Journal of Current Research in Oral Surgery
2025, Volume 5, Issue 1, Page No: 202-207

Available online at: www.tsdp.net

ISSN: 3062-3480

Original Article

Incidence, Pattern, and Treatment Outcomes of Zygomaticomaxillary Complex Fractures: A Retrospective Institutional Study

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Received: 27 February 2025; **Revised:** 26 May 2025; **Accepted:** 29 May 2025

ABSTRACT

Fractures of the zygomatic complex are among the most common injuries to the facial skeleton. Numerous therapeutic approaches for addressing these fractures have been documented in the scientific literature. To assess the frequency, patterns of injury, associated complications, and therapeutic approaches for zygomatic complex fractures at a single center. Information on 100 individuals with zygomatic complex fractures was gathered retrospectively. Details, including causation, fracture location, classification, concomitant injuries, clinical presentation, management via conservative or operative means, incision types employed, quantity of fixation points used, and any complications arising, were examined and evaluated. Interpersonal violence emerged as the leading cause of zygomatic complex fractures, impacting patients in the 20–40 and over 60 years age brackets with equal frequency. Non-displaced fractures were successfully managed with conservative measures. When operative intervention was indicated, fixation protocols varied, using one-, two-, or three-point fixation based on fracture displacement and severity. Significantly, our findings revealed that variables such as age, sex, or injury mechanism did not have a marked effect on the incidence of paraesthesia either before or after treatment. Ultimately, treatment selection should be tailored to the unique fracture configuration and the patient's individual needs to achieve the best possible results.

Keywords: Zygomaticomaxillary complex fractures, ZMC, Treatment strategies, Surgical management, Complications, Paraesthesia

How to Cite This Article: Tanaka H, Sato Y, Mori K, Okabe R, Ito T. Incidence, Pattern, and Treatment Outcomes of Zygomaticomaxillary Complex Fractures: A Retrospective Institutional Study. J Curr Res Oral Surg. 2025;5(1):202-7. https://doi.org/10.51847/mS0x7D7xPT

Introduction

Injuries to the midface pose a considerable challenge for clinicians owing to their profound aesthetic and functional repercussions. Fractures of the zygomatic bone represent a surgical pathology that tests practitioners globally, constituting the most frequent midface fracture type in our region [1, 2]. They rank second among mid-facial fractures, accounting for approximately one-quarter of all craniofacial bone injuries [3]. The intricacy of these fractures is directly linked to the causative mechanism, the direction and kinetic force of the impacting agent, its rate of acceleration change, and, significantly, the contact surface area and the duration of impact upon the recipient. Such fractures typically result from events such as traffic collisions, falls, or physical aggression. The zygomaticomaxillary complex not only confers structural integrity but is also crucial in determining facial appearance by contouring the midfacial breadth and emphasizing malar prominence [4]. Clinically, individuals sustaining zygomatic complex fractures commonly exhibit symptoms including double vision (diplopia), globe recession (enophthalmos), subconjunctival hemorrhage (ecchymosis), malar flattening, occlusal disturbance (gagging of occlusal contacts), and neurosensory deficits. Edema in the

midfacial area can also result in conspicuous cosmetic disfigurement [5]. A frequent neurological manifestation is altered sensation within the distribution area of the infraorbital nerve.

Therapeutic options for zygomatic complex fractures span from non-operative observation to surgical reconstruction. Minimally displaced fractures lacking functional impairment are generally handled conservatively. Operative management is typically mandated when fractures exhibit displacement, instability, or comminution into multiple fragments [6]. Over 70% of these fractures are treated surgically, typically with open reduction and internal fixation [7]. The management of zygomatic complex fractures is a multifaceted challenge, as these injuries often involve both the maxilla and the zygomatic bone, integral components of the midface. The primary objective is to reinstate accurate three-dimensional positioning and stability, while concurrently managing any concurrent damage to the infraorbital rim and orbital floor [8, 9]. The literature describes a variety of surgical approaches and fixation constructs, selected based on the extent and severity of the fracture and the presence of orbital floor involvement. Each method possesses distinct advantages and drawbacks [8, 9]. Common fixation hardware includes external pins, lag screws, Kirschner wires, transosseous wiring, mini dynamic compression plates (DCP), miniplates, and microplates [10, 11]. Despite the frequent occurrence of these injuries, a unified treatment algorithm remains absent among maxillofacial surgeons. Furthermore, there is a scarcity of thorough research examining the incidence, fracture configurations, and optimal treatment protocols for these injuries. The present investigation intends to address this deficiency by assessing the frequency, fracture patterns, complications, and management strategies for zygomatic complex fractures at a single center.

