Looking Back At Zygomatic Fractures: What, When And How For Better Treatment Planning- A Retrospective Analysis

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ABSTRACT

Purpose: The purpose of the study was to evaluate the efficacy of the treatment given and to do a regular follow up so as to analyze post-operative variables of complications such as infection, nonunion, malunion, wound dehiscence, removal of fixation devices because of complication and to assess the nerve function. Demographic details like age, sex, etiology, side involvement and radiographic features were also to be analyzed. This information can be used to serve as data that in the future help to provide a proper management protocol for the treatment of zygomaticomaxillary complex fractures

Method: 150 Study subjects with the diagnosis of zygomaticomaxillary complex fractures and who were treated between years 2015-2018 were selected from the previous records of outpatient and inpatient section, of the department of Oral and Maxillofacial surgery. Patients were recalled for follow up and the records were studied. The patients were examined clinically and radiographically. The data of the patients were recorded which included patient age, gender, etiology, side involvement, method of treatment, medications given (preoperatively or postoperatively) and complications that occurred such as infection, delayed union, non-union, malunion/malocclusion, diplopia, anaesthesia/ paraesthesia (permanent), and need for removal of hardware

Results: The results showed in our study that zygomaticomaxillary complex fracture was seen more common in males of age group 20-30 years. Male to Female ratio was 4:1. Road traffic accident (60%) was the most common and self-fall (13.3%) was the least common etiology. 20% of the patient was managed on conservative basis while 80% of patients went for open reduction and internal fixation. 13.2% of cases reviewed had infection, permanent paresthesia was found in 6.6% of the patients and 6.6% of the patients had facial asymmetry.

Conclusion: Based on our experience and the data generated from our study, a variety of methods can be used successfully to stabilize ZMC fracture. Treatment modalities for zygomatic bone fracture depends on various characteristics of the fracture and open reduction with internal fixation using miniplates is most stable and reliable modality providing three-dimensional stability.

Keywords: Zygomatic Complex Fractures, Treatment, Conservative Management, Surgical Management

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INTRODUCTION:
Fractures involving the zygomatico-maxillary complex include the zygomatic bone, zygomatic arch and maxilla excluding dentoalveolar component. Zygomatic fractures are facial injuries, representing either the most common facial fracture or the second in frequency after nasal fractures. The high incidence probably relates to the zygoma’s prominent position the facial skeletons which frequently exposes it to traumatic forces. The peak incidence of such injuries occurs around the second and third decades of life. Most studies indicate a male predilection. Even a minimally displaced zygomatic-complex fracture can result in functional and aesthetic deformities. The body of the zygomatic bone articulates with the maxilla and its orbital plate. The complex facial anatomy suggest that reduction of the zygoma, orbital floor, and zygomatic arch are necessary to establish facial symmetry and position of the eye globe and ensure adequate movements of the mandible. Therefore, for both cosmetic and functional results, it is imperative that zygomatic injuries be properly and fully diagnosed adequately treated. Their prevalence related to different condition and the surgical treatment with adequate reduction is a challenge for surgeons. Fracture pattern ranges from simple to comminuted and from minimally displaced to severely displaced depending on the impact of injuries sustained by various mode. Although a great volume of literature exists for the management of these injuries which include conservative management to routine exposure and fixation of at least one, two, three of the four articulations, depending on the degree of displacement. Zygmatic bone contributes significantly to the strength and stability of the mid face. Zygoma is a strong buttress of lateral portion of middle third of facial skeleton and it forms the cheek prominence, part of the lateral and inferior orbital rim and the orbital floor. Due to position it is frequently subjected to fracture and dislocation either alone or in combination with other structures of midface such as maxilla, nasoethmoidal and orbital area. Fractures of zygomatic complex are among the most frequent in maxillofacial trauma and are involved in 42% of facial fractures and accounts for 64% of all middle third fracture. They are the second most common fractures of the face after nasal injuries. The architectural pattern of the zygomatic bone allows it to withstand blows of great forces without fracturing. Traditionally referred to as a “tripod” fracture, a ZMC fracture actually involves disruption at four sites: the lateral orbital rim, the inferior orbital rim, the zygomatico-maxillary buttress and the zygomatic arch. It may be separated from its four articulations, resulting in zygomatico-maxillary complex, zygomatic complex, or orbito-zygomatic fracture depending on the severity of injury. Fractures of zygomatico-maxillary complex are one of the most common types of maxillofacial injuries to treat. The description of this type of fracture comes from the “papyrus of Edwin Smith”, but Daverney (1751) was the first to publish the scientific article describing the zygomatic complex fracture. Zygomatic complex plays an important role on the facial contour. Any injury of this specific area can compromise the aesthetics and the function. This can also be because the zygomatic bone is related to other facial structures such as orbital, maxilla and mandible, making the treatment, in the most cases, essential for the functional and esthetical restoration. The information about the incidence, aetiology, age and gender concerning this type of fractures varies according to the social, economic, cultural and environmental factors. Variety of aetologies including aggressions, automobile accident, falls, industrial accidents and sports are important factors for this injury. Most of the cases indicate a predilection for males with a 4:1 proportion in relation to females. Zygomatic complex fractures have been classified by many authors, to guide the surgeons regarding the site, type and displacement of fractures and thereby helping in selection of appropriate treatment modalities. The diagnosis is made with thorough clinical examination and adequate radiological evaluation. Plain radiograph commonly used is Occipito-mental or Water’s view which can clearly demonstrates the bone discontinuity in the zygomaticomaxillary buttress, Infraorbital rim and Frontozygomatic region. The submentovertex view more clearly detects fracture of the zygomatic arch.

