



Retrospective Analysis of Management of Zygomatic Complex Fractures

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Abstract

Introduction: Zygomatic bone and its surrounding bony anatomy are essential for maintaining facial contour - cheek prominence and orbital integrity. Management of the zygomatic complex (ZMC) fractures are important in the maintenance of function and facial integrity.

Aim and objectives: To analyse the incidence, aetiology, surgical management and complications encountered in the treatment of ZMC fractures in our super-speciality hospital, and to compare the number and location of fixation points and surgical access in our patient cohort with the literature.

Materials and Method: Retrospective analysis of all operative cases (Open Reduction and Internal Fixation) of zygomatic complex fractures (ZMC) over a three-year period (2017-2021) were reviewed. Craniofacial maxillofacial trauma patient's medical records were collected and out of which only the zygomatic complex fractures cases were reviewed. Only the medical records from the period from 2017-2021 were included. The parameters like etiology, site of the ZMC fracture, type of fracture, associated injuries, clinical findings, treated with conservative or surgical intervention, type of incisions used, number of fixation used and any complications encountered were reviewed and analysed.

Results: Out of 428 cases of craniofacial injury, 96 cases were ZMC fractures, Isolated ZMC fractures accounted for 43%, 33% with associated injuries, 13% isolated arch while 11% accounted isolated infraorbital rim fracture. Most common clinical findings were subconjunctival ecchymosis (71%), flattening of cheek (39%), malocclusion (22%) and so on.

Buccal sulcus incision (66%) was mainly used, followed by upper blepharoplasty incision (59%). Depending on degree of displacement of fracture one-point fixation (8%), two-point fixation (30%) or three-point fixation (27%) was performed. About 33% of cases were conservatively managed and followed up on regular intervals.

Lymph edema, infra orbital paresthesia, temporary blindness, diplopia, hemianopsia were some of the complications encountered which were managed successfully and followed up.

Conclusion: ZMC fractures are most commonly occurring midface fractures with variable etiologies. The most common ZMC fracture pattern was tripod type of fracture. Greater portion of the patient were treated with two-point fixation. Most of the complications were due to the impact and velocity of trauma.

Keywords: ZMC Fracture; Incidence; 2 Point Fixation; Complications

Introduction

The zygoma is the paired irregular bone that plays an important role in facial contour and esthetics of the face in the human body. It plays a major role in influencing the width of face and major buttress of midface between maxilla and cranium [1]. Zygomatic bone forms the major coupling in the midface and forms lateral orbital wall and remarkable portion of floor of the orbit. The prominence of this bone makes it more vulnerable for it to get injuries. It accounts for second most common mid face fractures next to nasal bone and 13% of all craniofacial fractures. Etiologies being road traffic accidents, assaults, animal attacks, fall and so on frequency of each varies from one country to another world-wide. Displaced fractures will lead to disturbance in vision, with restriction of eye mobility, compression of the coronoid leading trismus, deranged occlusion and so on leading to functional and esthetic deformity. A timely and planned intervention is essential for functional and esthetic outcome, as camouflage surgeries have suboptimal results as compared to surgeries done within two weeks of injury. Appropriate exposure and mobilization of the fracture fragments are essential for pertinent anatomical and functional reduction. Management of ZMC fractures cause a frequent challenge as there many literatures supporting one point, two point and three-point fixation.

The aim of this study was to analyze the parameters namely, type of fracture, type of incisions used, treatment methods and complications occurred in our case series.

Materials and Methods

A descriptive retrospective hospital-based study was carried out in patients suffering from craniomaxillofacial injury which were treated in Aaraikeye super-speciality hospital, Davangere over the period of three years (2017-2020) were included. Craniofacial maxillofacial trauma patient's medical records were collected and out which only the zygomatic complex fractures cases were reviewed. The parameters like etiology, site of the ZMC fracture, type of fracture, associated injuries, clinical findings, treated with conservative or surgical intervention, type of incisions used, number of fixation used and any complications encountered were reviewed and analysed. Bilateral ZMC fractures were considered as separate fractures. All ZMC fractures are classified according to Zing., *et al.* [2] The information was collected from the medical records, com-

puted tomography (CT) findings. Followup was established post-operatively 1 year follow-up. Any complications if occurred were recorded till the last day of follow-up. Since it is an retrospective study no Ethical clearance was taken for the study.