Materials and Methods

The current retrospective analysis was performed at a single center, Dr. D.Y. Patil Dental College and Hospital, located in Pimpri, Pune, India. Information was retrospectively compiled for 100 patients aged 20 years or older, all of whom had been clinically and radiographically identified with fractures of the zygomaticomaxillary complex and received treatment within the timeframe spanning July 2020 to July 2025. Ethical committee approval from Dr. D.Y. Patil Dental College and Hospital, Pimpri, Pune, India, was secured before the study was launched (DYPDCH/DPU/EC/583/193/2023).

The records were examined and evaluated for parameters encompassing causative factors, the precise anatomical location of the zygomaticomaxillary complex fracture, fracture categorization, accompanying injuries, presenting clinical signs, whether care involved conservative measures or operative procedures, the specific incisions utilized, the quantity of fixation points applied, and any ensuing complications.

Results and Discussion

One hundred individuals with zygomaticomaxillary complex fractures were enrolled in this investigation. From this cohort, 34 participants were in the 20–40 and over-60 age categories, whereas 32 were in the 41–60 age category. The study population's average age was calculated at 52.38 ± 18.07 years **(Table 1).** The sample comprised an even split of 50 male and 50 female participants **(Figure 1).** Assaults and interpersonal violence were cited as the primary mechanism of injury for 40 subjects, followed closely by other forms of trauma in 37 cases, with falls accounting for the remaining 23 subjects **(Figure 2).** Fractures involving the frontozygomatic buttress combined with buttress fractures of the maxilla (infraorbital) were the most widespread, detected in 25% of the sample, with isolated zygomatic arch fractures found in 24%. The fracture configuration encompassing FZ + Buttress + maxillary (infraorbital) + arch was encountered least often, appearing in only 7% of patients **(Table 2).** A non-surgical, conservative approach was chosen for 18% of patients, while the remaining 82% were treated surgically; within the surgical group, single-point fixation (18%) and three-point fixation (17%) were the predominant techniques **(Table 3; Figure 3).** The pre- and post-intervention rates of paraesthesia were contrasted using the McNemar test in **Table 4**. Before any operation, paraesthesia was present in 18 individuals. Following the corrective procedure, the same number, 18 individuals, reported the symptom. The difference in paraesthesia incidence between pre- and post-procedure did not reach statistical significance. **Table 5** presents an analysis of post-surgical paraesthesia across the designated age brackets via the Chi-square test. After the surgery, an equal number of six instances of paraesthesia were recorded within each of the three age groups. The analysis revealed no significant difference in post-surgical paraesthesia rates across age cohorts**. Table 6** details the comparison of post-surgical paraesthesia incidence between the sexes. Post-surgically, 13 males and 5 females indicated experiencing paraesthesia. The

application of Fisher's exact test yielded no significant difference in the condition between males and females. **Table 7** investigates the relationship between post-surgical paraesthesia and the fracture's original cause. Among the 23 patients with injuries from a fall, 5 (21.7%) experienced paraesthesia, compared with 18 (78.3%) who did not. Of the 37 individuals whose fractures were attributed to general trauma, paraesthesia occurred in 5 (13.5%) and was absent in 32 (86.5%). Among the 40 subjects who sustained fractures from violent encounters, 8 (20%) reported paraesthesia, whereas 32 (80%) remained unaffected. A non-significant association was observed between injury mechanisms and the subsequent development of post-surgical paraesthesia, as assessed by the Chi-square test.

Table 1. Distribution according to age groups.

Age group	N	Mean age
20–40	34	52.38 ± 18.07
41–60	32	
> 60	34	

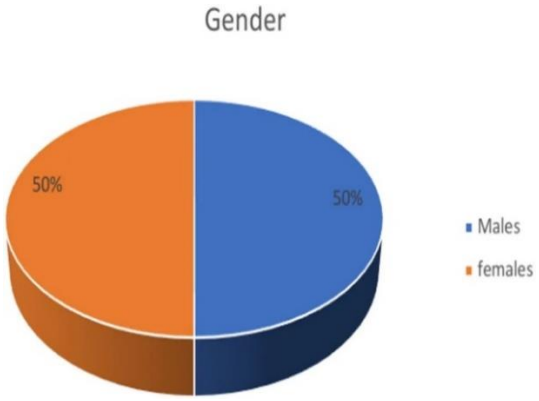

Figure 1. Distribution of the study participants based on gender.

