THE RETROSPECTIVE COMPARISON OF CLOSED AND OPEN REDUCTION IN THE MANAGEMENT OF ZYGOMATIC COMPLEX FRACTURE

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ABSTRACT

OBJECTIVES

This study aimed to determine the management and clinical outcomes of zygomaticomaxillary fractures (ZMC).

METHODOLOGY

This retrospective study was conducted from January 2023 to December 2024 in the Department of Oral & Maxillofacial Surgery at Nishtar Institute of Dentistry, Multan. A total of 90 patients, including both genders, were selected. The diagnosis was made on the CT scan of the face. The data was collected from the hospital records. SPSS version 23.0 was used for data analysis. Chi-square statistics were used to assess the association between the treatment approach and the incidence of ZMC fractures, as well as the side of ZMC fractures, with a level of significance set at $p < 0.05$.

RESULTS:*The mean age in this study was 35.54± 15.35 years. Males were 70(77.78%) and females were 20(22.22%). The dominant age group was 21-35 years, accounting for 32 (35.56%). The most common cause was RTA 41(45.56%) followed by fall 22(24.4%). Most fractures (64.4%) were managed through open reduction. Subconjunctival ecchymosis (55, 61.11%) was the most common clinical finding seen, followed by tenderness on the zygomatic buttress. Chi-square statistics revealed a statistically significant association ($p < 0.001$) between the treatment approach and the incidence of ZMC fractures and the side of ZMC fractures. Logistic regression identified closed reduction (AOR: 3.72, 95% CI: 1.21-11.47, p-value: 0.022) as a predictor of patients' aesthetic dissatisfaction.*

CONCLUSION:*The findings of this study concluded that the role of open reduction in displaced and comminuted fractures of the ZMC is in achieving superior aesthetic and functional outcomes.*

KEYWORDS: *Facial Injuries, Zygomatic fracture, Etiology, Open Fracture Reduction, Clinical Findings*

INTRODUCTION

The human facial skeleton is a complex and delicate structure, composed of multiple bones that provide both functional and aesthetic support to vital structures such as the eyes, nose, and mouth. Among the facial bones, the zygomaticomaxillary complex (ZMC) plays a pivotal role in maintaining midfacial integrity.[1,2] ZMC fractures, also known as tripod or tetrapod fractures, are among the most frequently encountered midfacial fractures in maxillofacial trauma, often resulting from high-energy impacts such as road traffic accidents, physical assaults, sports injuries, and falls. Due to its prominent anatomical location and structural significance, the zygomatic bone is highly vulnerable to trauma.[3] The zygomatic articulates with four adjacent bones: the maxilla, frontal, sphenoid, and temporal bones, which form a complex bony buttress that contributes to the contours of the cheek, lateral wall, and floor of the orbit and zygomatic arch.[4,5] The incidence of ZMC fractures varies widely across regions due to socio-demographic factors, cultural practices, and trauma patterns. Studies have revealed that ZMC fractures account for approximately 13 to 26% of all facial fractures, making them one of the most commonly encountered injuries in maxillofacial surgery.[6,7] The male-to-female ratio ranges from 3:1 to 5:1, indicating a higher involvement of males in outdoor activities, interpersonal violence, and road accidents. The age group most commonly affected is between 20 and 40 years, often considered the most active and productive period of life.[8] Patients presenting with ZMC fractures have a variety of signs and symptoms. The signs and symptoms of ZMC fractures depend on the severity and direction of displacement. The most common clinical features of ZMC fractures consist of flattening of the malar prominence, periorbital swelling and ecchymosis, subconjunctival hemorrhage, diplopia, and limited ocular motility due to orbital floor involvement, infraorbital hypoesthesia, and