Results

In the course of four years (2017-2021) we found 428 patients had craniofacial injury out of which 96 patients were ZMC fractures, out of which 73% were males and 27% were females with age range from 16-68 years. Road traffic accidents (85%) accounts to the most common etiology following with assault (14%) and animal attack (bear maul injury) (1%). All patients had preoperatively CT scans. Subconjunctival ecchymosis (55%) was the most common clinical findings, cheek flattening (28%) second, next was tenderness in buttress (32%) and infra orbital rim deformity (23%) presented in our cases table no.1. Table 2 illustrates the distribution of incidence of ZMC fractures, which reveal isolated ZMC fractures was most prevalent (43%) in our cases. ZMC fractures associated with other fractures have been categorized in table 3. ZMC fracture along with mandible fracture was mainly associated bone (44%). Table 4 shows various approaches used for exposure of the fracture fragments. Buccal sulcus incision (87%) and lateral eyebrow incision (77%) was most commonly used. Table 5 illustrates about the treatment modality, 2-point fixation (26%) was sufficed in majority of cases. One point fixation was used in 11% of cases of which 73% were fixed on the buttress as shown in table 6. Table 7 illustrates complications encountered in our series. Figure 1-8 illustrates the case performed.

Discussion

The architectural frame of zygomatic bone makes it to withstand impacts of greater forces without giving away. When the impact is too high it gets separated from the adjacent bones or nearby suture lines leading to ZMC fractures. Depending on the velocity of impact they are seen as isolated or in association with other facial fractures because of complex anatomy of midface. Restoration and maintenance of preinjury facial skeletal configuration should be the main moto for treating ZMC fractures. Effective and successful repair needs accurate diagnosis and precise surgical exposure and reduction to fabricate the complex three-dimensional anatomy. This article provides an overview of the epidemiology, aetiology, presentation, and management of surgically treated cases of ZMC fractures at our major trauma center over a period of three years.

Sl. No	Clinical findings	No.	Percentage
1	Restricted mouth opening	08	8%
2	Cheek flattening	27	28%
3	Subconjunctival ecchymosis	53	55%
4	Diplopia	04	4%
5	Temporary blindness	02	2%
6	Infra orbital rim deformity	22	23%
7	Malocclusion	15	16%
8	Head injury	06	6%
9	Tenderness in buttress	31	32%
10	Paresthesia	18	19%

Table 1: Clinical findings.

Sl.no.	ZMC fractures	No.	Percentage
1.	Isolated ZMC	41	43%
2.	ZMC with associated injuries	27	28%
3.	Isolated zygomatic arch	16	16%
4.	Isolated infra orbital rim fracture	12	13%
	Total	96	100%

Table 2: Distribution of incidence of ZMC fractures.

Sl.no.	Associated injuries (total 27)	No.	Percentage
1.	ZMC+ Le-fort	08	30%
2.	ZMC+ mandible	12	44%
3.	ZMC+ nasal	04	15%
4.	ZMC+ orbital floor repair	01	4%
5.	ZMC+ orbital floor exploration	02	7%

Table 3: Distribution of operative case of ZMC fracture.

Sl.no.	Incisions used (total 62)	No.	Percentage
1.	Lateral eyebrow	48	77%
2.	Subciliary	26	42%
3.	Buccal sulcus incision	54	87%
4.	Gilles temporal incision	10	2%
5.	Existing laceration	03	5%
6.	Lateral canthoplexy	01	2%

Table 4: Incisions used.

Sl.no.	Point of fixation	No.	Percentage
1.	1- point fixation	11	11%
2.	2- point fixation	25	26%
3.	3-point fixation	22	23%
4.	4- point fixation	04	4%
5.	Closed reduction	20	21%
6.	No surgery	14	15%

Table 5: Treatment modality.