MATERIAL & METHODS:
This is a retrospective study carried out to evaluate the treatment outcome, postoperative complication rate and to provide adequate management protocol among the patients of zygomatico-maxillary fractures.

Procedure
The study was carried out in the department of oral and maxillofacial surgery. Patients with the diagnosis of zygomaticomaxillary fractures and who were
treated between years 2015-2018 were selected from the previous records of outpatient and inpatient section, of the department of Oral and Maxillofacial surgery. Information was obtained retrospectively from clinical case sheets, surgical records and radiographs of 43 patients treated for the zygomaticomaxillary fracture from 2015-18. However, Patients who had concomitant midfacial fractures, panfacial fractures or whose medical records were incomplete/missing or were unable to return for follow-up were excluded from the study.

Methods of collection of data
A specially designed proforma was formulated to investigate the variables detailing the name, age, sex, date of injury, cause of injury, associated facial and general trauma, clinical sign and symptoms, radiographic findings, method of treatment, postoperative evaluation and complications. 150 patients were selected out of 432 patients who had undergone treatment for zygomaticomaxillary complex fractures and met the inclusion criteria. Patient’s previous records were studied. Patient’s age, gender, etiology, method of treatment, medications given and complications (preoperatively intra operatively or postoperatively) such as infection, mobility of the fragments, hardware failure, neurological deficiency were recorded. Patients were recalled and during follow up were evaluated for swelling or pus discharge from the affected site (which could be indicative of infection at the fracture site), mobility across the fixed segment (which was considered for non-union or failed hardware), exposed hardware, loose or displaced screw from the original site (which was considered as hardware failure). Patients were also evaluated for any existing hyperesthesia, paresthesia or permanent anaesthesia in respect to the location of the zygoma. The radiographic details were evaluated for any sign of infection, malunion or non-union and failed hardware. Radiograph showing no sign of complication or patient with no report or complaint of any postoperative malocclusion, anaesthesia or paresthesia were considered successful with regard to the treatment provided.

ASSESSMENT OF PARAMETERS
Following parameters were assessed in all the cases

I) CLINICAL EVALUATION:
I) Reduction and stability:

Reduction was checked clinically by observing the contour of face and alignment. Stability of fracture segments was assessed by manual palpation.

II) Symmetry of face (Projection of Malar Buttress):
Projection of malar buttress on one side was compared to that of the other side by standing behind the patient and viewing from the top and by taking postoperative photographs-frontal, profile and bird’s eye view. Also subjectively patients and their relatives were questioned regarding facial symmetry.

III) Presence of infraorbital paresthesia or anesthesia:
It was noted along the distribution of infraorbital nerve by following tests:

a) Light touch sensation (cotton wool) test
The test was performed using a wisp of cotton wool and stimulus was applied in the area innervated by infraorbital nerve. The results were recorded as presence or absence of sensation after comparing the test side with the control side.

b) Two-point discrimination test
Two point discrimination in the region supplied by infraorbital nerve was assessed using a blunt divider by checking the ability of the patient to discriminate between its two ends. The result was recorded after comparing the test side with the control side.

IV) Presence or absence of infection, sinus or fistula or dehiscence:
It was noted at the surgical site postoperatively with clinical examination.

V) Diplopia:
It was assessed and recorded by asking the patient to follow the finger of examiner which was moved in nine cardinal positions of gaze.