trismus if the zygomatic arch is involved.[9,10,11,12] The subtle nature of some ZMC fractures may lead to underdiagnosis, particularly in polytrauma patients or those with concomitant head injuries. Therefore, a high index of suspicion is warranted.[13] A thorough clinical examination, complemented by imaging, is essential for accurate diagnosis and planning of ZMC fracture management. While plain radiographs have been traditionally used, they often lack sensitivity in detecting complex fractures or orbital involvement. In computed tomography (CT) scans, the axial and coronal views are considered the gold standard. The management of ZMC fractures aims to restore anatomical alignment, functional competence, and facial aesthetics. The decision between conservative and surgical intervention depends on the degree of displacement, functional impairment, cosmetic concerns, and associated injuries.[14,15,16,17] Despite the substantial literature on ZMC fractures, there is a persistent need for institutional audits and retrospective analysis to identify trends in management and outcomes. Patient demographics, variability in fracture patterns, and treatment modalities are mandatory for a localized approach in order to optimize protocols and improve patient care. This study aimed to evaluate the clinical management approaches and postoperative outcomes of patients diagnosed with ZMC fractures.

METHODOLOGY

This study was designed as a retrospective observational analysis conducted at the Department of Oral & Maxillofacial Surgery, Nishtar Institute of Dentistry, Multan, over the period from January 2023 to December 2024. Prior to data collection, ethical approval (Ref 6684/NID) was obtained from the Institutional Review Board of Nishtar Institute of Dentistry, Multan. Due to the retrospective nature of the study, patient consent was waived. Patients aged 18 years or older of any gender, with a Radiologically confirmed diagnosis of ZMC fractures on CT scan, who underwent either open, closed reduction, or observation for fracture management, and had complete preoperative and postoperative records, with a minimum follow-up duration of 6 months, were included in the study. Patients with incomplete or missing clinical or radiographic records. Patients with associated panfacial fractures or severe head injuries obscuring ZMC fracture analysis, and Patients lost to follow-up before 6 months post-treatment were excluded from the study. Data were collected from the electronic hospital database and surgical records using a structured data collection proforma. The data collected included demographic information, etiology of trauma, fracture characteristics, radiological findings, management approaches, type and number of fixation devices, associated complications, and postoperative follow-up data. All zygomatic complex fractures were classified according to Zingg et al.[13], as shown in Figure 1.

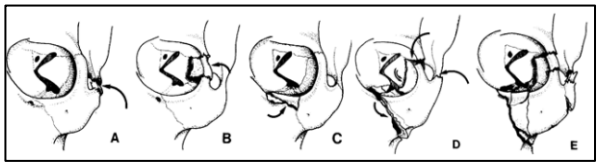

Figure 1: Schematic illustration of fracture types. A: Type A1, isolated zygomatic arch fracture. B: Type A2, isolated lateral orbital wall fracture. C: Type A3, isolated infraorbital rim fracture. D: Type B, tetrapod fracture. E: Type C, multifragment zygoma lateral orbital complex fracture.

Strict inclusion and exclusion criteria, standardized data extraction, data collection by two independent investigators, radiographic evidence of bone continuity and clinical recovery, and blinded statistical analysis (open reduction vs closed reduction) were employed to minimize the risk of bias in this study. The collected data were analyzed using SPSS 23.0 version. Descriptive statistics were obtained for demographic data, fracture patterns, and treatment modalities. Chi-square statistics for the association between treatment approaches and incidence of ZMC fracture and side of ZMC fracture. Multivariate logistic regression analysis to identify predictors of unfavorable outcomes with odds ratios and 95% confidence intervals reported. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 90 patients were included in the study, comprising 70 males (77.8%) and 20 females (22.2%), indicating a male-to-female ratio of approximately 3.5:1. The mean age of the patients was 35.54±15.35 years. The majority of cases (48; 53.3%) were within the 21-35 years age group, followed by the 36-50 years age group (22; 24.4%). The age groups 18-20 and those over 50 had a similar number of cases (10; 11.1% each). The most frequent incision used was Gilles temporal incision 70(77.78%) followed by lateral eyebrow 52(57.78%), infra-orbital 39(45.34%), subciliary 15(17.44%) and lateral canthopexy 03(3.48%). Existing laceration was used in 06(6.97%) cases. In 13 (15.12%) cases, one-point fixation was used, while in 28 (32.55%) cases, two-point fixation was used, and in 17 (19.76%) cases, three-point fixation was used. The most commonly involved area for one-point fixation was the zygomatic buttress (11, 12.22%), followed by the FZ (02, 2.32%) and the infraorbital (01, 1.16%). The clinical findings seen in these patients were subconjunctival ecchymosis 55(61.11%), tenderness on buttress 39(45.34%), flattening of cheek