Sl.no.	Areas of one-point fixation (total 11)	Number (Percentage)
1	FZ	2 (18%)
2	Buttress	8(73%)
3	Infra orbital rim	1(9%)

Table 6: One-point fixation.

Sl.no	Complications	No. of pts
1.	Infraorbital paresthesia	6
2.	Lymph edema	4
3.	Diplopia	1
4.	Hemianopsia	1
5.	Temporary blindness	2

Table 7: Complications.

ZMC fractures were more common in males than females, our result suggestive of males are more active in outward activities and any substance intoxication. The most common cause of injury in our series was road traffic accidents in accordance with Patil, *et al.* in India [4] probably due to urbanization, not wearing protective gears and alcohol abuse are the main reasons for the maxillofacial injury and mainly in developing countries as ours. Study conducted by Shapiro, *et al.* [5] concluded that incidence of morbidity and mortality, frequency and severity of facial fractures have reduced after the use of protective devices like helmet and seat belts. Animal attack by Bear was observed in one of our cases where an elderly-women working in the field was attacked, leading to avulsion of scalp from forehead to occipital region causing lateral displacement of ZMC. Assault was second most common cause in our series,

mainly seen in developed countries as disclosed in an analysis of Polish literature [6]. Falls, sports-related injuries, civilian warfare, industrial, work related accidents were less common incidence which are the other causes for injuries. Etiology and incidence of ZMC fractures varies in severity, velocity of impact, type and cause depending on the socioeconomical, cultural and environmental factors among the studied population and varies from country to another and even within same country [7]. The significance of illicit drug use or alcohol use relating to injury were unable to comment due to inadequate documentation in the patient's files.

The most common symptom in ZMC fractures was tear in the periosteum leading to Subconjunctival ecchymosis (55%), tenderness in the buttress (32%), cheek flattening (28%), infra orbital rim

deformity (23%) was in accordance with other studies [4]. Head injury was seen in 6% of our cases having Glasgow Coma Scale (GCS) of less than 8 were waited for the GCS to improve then they were treated for ZMC fractures. Temporary blindness was seen in 2% of cases which had frontal bone fracture along with Lefort II fracture, the vision regained after about 6 months on steroid therapy. The infraorbital nerve involvement reported incidence was 69.6% [8]. In our study nerve involvement was seen in 16% of cases suggesting that fracture line had crossed along the infraorbital canal, which regained after about approximately 6 months. Diplopia was seen in 4% of cases which had orbital rim/floor fracture suggestive of muscle entrapment, exploration, releasing the muscle and fixing of the orbital rim fixed the issue.

Isolated ZMC fractures were observed in 43% of cases predominantly tripod type of fracture as in previous studies showed 57% by Zing, *et al.* [2], 54.35% by Ashwin, *et al.* [8] and 28% of our cases were associated with other craniofacial bones of which 44% were along with mandible. This gives the intensity of impact of the injury.

Treatment modalities is influenced by various factors like age of the patient, time of presentation, function loss, finances, esthetic concern, and any associated systemic diseases. The amount of degree of displacement, esthetic and functional deficit are the main deciding factors for the treatment of ZMC fractures. Hence management may vary from simple observation for resolving oedema, diplopia and paresthesia to very aggressive open reduction and internal fixation. The fractures of zygomatic complex can be isolated, un-displaced or single in low impact injury or can be rotated, displaced at one or more points around horizontal or vertical axis as seen in medium or heavy impact injuries leading to comminuted or dislocated unfavourable fracture. By assessing the status of the normal articulation of the ZMC with the craniofacial skeleton on CT we can check the amount of displacement of bones.

According to Edward, *et al.* a general rule for minimally displaced or non-displaced fracture are usually treated conservatively and followed up regularly to check for any displacement at later intervals [9]. Closed reduction was considered in 16% of isolated zygomatic arch fractures, through indirect reduction using Gilles lift. Patients were asked to restrain from any untoward force on the side of reduction for atleast 3 months. This was similar to a study

in which 26 fractures of isolated arch fractures were managed by closed reduction [10]. Rotation or late displacement was not encountered any of our cases during follow up. Carrol-Girard screw was used by Uda, *et al.* for closed reduction and internal fixation [11].