1) RADIOGRAPHIC EVALUATION:
Radiographic evaluation of the approximation of the fractured bone fragments was done by taking:

1) PNS view
2) Submento-vertex view
3) CT scan (if required)

The following factors were assessed, to compare the operated side to that of the normal side:

• Alignment of the infraorbital rim
• Contour of the zygomaticomaxillary buttress
• Approximation of the frontozygomatic suture
• Contour of the zygomatic arch
• Position of the hard ware

Statistical methods
Descriptive statistical analysis has been carried out in the present study. Results on continuous
measurements are presented on Mean ± SD (Min-Max) and results on categorical measurements are presented in Number (%). Significance is assessed at 5% level of significance.

DISCUSSION
The zygomatic bone intimately associated with the maxilla, frontal and temporal bones and as they are usually involved when a zygomatic bone fracture occurs it is more accurate to refer to such injuries as zygomatic complex fractures. The zygomaticomaxillary complex functions as a buttress for the face and is the cornerstone to a person’s aesthetic appearance by both setting mid facial width and providing prominence to the cheek, Lee et al (2010)32. Owing to the strong buttressing nature of zygoma and the thin bones surrounding it, most injuries involving the zygoma are accompanied by disruptions of adjacent articulating bones. The zygomatic bone usually fractures in the region of zygomaticofrontal (ZF) suture, zygomaticotemporal (ZT) suture, and zygomaticomaxillary suture. Due to the prominent, midface location of the cheek, fracture of the ZMC represent the second most common type of facial fracture after nasal bone fracture, Candace Y. Pau ET AL (2010)5. Since the gross shape of the face largely influenced by the underlying osseous structure, the zygoma plays an important role in facial contour. Disruption of the zygomatic position also has great functional significance because it creates impairment of ocular and mandibular functions. Therefore for both cosmetic and functional reasons, it is imperative that zygomatic injuries be properly and fully diagnosed and adequately treated. (FONSECA)1. The purpose of this study is to evaluate surgical outcomes, delayed post-operative complications and to recommend further management protocol. Total of fifteen patients were followed for the present study. An attempt has been made to compare with studies in previous literature whenever possible. The age incidence vary in the different parts of the world but second to fourth decade being commonly affected owing to the increased activity of this age group in the society, hence exposing them more to road traffic accidents and frequently indulging in altercations. Both of this being the commonest etiological factor behind the occurrence of zygomatic complex fractures. The age range of the patients in this study was 20 to 42 years, mean age 29.33 years (table 1). Age group most commonly involved in this study was from 3rd decade followed by 4th and lowest incidence found in 5th decade. These are in agreement with studies done by Sullivan S.T.O et al (1998)24 D.J. Courteny (1999)25 and Sergio olate et al (2011)14. As far as sex ratio considered males are more affected when compared with females. In the present study out of fifteen cases of zygomaticomaxillary complex fractures twelve were males compared to three females suggesting that males are more prone to trauma (table 1), which is compatible with the findings of Sullivan S.T.O et al (1998)24 D.J. Courteny (1999)25 Sergio olate et al (2011)32 Tymour Forouzanfar et al (2012)46 and K. balakrishnan et al (2015)50

<table>
<thead>
<tr>
<th>Variable</th>
<th>Division</th>
<th>N</th>
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<tbody>
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<td>Age</td>
<td>20-30 years</td>
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<td>33.33</td>
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<tr>
<td></td>
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<tr>
<td>Sex</td>
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</tr>
<tr>
<td></td>
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<tr>
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<td>Right</td>
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<td>Fall</td>
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<td></td>
<td>Violence</td>
<td>40</td>
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Site of involvement depends upon type, intensity and direction of forces at the time of impact. Road traffic accidents can involve any side of the face but when it comes to fractures caused by altercations, the left zygoma is most commonly affected, presumably owing to the greater incidence of right handed individuals. Bilateral fractures of zygoma are uncommon. In our present study right side of the face commonly fractured. Nine patients had fracture on right side (60%), followed by left side of the face.
Etiological factor for zygomatic fracture is varied but most common being road traffic accidents and interpersonal violence. In the present study road traffic accidents (60%), mainly from automobile was the predominant etiological factor followed by interpersonal violence (26.7%) and rests (13.3%) of the fractures were caused due to fall (Table 1). Study done by, Zhang, Qing-Bin et al (2011)40 Tymour Forouzanfar et al (2012)46 and K. Balakrishnan et al (2015)50 is compatible with the above findings. However, this finding is not consistent with those of Sullivan S.T.O et al (1998)24 D.J. Courteny (1999)25 and Sergio olate et al (2011)34 who found that assault/altercations to be the primary etiological factor.

