization and pattern. The fractures were classified into five groups according to Zingg classification system. **Results**. The study included patients aged 10-82 divided into four groups, with the most affected group being 30-49 years old. Men were more often treated for zygomatic bone fractures (male: female ratio 3:1). Left-sided fractures of the zygomatic bone occurred more often (55.2%) than the right-sided ones. Type B was the most common type of fracture, while the zygomaticomaxillary buttress fracture was the most common injury. Early treatment was administered in 78 patients (60.94%), while 50 patients (39.06%) underwent delayed reconstruction. The analysis of complications concerning the time of surgical intervention revealed a higher incidence of ectropion in cases treated early, while infraorbital paresthesia and facial asymmetry were more prevalent in cases treated late. **Conclusion**. Zygomatic bone fractures have high morbidity risk, and may cause temporary incapacity to work, and potentially permanent and functional damage.
Key words: Zygomatic Fractures; Fractures, Bone; Facial Bones; Epidemiology; Risk Factors; Surgical Procedures, Operative; Postoperative Complications

Sažetak
Uvod. Prelomi zigomatične kosti spadaju u najčešće prelome u maksilofacijalnoj regiji. Studija koju predstavljamo ima za cilj da analizira epidemiološke karakteristike i kliničku sliku preloma zigomatične kosti. **Materijal i metode.** Retrospektivna studija koja je sprovedena na Klinici za maksilofacijalnu hirurgiju Univerzitetskog kliničkog centra Vojvodine u Novom Sadu uključila je 128 bolesnika sa dijagnostikovanim izolovanim prelomima zigomatične kosti. U obzir su uzeti sledeći parametri: pol, starost, etiologija traume, klinička slika, nalaz kompjuterizovane tomografije, analiza lokalizacije preloma i obrazac preloma. Prelomi su klasifikovani u pet grupa korišćenjem Zingove klasifikacije (*Zingg classification*). Dobijeni podaci su analizirani pomoću statističkog paketa SSPS20. **Rezultati**. Studijom su obuhvaćeni bolesnici starosti 18−82 godine podeljeni u četiri grupe, pri čemu je prelom najučestaliji bio u grupi 30−49 godina. Muškarci su češće pogođeni od žena (odnos muškarci žene 3 : 1). Levostrani prelom se javljao češće (55,2%) nego desnostrani. Najčešći tip preloma je prelom tipa B, dok je najčešće bila povređena zigomatičnomaksilarna sutura. Imedijentno lečenje primenjeno je kod 78 bolesnika (60,94%) dok je kod 50 bolesnika načinjena odložena rekonstrukcija. Analizom komplikacija u pogledu vremena hirurške intervencije utvrđena je veća incidencija ektropiona kod rano lečenih slučajeva dok su infraorbitalne parestezije i asimetrija lica bile češće kod bolesnika koji su lečeni odloženo. **Zaključak**. Prelomi zigomatične kosti imaju visok morbiditet, izazivaju privremu nesposobnost za rad, a potencijalno i trajna funkcionalna i estetska oštećenja.
Ključne reči: prelomi zigomatične kosti; prelomi kosti; kosti lica; epidemiologija; faktori rizika; operativne hirurške procedure; postoperativne komplikacije

Introduction

The zygomatic bone is integral to the maxillofacial skeleton, that is, the structure of the floor and the lateral wall of the orbital cavity, and the zygomatic arch. Malar eminence is the most prominent part of the zygomatic region, which defines the facial appearance [1]. The position of the zygomatic

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bone in the facial region is exposed to different forces, which makes it the second most frequently injured facial bone, following the mandible. Since the bone itself comprises a pair of quadrangular bones with three sides, four edges and three processes, the zygomatic bone attaches to the skull through these processes (temporal, frontal and maxillary and posteromedial edge of the bone). Typically, these structures are fractured individually as single-process fractures or collectively as classic tetrapod fractures [1].

The etiology of zygomatic bone fractures includes factors such as traffic accidents, assault, falls, sport-related injuries and work-related injuries. The predominant etiological causes of fractures vary in different geographical areas [2]. Socioeconomic, cultural and lifestyle factors have a significant influence on these variations.

The zygomatic bone fractures have a classical clinical appearance, potentially causing facial asymmetry, deformity of the midface, sensory disturbance, occlusion disruptions, and disturbance in ocular function. Diagnosis is based on anamnesis, clinical findings and imaging (plain radiography, computed tomography, ultrasound or nuclear magnetic resonance) [2, 3]. Early diagnosis, accurate evaluation and timely intervention are crucial for perfect treatment.