37(43.02%), infra-orbital rim deformity 31(36.04%), paresthesia 24(27.90%), restricted mouth opening 15(17.44%), malocclusion 13(15.11%), head injury 08(9.30%), diplopia 07(8.14%) and temporary blindness 02(2.33%). Chi-square statistics revealed a statistically significant association ($p < 0.001$) between treatment approaches and the side of the ZMC fracture, as well as the incidence of ZMC fractures involved, as shown respectively. Complications were noted in 18 patients (20%). The distribution of complications in different treatment approach groups is given in the Table. Infraorbital paresthesia was the most common complication and was mostly transient, resolving within 3 months in the majority of cases. Satisfactory aesthetic outcomes were observed in 82 patients (91.1%). Mild malar asymmetry in 6 patients (6.7%) in the closed reduction group. Moderate asymmetry requiring revision in 2 patients (2.2%), both of whom were initially managed conservatively. Logistic regression analysis for patient dissatisfaction revealed that closed reduction was significantly associated with aesthetic dissatisfaction (Adjusted Odds Ratio: 3.72, 95% Confidence Interval: 1.21-11.47, p-value: 0.022).

Table 1: Etiology, Side Distribution, Incidence, and Treatment Approaches of ZMC Fractures (n = 90)

Variable	Category	Frequency(n)	%age
Etiology	Road Traffic Accidents	41	45.6
	Falls	22	24.4
	Sports Injury	15	16.7
	Violence	06	6.7
	Animal Injury	06	6.7
Side Distribution	Right side	59	65.6
	Left side	25	27.8
	Bilateral	06	6.7
Incidence of ZMC Fracture	Isolated ZMC Fracture	41	45.6
	ZMC is associated with injuries	22	24.4
	Isolated Zygomatic Arch	16	17.8
	Isolated Infraorbital Fracture	11	12.2
Treatment Approach	Open Reduction	58	64.4
	Closed Reduction	23	25.6
	No Surgery	09	10.0

Table 2: Frequency of ZMC with Associated Injuries (n = 22)

Associated Injury	Frequency (n)	%age
ZMC only	68	75.6
ZMC & Le Fort fracture	10	11.1
ZMC & Mandible fracture	04	4.4
ZMC & Nasal fracture	04	4.4
ZMC & Orbital floor repair	03	3.3
ZMC & Orbital floor exploration	01	1.1

Table 3: Association of Side of ZMC Fracture with Treatment Approach

Variable	Chi-Square (χ^2)	p-value
Side of fracture × Treatment	48.067	0.000
Treatment × Incidence	42.467	0.000

Table 4: Association of Treatment Approach with Incidence of ZMC Fracture

Variable	Chi-Square (χ^2)	P-value
Treatment × Incidence of fracture	22.978	0.000

Table 5: Postoperative Complications in ZMC Fracture Management

Complication	Frequency (n, %)	ORIF Group	Closed Reduction Group
Infra-orbital nerve paresthesia	08 (8.9%)	05	03
Postoperative infection	04 (4.4%)	03	01
Malar depression	03 (3.3%)	01	02
Diplopia (transient)	02 (2.2%)	01	01
Plate exposure	01 (1.1%)	01	00