A criteria for selection of patients with surgical intervention of ZMC fractures was proposed by Pozatek, *et al.* [12]. Out of 96 cases in our series 64% were treated with open reduction and internal fixation. This was in accordance with Bradely, *et al.* [10]. ORIF was chosen by 81% of plastic surgeons, ENT and 1600 OMFS according to the survey [28]. ORIF was preferred in 84% of patients in a retrospective study of 210 cases of ZMC fractures while 16% as closed reduction [7]. Exposure for open reduction and internal fixation utilises various approaches like coronal, lateral eyebrow, upper eyelid, transconjunctival, subtarsal and subciliary lower eyelid; and maxillary vestibular approaches, have been well described in the literature [13]. With aesthetic and functional restoration of both face and orbit as the main aim of reducing zygomatic fractures, lateral eyebrow incision, subciliary incision and intraoral vestibular incision were most commonly utilized for surgical exposure in our study. As for the zygomatic arch, Gillies temporal approach was preferred. These approaches provided best result with minimal complications such as pain and palpability of implants.

Buccal sulcus incision (87%) was most commonly used for the exposure of the fracture, which provide a stable zygomatic buttress without an external scar formation. Other incisions being subciliary (42%) for exposure of infraorbital rim, lateral eyebrow (77%) for FZ area and existing laceration (5%). No significant difference was found in the incidence of ectropion and entropion between subciliary and transconjunctival incisions in study conducted by Momeni Roochi M., *et al.* [14] Waheed El-Anwar M., *et al.* (2017) compared transconjunctival and subciliary approaches and found that lateral canthotomy was mostly needed in transconjunctival incision, transient postoperative edema was present with these cases and postoperative ectropion and sclera show was detected more with subciliary [15]. Subciliary incision has the disadvantage of causing transient ectropion formation, however it can be prevented by preserving the preseptal portion of orbicularis oculi muscle. None of cases in our series experienced ectropion.

There are significant researches on efficacy of 1-point fixation, 2-point fixation and 3-point fixation. To achieve an acceptable reduction not every articulation needs to be addressed however, at least one, two or three articulations out of four must be addressed intra operatively to reduce these fractured segments accurately [8]. Kim, *et al.* studied in 29 patients who underwent one point fixation at zygomatic buttress and verified with 3D CT scan and found out that one point fixation at zygomatic buttress provides enough stability of ZMC without comminuted fractures of lateral orbital rim [16]. Theoretically single plate will stabilize the fractured segment for rotation and translation in the 2-axis perpendicular to the plane of the plate. In our series 73% of cases was fixed only in buttress region, 18% in frontozygomatic and 9% in infra orbital rim region depending on the degree of displacement. None of the cases had any degree of rotation or translation post operatively.

In this study two-point fixation (26%) of the zygomatic complex at the frontozygomatic and the zygomatic buttress region was advocated after all the three points were exposed and evaluated for reduction of the fractured segments at the frontozygomatic, infraorbital, sphenozygomatic suture and zygomatic buttress region. The zygomatic buttress and frontozygomatic are favoured for rigid internal fixation because of the stability provided against rotation and correct alignment to pretraumatic state respectively as this approach has an esthetic outcome with scars well hidden within the eyebrow and intra orally and also preventing the problems of ectropion and neurological disturbance associate with infraorbital exploration. Chakranarayan A, *et al.* [17] conducted a study on efficacy of two-point fixation for treatment of ZMC fractures and found a stable fixation and immobilization of isolated ZMC fractures. Mittal, *et al.* in their study on pre and post operative values on vertical dystopia and malar height discrepancy showed a statistically significant increase in clinical parameters post operatively and concludes that two-point fixation provides a stable fixation [18]. In our trauma centre two-point fixation was maximally used in 3 years. Acquiring an informed consent for performing infraorbital approach for reducing and fixing was bit tiresome as they were not prepared for scar below the eye as most of the patients were in young age group.