This study aims at analyzing retrospectively the epidemiology and clinical presentation of isolated zygomatic bone fractures treated at the Clinic of Maxillofacial Surgery, University Clinical Center of Vojvodina, Novi Sad.

Material and Methods

Study design and population: The retrospective study was conducted on patients treated at the Clinic of Maxillofacial Surgery, University Clinical Center of Vojvodina, Novi Sad from January 1, 2017, to December 31, 2022 (duration of five years).

Inclusion criteria: The study included all patients older than 18 with isolated zygomatic bone fractures.

Exclusion criteria: Patients with isolated zygomatic arch fractures, other facial bone fractures, and patients with incomplete data records were excluded.

The study was approved by the Ethical Committee of the University Clinical Center of Vojvodina.

All patients signed their informed consent for participation in the study.

Parameters: Data were collected from medical records focusing on the following parameters: gender, age, etiology of trauma, clinical presentation, computed tomography (CT) analysis of the fracture site, and fracture pattern.

Classification: Fracture sites were classified according to Zingg zygomatic fracture classification system into five groups (A1, A2, A3, B, C). A1 is isolated zygomatic arch fracture, A2 is the separation of frontozygomatic suture, A3 indicates infraorbital separation, B represents monofragment type with a fracture on all sites of articulation and C signifies multifragment fractures [4].

Ophthalmic examination: Preoperative ophthalmic examination included the assessment of visual activity and evaluation of extraocular muscle movements.

Surgical technique: All patients underwent surgery under general anesthesia, and the time of surgery was determined individually based on clinical findings (presence of edema, periorbital hematoma). The surgery was categorized as early treatment (12-24 hours after injury) or delayed (up to two weeks after injury).

Preoperative medication (antibiotics, analgesics) was administrated and continued postoperatively for ten days.

Statistical analysis: data were analyzed using the Statistical Package for Social Science (SPSS) version 20. The Chi-square test was used to compare qualitative variables (p-value < 0.05).

Results

A total of 128 patients were included in the study, ranging in age from 15 to 78 (mean age of 43.2 SD±18.2). The patients were divided into four groups: I (18-29), II (30-49), III (50-69), IV (80+). The study included 96 males and 32 females, with male to female ratio 3:1 **(Graph 1)**.

Assault was the primary cause of trauma, showing the age-related correlation. In age groups I and II, assault was the main cause of injury, while falls prevailed in the age group III. Gender analysis showed that females are more susceptible to injury when falling, while males are mostly injured in assaults **(Graph 2)**.

Clinical presentation of fractures included epistaxis, subconjunctival bleeding and palpable step-off in most cases **(Table 1)**.

In addition to clinical examination, CT and posterior-anterior radiography (occipitomental-Waters view) were used for the evaluation of the patients. The fractures occurred more frequently on the left side (54.68%) compared to the right side (45.31).

Our study excluded isolated zygomatic arch fractures because of their specificity. Types A3 and B fractures were predominant, with the zygomaticomaxillary buttress being the most commonly affected site (in 96 cases) **(Graph 3)**.

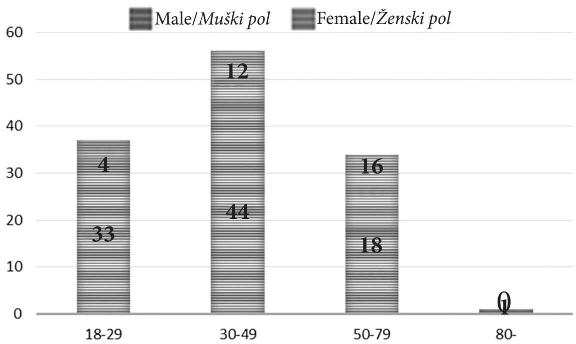
In the study, early treatment was administered to 78 patients (60.94%), while delayed reconstruction was performed in 50 patients (39.06%) because of the local status (facial edema, general condition, etc.).

Different surgical approaches were used for zygomatic bone fracture treatment: upper buccal approach (64.84%), lateral eyebrow approach (27.34%), subciliary approach (21.09%) and transcutaneous approach (33.59%) **(Table 2)**.