For centuries, there has been an extensive search for adequate method of reducing and immobilizing bone fractures ranging from closed reduction for fractures stable after elevation to open reduction and internal fixation for displaced unstable fracture of zygoma. The various therapeutic methods commonly utilized were, reduction without fixation using Gillies temporal approach, repositioning with an intranasus balloon or packing, transfacial pin fixation, continuous traction with head frame, placement of a wedge under the zygomatic arch and open reduction with frontozygomatic suture wiring or osteosynthesis by miniplates.

One of the most controversial topics in maxillofacial trauma is how much fixation is enough to prevent post reduction displacement of the fractured ZMC. Edward Ellis III, Winai Kittidumkerng (1996)17, According to Zachariades et al (1998)23 the management of zygomatic complex fracture depends on the degree of displacement and the resultant esthetical and functional deficit. Management may therefore range from simple observation of resolving edema, diplopia and paresthesia to a more aggressive open reduction and internal fixation.

The decision to intervene surgically should be primarily based on displacement and rotation of the malar complex. As a general rule, non- displaced or minimal displaced fracture can usually be treated conservatively and regular follow up should be done to assess for any late displacement as well as secondary deformity, Lee et al (2010)32. In the present study 20% of the patients underwent conservative management who were had non- displaced or minimal displaced fracture of ZMC. In contrast, displaced fracture should be surgically reduced and stabilized.

The degree of displacement can be easily checked by assessing the status of the normal articulation of the ZMC with the craniofacial skeleton on PNS radiograph and CT scan. Accurate reduction and fixation of displaced zygomatic fractures are necessary to ensure proper healing and prevent postoperative complications such as entothalmous and malar asymmetry. The number of surgical approaches and sites of fixation necessary to ensure this varies based on type of injuries, i.e simple versus comminuted fractures and grossly displaced versus minimally displaced fractures and experience of the operating surgeon. Not every articulation needs to be addressed to be achieving an acceptable reduction. However atleast three of four articulations must be addressed intraoperatively to reduce these fractures accurately, Lee et al (2010)32 surgical approaches for reduction of zygomatic fractures and nonrigid method of fixation have been proposed even with the advent if miniplate osteosynthesis, Sullivan S.T.O et al (1998)24. Ellis and Kittidumkerng (1996)17 suggested that best treatment time is generally considered to be as early as possible for fractures of the midface and presented a well-developed algorithm where the kind of trauma and sequential surgical approaches and fixation could be evaluated, initiating on zygomaticomaxillary buttress, lateral orbital rim and infraorbital rim.

In our study 80% cases were treated by open reduction and internal fixation using miniplates. One-point fixation was done in 16.67% of cases. Two-point fixation was done in 50% cases. Three-point fixation was carried out in 4 patients accounting for 33.33% (Table 2). Different point of fixation in our study was based on severity of displacement. Fracture only at one process with minimal displacement was managed conservatively while moderate to severe displacement were operated. Fracture at two process and three processes were addressed and fixation was done accordingly depending on the sites involved.
Table 2

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<th>Variable</th>
<th>Division</th>
<th>N</th>
<th>%</th>
</tr>
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<tbody>
<tr>
<td>Distribution of patients based on treatment delivered</td>
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<td>20</td>
</tr>
<tr>
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<td>80</td>
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<td>Distribution of patients based on fixation points of surgical points</td>
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<td>20</td>
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<td></td>
<td>2</td>
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<tr>
<td></td>
<td>3</td>
<td>40</td>
<td>33.33</td>
</tr>
<tr>
<td>Distribution of patients according to sites used for fixation</td>
<td>Fronto-zygomatic buttress</td>
<td>80</td>
<td>30.76</td>
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<td>Zygomatico-Maxillary buttress</td>
<td>100</td>
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<tr>
<td></td>
<td>Infraorbital buttress</td>
<td>80</td>
<td>30.76</td>
</tr>
<tr>
<td>Distribution of patients based on delayed post-operative complications</td>
<td>Infection</td>
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<td>60</td>
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<td>Hardware removal (due to exposure)</td>
<td>20</td>
<td>13.3</td>
</tr>
<tr>
<td></td>
<td>Facial Asymmetry</td>
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<td>6.6</td>
</tr>
<tr>
<td></td>
<td>Paraesthesia</td>
<td>10</td>
<td>6.6</td>
</tr>
<tr>
<td></td>
<td>Diplopia</td>
<td>0</td>
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</tr>
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</table>