A systematic review of 2-point vs 3-point fixation revealed that 3-point fixation can be used as a standard treatment modality in effective management of ZMC fractures [19]. Widodo, *et al.* (2021)

compared 2-point and 3-point fixation and found out that 3-point fixation had better outcome in the assessment of enophthalmos, vertical dystopia, malar height, malar projection and maintaining postoperatively stability [20]. Surgical outcome was evaluated and compared with CT scans in two and three point fixation in two groups and found no significant difference in stability and they concluded that two point fixation was as good as three point fixation with respect to stability of fractures [21]. This was similar observation in the study conducted by Latif, *et al.* and found that post operative outcome relatively had same mean values at 1 week, 3 week and 6 weeks postoperatively compared with 2 point fixation [22]. Postoperatively follow up of minimum of 6 weeks is primarily important in achieving functional stability and appropriate esthetics [23]. Three point fixation was performed in 23% of our case series effectively and were followed up for atleast one year.

Orbital floor exploration was done in 2 cases and orbital repair in one case where there was a diplopia as presenting symptom along with ZMC fracture, once explored through subciliary incision and entrapment was released the symptoms were reduced and floor repair was carried out with titanium mesh. Post operatively patients were relieved of complaints.

To enumerate the complications there were infra orbital paraesthesia which was encountered in about 6 patients in our series which almost took 6 months to get into normalcy, this may be due muscle entrapment/manipulations of nerve during the reduction or pre-injury. Ashwin, *et al.* [8] reported 16 patients with persistent infra orbital nerve paraesthesia for 6 months follow up. Crossara, *et al.* compared the esthetic outcome of using subciliary, subtarsal and infra orbital incisions for orbital rim and floor fracture and suggested the superiority of the subciliary and subtarsal incisions over infraorbital incision, since noticeable scars were seen in infra orbital incision then subciliary and subtarsal incisions and all three incisions had no statistically significant difference in ectropion, scleral show or chronic edema rates. They also suggested use of a stepped skin-muscle flap or any other preventive measure, in order to prevent vertical shortening of the lower eyelid [24]. Lymphedema was seen in 4 patients, 3 cases with lateral extension of subciliary incision was used and one with existing laceration at the infra orbital region. It was observed during 3rd post operative day and regressed almost after 8 days post operatively. Diplopia was seen in 1 of our patients which subsided by giving steroids for

15 days. Hemianopsia was seen in one of our patients who had suffered head injury and had recovered. Hemianopsia is a condition where lateral side of the vision is blurred. Ophthalmologist managed medically and the condition recovered after about 5 months. Temporary blindness was found in 2 of our cases where methyl prednisone 1mg for 15 days was prescribed and slowly tapered for 15 days and patient recovered from the condition.

Retrospective study in our series clearly signify that two point fixation as a first choice in managing ZMC fractures. Zygomatic buttress and fronto zygomatic region are highly endorsed for fractures with moderate displacement. Drawback of this study was that there was no emphasis on the biomechanics for two point fixation.

Conclusion

The ultimate goal of treating ZMC fractures begins with accurate and precise diagnosis formulating a treatment plan that emphasis on proper reduction of bony segments and to restore facial form and aesthetics. A beneficial treatment plan within two weeks of injury will leads to accurate anatomic reduction and precise fixation. On the basis of our experience and the data from our study, various methods have been successfully followed to treat ZMC fracture and conclude that ZMC fractures rely mainly on the characteristic degree of displacement along with eye involvement and functional impairment and open reduction and internal fixation along titanium miniplates serves as absolute reliable entity in providing three dimensional stability. Stable fixation can be achieved when fixation was done at fronto-zygomatic region and zygomatic buttress in isolated ZMC fractures. There is ongoing lack of consensus in aspects with regards to locations and number of fixation points used, orbital floor repair and exploration, surgeon's training background their experience, availability of resources and preferences play a major role in contributing and maintaining the variety of surgical approaches to ZMC fractures. Nevertheless, further studies should be conducted to assess uniform parameters with bigger sample size and research should also be conducted to guide the law and impose strict traffic legislation to help and prevent such accidents.

Conflict of Interest

Nil.

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IRB Approval

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