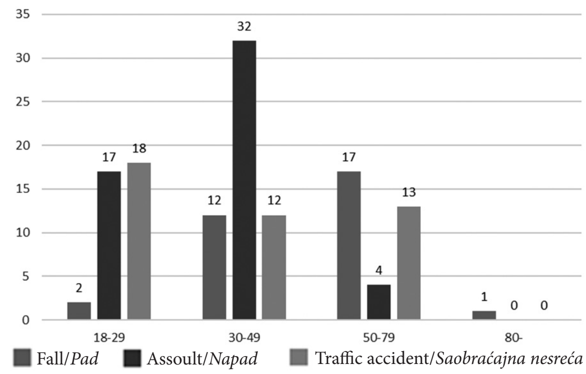
During the follow-up period of six months, all complications were documented: infraorbital paresthesia (29.68%), ectropion (7.81%), enophthalmos (0.78%), diplopia (1.56%) and facial asymmetry (3.90%) **(Graph 4)**. Analysis of complications concerning the time of surgical intervention showed a higher incidence of ectropion in cases treated earlier

Table 1. Clinical presentation of zygomatic bone fractures
Tabela 1. *Klinička prezentacija preloma zigomatične kosti*

Clinical presentation/*Klinička prezentacija*	Number of patients/*Broj bolesnika*	Percentage/*Procenat*
Facial asymmetry/*Facijalna asimetrija*	84	65.62%
Depression of malar eminence/*Depresija malarne eminencije*	65	50.78%
Subconjunctival hemorrhage/*Subkonjuktivalno krvarenje*	114	89.06%
Periorbital hematoma/*Periorbitalni hematom*	85	66.40%
Antimongoloid position of the eye/*Antimongoloidni položaj oka*	75	58.59%
Diplopia/*Diplopija*	9	7.03%
Limited mouth opening/*Ograničeno otvaranje usta*	14	10.93%
Malocclusion/*Poremećaj okluzije*	56	43.75%
Paresthesia/*Parestezija*	62	48.43%
Epistaxis/*Epistaksa*	124	96.87%
Palpable step-off/*Palpabilan koštani stepenik*	96	75%



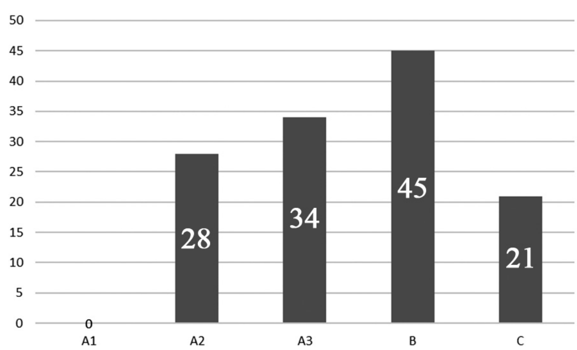
Graph 1. Gender and age distribution of zygomatic bone fracture
Grafikon 1. *Polna i starosna distribucija preloma zigomatične kosti*



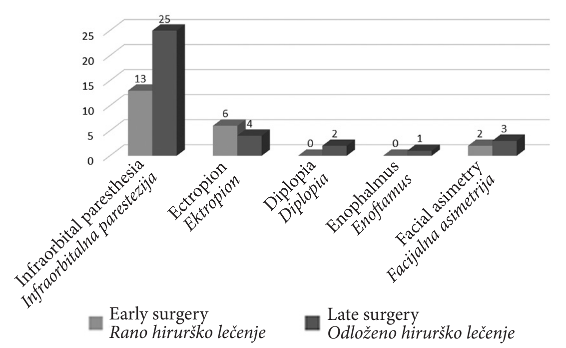
Graph 2. Etiological distribution of zygomatic bone fractures
Grafikon 2. *Etiološka distribucija preloma zigomatične kosti*

Table 2. Surgical approach used for zygomatic bone fracture treatment
Tabela 2. *Hirurški pristup korišten za lečenje preloma zigomatične kosti*

Surgical approach/*Hirurški pristup*	Number of patients/*Broj bolesnika*	Percentage/*Procenat*
Upper buccal approach/*Gornji bukalni pristup*	83	64.84%
Lateral eye brow approach/*Lateroorbitalni pristup*	35	27.34%
Subciliary approach/*Subcilijarni pristup*	27	21.09%
Transcutaneous approach/*Transkutani pristup*	43	33.59%



Graph 3. Zygomatic bone fractures classification according to Zyngg classification system
Grafikon 3. *Klasifikacija preloma zigomatične kosti prema Zingovoj klasifikaciji*



Graph 4. Postoperative complications in early and delayed surgical bone repairs
Grafikon 4. *Postoperativne komplikacije kod rano operisanih i odloženih hirurških repozicija*

and infraorbital paresthesia and facial asymmetry in cases treated late. Diplopia and enophthalmos had equivocal outcomes in both early and late treatments.