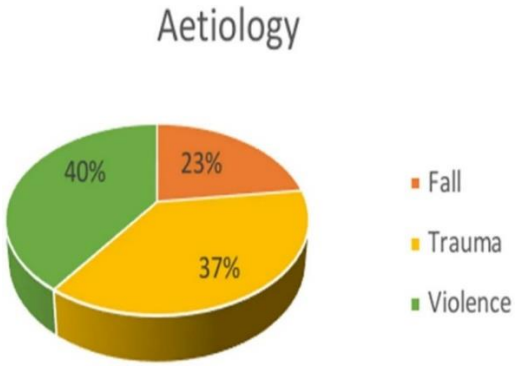

Figure 2. Distribution of the etiology of fracture.

Table 2. Distribution of ZMC fracture type.

ZMC fracture type and treatment	N
FZ + BUTTRESS + MAXILLARY (infraorbital)	19
ZYGOMATIC ARCH	18
FZ (FRONTOZYGOMATIC) + MAXILLARY BUTTRESS	14
FZ (FRONTOZYGOMATIC)	10
MAXILLARY BUTRESS	8
FZ + MAXILLARY BUTTRESS + (infraorbital rim) + Zygomatic arch	7

Table 3. Distribution of treatment procedures done in ZMC fracture.

Treatment approach	N
Conservative management	18
One-point fixation	18
Three-point fixation	17
Two-point fixation	13
Three-point fixation	8
Three-point/arch (conservative)	8

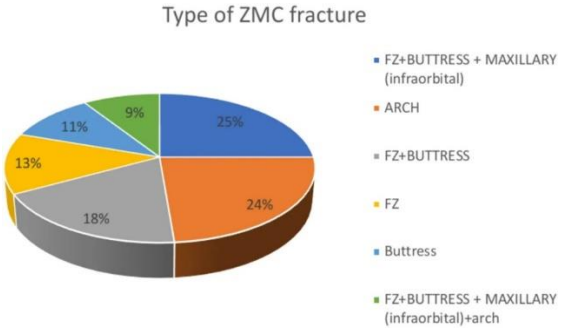

Figure 3. Distribution of ZMC fracture type.

Table 4. Comparison of pre-operative and post-operative paraesthesia.

Paraesthesia	Present	Absent	*p*-value
Pre-operative	18	82	1.000
Post-operative	18	82	

McNemar test; for statistical significance; P-value < 0.05.

Table 5. Comparison of post-operative paraesthesia among different age groups.

Age	Present	Absent	P-value
20–40	6 (17.6%)	28 (82.4%)	0.991
41–60	6 (18.8%)	26 (81.3%)	
> 60	6 (17.6%)	28 (82.4%)	

Chi-square test; for statistical significance; P-value < 0.05.

Table 6. Comparison of post-operative paraesthesia among males and females.

Sex	Present	Absent	P-value
Male	13 (26%)	37 (74%)	0.066

Female	5 (10%)	45 (90%)

Fisher's exact test; for statistical significance; P-value < 0.05.

Table 7. Comparison of post-operative paraesthesia by fracture etiology.

Aetiology	Present	Absent	P-value
Fall	5 (21.7%)	18 (78.3%)	0.660
Trauma	5 (13.5%)	32 (86.5%)	—
Violence	8 (20%)	32 (80%)	—

Chi-square test; for statistical significance; P-value < 0.05.