DISCUSSION

This retrospective analysis of 90 patients with ZMC fractures provides meaningful insights into the demographic trends, etiological factors, surgical intervention, and complications associated with the management of these injuries. The demographic analysis of this study demonstrated that the predominant age group seen was the third decade. This study is consistent with the study done by Menon et al.14 Males were found to be more dominant than females in this study. Menon et al.[14] in their study also revealed that the predominant gender was male, which supports this study. Kambalimath demonstrated that males were frequently involved than females.[15] These studies support our study. The reason could be that males are more involved in outdoor activities than females. The findings of this study revealed that RTA was the most common cause of ZMC fracture, which aligns with a study by Patil et al.[16] Urbanization and not wearing a protective helmet may be contributing factors. Falls were the second most dominant cause of ZMC fractures in our study, which is inconsistent with Kambalimath et al.[15], who reported that assault was the second most predominant cause of ZMC fractures. Bogusiak etal.[2] in their study proposed that assault was the second most common cause of ZMC fracture, which opposes this study. The etiology varies from country to country and even within the same country, depending on ethnicity and velocity impact too.[17] The most common clinical findings in this study were subconjunctival acchymosis, followed by tenderness of the zygomaticomaxillary buttresses, flattening of the cheek, infra-orbital rim deformity, and paresthesia, which is consistent with the study done by Kambalimath et al.[15] and Patil et al.[16] In most of the cases isolated ZMC fracture (47.7%) was seen in our study which is in accordance with study by Zingg et al.[13] (57%) and study by Ashwin et al[18] (54.35%). Lee

et al.[19] in their study results demonstrated that fractures with minimal or no displacement should be treated conservatively or with closed reduction. Our study revealed that 20 cases were treated by closed reduction, which is consistent with the study by Kambalimath et al.[15] In a similar study, Bradley et al.[20] treated 26 isolated ZMC fractures by closed reduction. This study is also in accordance with our study. The most common side involved in this study was the right side of the cheek, which is similar to the results of the study done by Menon et al.[14] Gomes et al.[21] showed that left side of the face was most frequently involved in their study and the reason that he concluded that most of the people are right handed and mostly in danger side is left side of the cheek thus, involving left side of ZMC. This study contrasts with our study. In this study, the most common site for one-plate fixation was the zygomatico-maxillary buttress, which is consistent with a study by Kim et al.[10] Kim found sufficient stability of the ZMC fracture when one plate was used at the zygomatic buttress area and verified this by a postoperative 3D CT scan.[10] The overall complication rate was 20% with the most common being infraorbital nerve paresthesia (8.9%), followed by wound infection and mild diplopia. These complications were transient and managed conservatively. Dhabaria et al.[22] also revealed that nerve paresthesia occurred in 10-20% of cases, depending on the extent of injury and surgical exposure. Our analysis also demonstrated a significant dissatisfaction with closed reduction in managing ZMC fractures. The findings of this study suggest several important clinical implications. ORIF with multi-point fixation should be the standard care for displaced and comminuted ZMC fractures. Closed reduction should be considered in minimally displaced fractures, particularly in resource-limited settings, but with caution due to the high risk of residual deformity. Follow-up with clinical and radiographic evaluation is essential for the timely detection of suboptimal healing and esthetic compromise.

LIMITATIONS

This study is a retrospective, single-center study with a lack of standardized outcome tools (patient-reported esthetic and functional outcomes), limited follow-up duration, and uncontrolled confounding variables. Future studies may include prospective multicenter trials, standardized outcome measurement tools, extended long-term follow-up, 3D imaging, and surgical navigation (3D virtual surgical planning, intraoperative navigation), as well as patient-specific implants in complex and comminuted ZMC fractures.

CONCLUSIONS

This study concluded that open reduction demonstrates superior results in terms of healing, aesthetic restoration, and complication rates compared to closed reduction, particularly in displaced or comminuted fractures. Closed reduction should be applied judiciously in selective cases.

CONFLICT OF INTEREST: None

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AUTHORS CONTRIBUTION

Sehrish Liaqat *- Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Supervision; Final Approval*
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Abid Hussain Kanju *- Concept & Design; Data Acquisition; Data Analysis/Interpretation; Drafting Manuscript; Critical Revision; Final Approval*

The authors accept responsibility for all aspects of the work and will ensure that any concerns regarding the accuracy or integrity of any part are properly investigated and resolved.