Discussion

The middle-aged (30-49) male population was most frequently affected by zygomatic bone trauma, potentially attributed to high activity levels and outdoor occupations in this period of their life. Male predominance can be explained by the lifestyle, in which case it can be concluded that the male population is more exposed to trauma than the female population. The male-to-female ratio in our study was similar to other studies in Europe, while the studies in Asia and Africa showed a higher ratio [5, 6].

The assault was the main cause of trauma in the age groups I and II, predominantly in the male population. In age group III, falls were the main cause of trauma, potentially due to the patients' age and changes in the quality of life.

Traffic accidents (motor vehicle accidents) were the most frequent etiology factor in the age group 18-29 in the study and it was more often in the age group II than in others. This trend can be explained by the inexperience of traffic participants, especially young drivers [7].

Our study revealed that fracture of the left zygomatic bone was more frequent than fracture of the right zygomatic bone, especially in the cases of assault-related fractures. This can be explained by the observation that a right-handed attacker hits directly the left half of the victim's face, which is consistent with our study, with the assault being the main cause of injury.

The zygomaticomaxillary buttress was the most common fractured site in our study, differing from other studies where zygomaticofacial suture was the most common site of injury [4, 8].

Fractures are differently classified in various studies. In our study, we used Zingg modified method of classification because it was the most applicable one [3, 4]. Type B was the most common type of fracture, which is a classic tetrapod fracture and the most common type in some studies [9].

The surgical approach used for bone repair depended on the fracture localization and type, and it was selected to provide maximal visualization of fracture sites and minimal complications (pain, nerve injuries, cosmetic deformities, etc.) [10, 11]. In our treatments, we used upper buccal and transcutaneous approaches, which were selected based on the surgeons' experience, clinical findings and radiological findings. The early repair was done in most cases to ensure adequate bone repairs.

Complications following zygomatic bone fracture treatment are not very often. Infraorbital paresthesia was reported as the most common complication in our study, aligning with the existing studies [12]. Buccal paresthesia was a direct consequence of infraorbital nerve affection. In our study, 48.42% of patients were diagnosed with infraorbital nerve paresthesia preoperatively and 29.68% after reduction. Proper reduction of the fracture and decompression of the infraorbital nerve were important in the recovery of sensory disturbance. Postoperative paresthesia of the infraorbital nerve could also result from improper fracture reduction or severe injury of the nerve. Six months after surgery, most of our patients recovered from infraorbital paresthesia. However, Folkestadt and Grandström showed in their study that recovery of neurosensory affection of infraorbital nerve could take up to one year, and some patients could still have infraorbital nerve paresthesia despite proper reduction [13].

Postoperative enophthalmos can be caused by periorbital fat atrophy, and one case was detected in our study, which possibly occurred after delayed surgery [14].

In our study, 7.03% of patients had preoperative diplopia, while postoperative diplopia was detected in 1.56%. A study conducted by Calderoni shows that 7.01% of patients had persisting diplopia after treatment, and a study conducted by Zigg et al. states that diplopia persisted in 17% of cases and enophthalmos in 11% of cases [4]. In our study, the percentage was significantly lower, but we did not consider the orbital 'blowout' fractures, in which cases diplopia is a common symptom, and we focused on isolated zygomatic bone fractures only.

Postoperative ectropion was reported in 7.81 cases, with a higher frequency in late surgical repairs. The ectropion was caused due to subciliary incision leading to the formation of a hypertrophic scar. Anti-scar treatment was used for the ectropion repair. The incidence of ectropion due to surgical incision varied [15].

Surgical delayed repairs may be useful if we consider that surgical incision can be better planned in pre-existing skin creases after the resolution of soft tissue edema. However, delayed reparation increases the difficulty in manipulating the bone fragments due to callus formation, which can cause inadequate fracture reduction [16].

Our study showed relatively different complications in early and late repairs. Diplopia and enophthalmos were similar in both types of repairs, while ectropion was more prevalent in early repairs and infraorbital paresthesia and facial asymmetry in late repairs [17, 18].

Some studies show that there was no significant association between early or delayed repairs, and no statistically significant correlation was found between postoperative complications and the time of operation [19, 20].

The limitation of our study was its retrospective character. This can be overcome by recording a large number of patients who can be evaluated retrospectively. Inadequate data records were another limitation, which was the reason why many cases were excluded from the study.

Conclusion

Zygomatic bone fractures are one of the most common maxillofacial injuries resulting mainly from assault and traffic-related injuries, and they significantly impact the young population, leading to temporary work incapacity due to injuries and surgical treatment. This fact has important socioeconomic significance. Epidemiological studies need larger datasets to achieve more precise evaluation. Conducting a detailed multicentric study is crucial for legal and therapeutic strategies in our region.