The zygomatic bone possesses an architectural framework that enables it to withstand significant impact forces without fracturing. Separation from neighboring bones or adjacent suture lines occurs only when the force exceeds the structural tolerance of the zygomaticomaxillary complex, thereby producing zygomaticomaxillary complex fractures. Owing to the sophisticated anatomy of the midface, these injuries may manifest either in isolation or concurrently with other facial skeletal fractures, contingent upon the velocity of the traumatic impact. Reconstructing the pre-traumatic anatomical configuration stands as the central therapeutic priority when managing zygomaticomaxillary complex fractures. Achieving a favorable and successful repair requires accurate diagnostic assessment, meticulous surgical exposure, and anatomical reduction to faithfully recreate the intricate three-dimensional midfacial architecture. This manuscript delineates the epidemiological profile, causative factors, clinical features, and therapeutic management of operatively managed zygomaticomaxillary complex fractures at our major trauma facility over 3 years [12]. Typical causative mechanisms include vehicular collisions, interpersonal aggression, accidental falls, and athletic trauma [13], with violent assault emerging as the leading factor, accounting for 40% of cases in this series. Fractures of the zygomatic arch generally stem from laterally directed blows, which are commonly encountered in physical altercations and sporting activities, a finding that aligns with reports published by Brucoli *et al*. [13], Bogusiak and Arkuszewski [14], and Ungari *et al*. [15]. The aetiological spectrum demonstrates geographical variation; assaults account for 20%–64.5% across international cohorts [12–15], while motor vehicle crashes [16–19] and recreation-related incidents [15] also carry considerable aetiological weight. The existing literature indicates that zygomaticomaxillary complex fractures commonly involve multiple anatomical landmarks: the zygomaticomaxillary buttress, the infraorbital rim, the frontozygomatic articulation, and the zygomatic arch [16]. This aligns with our dataset, wherein 25% of individuals sustained fractures across multiple regions and 24% presented with isolated arch disruptions. The least commonly encountered fracture configuration spanned all four sites and was observed in merely 7% of cases. By way of comparison, Ali [20] reported buttress involvement in 75% of instances, with alternative sites appearing far less regularly. This divergence likely reflects differences in predominant trauma mechanisms—namely, motor vehicle collisions in their cohort versus interpersonal violence in ours—which directly shape resultant fracture morphology. Regarding therapeutic pathways, conservative observation was undertaken in 18% of patients; the remainder received operative intervention, with single-point fixation as the most frequently used modality (18%), followed by three-point fixation (17%). These proportions closely match those reported by Salentijn *et al*. [16], which documented conservative management in 16.3% of subjects and surgical treatment in 83.7%, alongside fixation point distributions of 22.9%, 42.4%, and 18.4%. Procedure-related adverse events remain uncommon but may include dysfunction of the infraorbital nerve (ION). Salentijn *et al*. [21] observed ION-related symptoms in 64.4% of individuals, their presence correlating with the magnitude of traumatic insult. Forouzanfar *et al*. [22] described an identical incidence of ION paraesthesia, noting that 77% of affected patients recovered complete sensory function following therapeutic intervention. Salentijn *et al*. [16] documented enduring nerve-related symptoms in a minority of cases. Our own data similarly captured persistent infraorbital nerve symptomatology. Prompt surgical management, in conjunction with adequate fixation, generally fosters neurological recovery; residual paraesthesia may be attributable to inadequate reduction or alignment or to substantial nerve injury. We identified no statistically significant differences in post-operative nerve symptomatology when stratified by chronological age or biological sex, findings consistent with those of Tabrizi *et al*. [23], who likewise detected no sex-based disparities in sensory recovery at the half-year mark. The risk of developing post-operative paraesthesia demonstrates a stronger association with the anatomical positioning of the fracture, especially when the infraorbital canal or the orbital floor is compromised, rather than with the nature of the inciting trauma [24, 25]. The large majority of individuals regain sensory nerve function within a three-month window following expedient surgical repair and stabilization [26]. Within our cohort, rigid fixation proved effective across the board, with no recorded instances of skeletal displacement,

hardware loosening, or infectious complications, reflecting the adequacy of both the operative interventions and the subsequent post-operative regimen.

Certain limitations must be acknowledged in the context of this investigation. These include its retrospective design, limited sample sizes for specific fracture subcategories, data sourced exclusively from a single institution, and an absence of longitudinal surveillance addressing both functional restoration and aesthetic outcomes. Reliance on clinical documentation without a standardized methodology for assessing nerve injury introduces the risk of bias.

Conclusion

Zygomatic complex fractures rank among the most prevalent injuries within the domain of maxillofacial trauma, with interpersonal violence representing a principal causative factor. Notwithstanding ongoing advances in therapeutic techniques, considerable debate persists over the most suitable strategies for achieving precise anatomical reduction, robust stabilization, and secure fixation of these injuries. To summarise, our analysis established that violent assault was the foremost etiology of zygomaticomaxillary complex fractures, exerting a comparable impact on patients within both the 20–40 and the over-60 age brackets. For non-displaced fracture variants, non-operative management yielded satisfactory results. In scenarios requiring surgical correction, fixation protocols varied, using one-, two-, or three-point anchorage methods based on the extent of displacement and overall fracture severity. Notably, our observations confirmed that parameters such as patient age, biological sex, or the mechanism of injury did not exert a meaningful influence on the manifestation of paraesthesia either before or after therapeutic management. Based on the synthesis of our clinical experience and the evidence from this study, it is apparent that a diverse array of fixation techniques can effectively achieve stability in zygomaticomaxillary complex fractures. The selection of the specific method should be tailored to the distinctive fracture morphology and the individualized requirements of each patient, thereby ensuring the optimal clinical results.

Limitations

- Retrospective and single-center design.
- Limited sample size for certain fracture subtypes.
- Absence of long-term functional/aesthetic follow-up.

Acknowledgments: None

Conflict of Interest: None

Financial Support: None

Ethics Statement: The studies involving humans were approved by Dr. D.Y. Patil Vidyapeeth, Dr. D.Y. Dental College and Hospital, Pune. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

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