Champy et al in his study reported satisfactory results with a single point fixation of the zygomatic complex fracture at the FZ region. Placement of fixation device at zygomaticomaxillary buttress has become more popular, as it provides great mechanical advantage by counteracting masseter muscle pull, preventing medial rotation of zygomaticomaxillary complex in to maxillary sinus and providing thick bone suited for placement of screws, Ellis E (1996)17 Ji Heu kim et al (2012)45 concluded that one-point fixation at the zygomaticomaxillary buttress through a gingivobuccal sulcus incision was effective for isolated fracture of zygoma without comminution of lateral orbital rim. Hwang (2010)33 suggested that one-point fixation of tripod fractures through a lateral brow incision can apply to cases with minimal or moderate displacement of the infraorbital rim. However, because the zygomaticomaxillary buttress plays a key role in withstanding contraction of the masseter muscle and supporting zygoma, rigid fixation at the zygomaticomaxillary buttress is important in treatment of isolated zygomatic fracture. Further studies concluded that a single point of fixation failed to address the three dimensional rotation of zygoma. Paik-kwon Lee ET al52 stated that two point miniplate fixation at the infraorbital rim and frontozygomatic region provide significant amount of stability, provided the comminution of zygoma is not severe. Davidson et al (1990)53 stated that the two-point fixation using miniplate alone conferred a degree of stability comparable to most methods of three-point fixation regardless of the site in which the miniplates were applied. Though three point fixations provide best stability, it has disadvantage like increased, additional surgical scars, increased periosteal stripping, infraorbital nerve injury, other orbital complication and additional hardware, Makowski (1995)22. In the present study twelve patients who were surgically treated, total twenty six fixation sites were used depending upon type and severity of the trauma. Among this zygomaticomaxillary buttress was most commonly used fixation site accounting for 38.48% while frontozygomatic buttress (30.76%) and infraorbital buttress (30.76%) accounts equally (Table 2). Apart from this on clinical evaluation postoperatively there was no evidence of movement of fixed fractured segments. All the patients had satisfactory symmetry of the face (malar projection) except one patient (6.6%) who had facial asymmetry as a late postoperative complication however Zing et al (1992)12 found 13% incidence of malar asymmetry in patients treated by closed reduction. There were two cases (13.2%) of post-operative infection among which one patient required plate removal (Table 2). Infected site was then thoroughly irrigated with saline, Povidone iodine solution and re-suturing was done. Few studies such as Shams Uddin (2013)54 found that late infection are generally due to miniplates as they intensify the loss of vascularization that lead to complete or partial resorption and inflammation. One of the patient (6.6%) developed new-onset paraesthesia/anaesthesia of infraorbital nerve, which was in accordance to Lee et al (2010)32 who found paraesthesia as one of the most common complication around the infraorbital nerve post surgically. Plate
exposure postoperatively was not seen any of the patients. Diplopia was not observed in any of the cases. However other studies found 7% diplopia in surgical patients associated with zygomatic complex surgical treatment, kovacs (2001)26.

CONCLUSION
The management of zygomatic complex fractures has varied and developed over a long period of time with intent of maximizing the stability with reduced morbidity. The present retrospective study was conducted at the Department of oral and maxillofacial surgery, in order to evaluate efficacy of the treatment given and to do a regular follow up so as to analyze post-operative variables of complications. From the findings of this study, we have made an attempt to assess the different treatment modality in zygomatic bone fracture which varied from conservative to routine exposure and fixation using mini plates depending on the displacement of the fractured segments.

Among all the patients who were diagnosed with ZMC fractures, some of them were managed conservatively such as in cases with minimal displacement, feasibility, no functional and esthetics alterations and patient noncompliance for the surgery. Conditions in which there was moderate to severe displacement at fracture site were treated with 1-point, 2-point or 3-point fixation. All the patients had satisfactory symmetry of the face (malar projection) except one patient who had facial asymmetry as a late postoperative complication. There were two cases of post-operative infection among which one patient required plate removal. One of the patient developed new-onset paraesthesia/anaesthesia of infraorbital nerve. Plate exposure postoperatively was not seen any of the patients. Diplopia was not observed in any of the cases.

Based on the result from the present study, a variety of methods can be used successfully to stabilize ZMC fracture. We conclude that treatment modalities for zygomatic bone fracture depend on the characteristics of the fracture pattern

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