References

1. Abdullah K, Shahzad M, Bhangwar AW, Hassan SG, Panjabi SK. Isolated zygomatic bone fracture: assessment of outcome by two point fixation. Professional Medical Journal. 2020;27(2):246-50.
2. Trivellato PF, Arnez MF, Sverzut CE, Trivellato AE. A retrospective study of zygomatico-orbital complex and/or zygomatic arch fractures over a 71-month period. Dent Traumatol. 2011;27(2):135-42.
3. Khan TU, Rahat S, Khan ZA, Shahid L, Banouri SS, Muhammad N. Etiology and pattern of maxillofacial trauma. PLoS One. 2022;17(9):e0275515.
4. Zingg M, Laedrach K, Chen J, Chowdhury K, Vuillemin T, Sutter F, et al. Classification and treatment of zygomatic fractures: a review of 1,025 cases. J Oral Maxillofac Surg. 1992;50(8):778-90.
5. Gomes PP, Passeri LA, Barbosa JR. A 5-year retrospective study of zygomatico-orbital complex and zygomatic arch fractures in Sao Paulo State, Brazil. J Oral Maxillofac Surg. 2006;64(1):63-7.
6. Emodi O, Wolff A, Srouji H, Bahouth H, Noy D, Abu El Naaj I, et al. Trend and demographic characteristics of maxillofacial fractures in level 1 trauma center. J Craniofac Surg. 2018;29(2):471-5.
7. Ajike SO, Adebayo ET, Amanyiewe EU, Ononiwu CN. An epidemiologic survey of maxillofacial fractures and concomitant injuries in Kaduna, Nigeria. Nigerian Journal of Surgical Research. 2005;7(3-4):251-5.
8. Brucoli M, Boffano P, Broccardo E, Benech A, Corre P, Bertin H, et al. The “European zygomatic fracture” research project: the epidemiological results from a multicenter European collaboration. J Craniomaxillofac Surg. 2019;47(4):616-21.
9. Schaffar R, Belot A, Rachet B, Woods L. On the use of flexible excess hazard regression models for describing long-term breast cancer survival: a case-study using population-based cancer registry data. BMC Cancer. 2019;19(1):107.
10. Chu H, Chu Y, Xu X. Minimally invasive treatment with zygomatic complex fracture reduction by percutaneous bone hook traction. J Oral Maxillofac Surg. 2021;79(7):1514-27.

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11. Nalić B, Mijatov I, Mijatov S. Epidemiology of lower jaw fracture in patients treated at the Department of Maxillofacial and Oral Surgery of the Clinical Centre of Vojvodina. Med Pregl. 2013;66(7-8):322-5.
12. Rizvi A, Khan I, Snee D, Bruzual L. Zygomatic complex fractures in the emergency department: diagnosis and management. Emerg Nurse. 2021;29(6):20-4.
13. Folkestad L, Granström G. A prospective study of orbital fracture sequelae after change of surgical routines. J Oral Maxillofac Surg. 2003;61(9):1038-44. Erratum in: J Oral Maxillofac Surg. 2003;61(11):1375.
14. 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(8):593-9.
15. da Hora Sales PH, Vasconcelos RB, Papaléo RF, de Freitas Silva L, da Silveira Santos DF. Aesthetic approaches in complex fractures of the zygomatic bone. Minerva Stomatol. 2019;68(1):59-60.
16. Wang HD, Dillon J. Contemporary management of zygomaticomaxillary complex fractures. Semin Plast Surg. 2021;35(4):256-62.
17. Zhang Q, Wang B, Zhang S, Ma D. The value of intraoperative computed tomography in the treatment of zygomatic complex fractures. J Oral Maxillofac Surg. 2023;81(11):1372-82.
18. Mishra P, Khan P, Salunkhe SM, Pendyala SK, Mathur M, Ummadisingh L, et al. Factors affecting quality of life in zygomatic fractures: an original research. J Pharm Bioallied Sci. 2022;14(Suppl 1):S242-4.
19. Long L, Douglas J, Morton M, Carter L, Parmar J. Success of day-case treatment of zygomatic and orbital fractures. Br J Oral Maxillofac Surg. 2022;60(4):470-4.
20. Rahman RA, Ghazali NM, Rahman NA, Pohchi A, Razak NHA. Outcome of different treatment modalities of fracture zygoma. J Craniofac Surg. 2020;31(4):1056-62.