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Zygomatico maxillary complex fractures. What osteosynthesis? 1, 2, 3 or 4 point fixation

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ABSTRACT

The zygomatico maxillary complex (ZMC) is a major buttress of the midfacial skeleton. The ZMC is important to structural, functional, and aesthetic appearances of the facial skeleton. A ZMC fracture is also known as a tripod, tetrapod, or quadripod fracture, trimalar fracture or malar fracture [1],[2]. Zygomatico maxillary complex is the second most common mid-facial bone fractured after the nasal bones and overall represents 45% of all midface fractures[3].The architectural pattern of zygomatic bone allows it to withstand blows of great forces without fracturing. Because of such heavy forces zygomatic bone gets separated from adjacent bone at or near the suture lines. It may be separated from its four articulations, resulting in a zygomatico-maxillary complex, zygomatic-complex or orbito-zygomatic fracture. These articulations encompass an area which has the horizontal and vertical lines of osteosynthesis as described by Gruss and Mackinnon [4].

INTRODUCTION

Management of ZMC fractures is a frequent challenge in maxillo facial surgery. The surgical approach is decided based on the findings from the physical examination and imaging studies. Adequate exposure and mobilization of the fracture fragments are critical for ensuring appropriate anatomical reduction.

This study was designed to compare 1, 2, 3 and 4 point internal fixation, to find the better clinical results and fewer complications, consequently contributing towards the greater goals of a better treatment option and in due process benefit the concerned patients.

MATERIALS AND METHOD

This is a retrospective study of 45 cases of fractures of the zygomatico maxillary complex, operated in the maxillofacial surgery department of the Avicenne Teaching Military Hospital of Marrakech between January 2011 and December 2017.

The purpose of this study was to quantitatively evaluate and compare the differences of post-surgical outcome in patients with simple fractures of the ZMC treated through different numbers of point fixation. And that by setting side by side, the results of our 2 point fixation approach at the maxillofacial surgery department of the Avicenne Teaching Military Hospital and approaches described in the preexisting literature.

Our study included only patients with CT scans showing fractures at the three ZMC buttresses (Stage B of Zing's classification):

+Fracture of the zygomatic arch and/or diastasis of the temporozygomatic suture

+Fractures of the inferior orbital rim and anterior and posterior maxillary sinus walls and/or diastasis of the zygomaticomaxillary suture

+Fracture of the lateral orbital rim and/or diastasis of the frontozygomatic suture

RESULT AND DISCUSSION

The patients' main age was 43 years (extremes: 21-65 years).Our study included 37 males (82,2%) and 8 females (17,8%).The most usual circumstances of the occurrence of the traumatism are: Road traffic accidents: 29 cases from 45 (64,4%) and brawls or aggressions: 7 cases from 45 (15,5%).

The mechanism of zygomatic trauma was direct in 94,29% of the cases and indirect in 5,71% of the cases.

Out of 45 patients 25 (55,56%) had limitation of mouth opening. Enophthalmos was found in 6,66 % in 3 patients. Among patients who had enophthalmos, 2 (4,5%) were diagnosed with vertical diplopia. Sensory disorders were common and they represented 35,56% (16 cases). They consisted in hypoesthesia at the region of the infraorbital nerve V2 (Lower eye lid, upper lip and lateral side wall of the nose). A total of 29 (64,5%) patients had skeletal deformities such as flattening of the malar prominence, deformity of orbital margin and deformity of zygomatic buttress.

Exposure was achieved for our patients through: Lateral eye brow incision giving access to the frontozygomatic suture and subtarsal incision giving access to areas along the orbital floor, the medial and lateral rim. Repositioning was achieved through percutaneous Ginstet hook reduction. (figure1)

Orbital floor reconstruction was achieved when reduction of the thin bone fragments was not possible or insufficient to avoid a soft tissue displacement. Materials with different rigidity were used to cover or bridge the defect depending on its size and localization: Prolene mesh was used for 4 patients who were had for small linear defects (up 1 to 2 cm) and patients with for larger defects (2 patients), iliac bone grafts were used.

The reduced bones were fixated with plates and screws using 2 point fixation in the previously exposed areas: frontozygomatic fixation through lateral eye brow incision and infra orbital rim through an infra orbital incision. (figures 2,3)

The following medications were prescribed to our patients: analgesia, antibiotics (Amoxicillin clavulanic acide 3g/day), nasal decongestant may be helpful for symptomatic improvement in some patients, regular perioral and oral wound care including disinfectant mouth rinse.

DISCUSSION

There was no significant difference between the results of our series and those of literature; ZMC fractures account for 13% of all cranio-facial trauma [5] with predominance in young adult males, and that because of their frequent exposure to assaults and risky behavior. The most common etiologies are road accidents followed by aggression.

Locally, the appearance of patients with ZMC fractures is quite remarkable. As for all facial traumas, edema is very important, installs in the few hours following the trauma and persists for several days.

It is localized over the malar prominence, lateral orbit, upper and lower eyelids, associated to ecchymosis and tenderness. Loss of malar projection with increased width of the face are also noticed, they can be masked by the importance of the edema.

Enophthalmos results from a retrusion of the ocular globe into the orbit. Diplopia is a troubling and not uncommon complication of malar fractures that is reported in 3.4 to 8 percent of cases [6], [7]. The Lancaster test is used to monitor the persistence or disappearance of diplopia. When diplopia is definitive it is often due to permanent entrapment or fibrosis of the oculomotor muscles or nerve palsy. This test allows quantifying limitations on a diagram and following the evolution.

In simple ZMC fractures, hypoesthesia will most often occur in the territory of the infra-orbital nerve. Hyperesthesia may also be found.

Limited mouth opening may be present and is generally mild and is typically due to pain with masseteric pull given its attachment to the zygoma. Severe displacement may cause direct impingement on the coronoid process.

CT scanning has supplanted plain radiography as the imaging modality of choice. Almost all malar fractures require direct CT scanning in both the axial and coronal planes (< 3-mm slice thickness) to categorize the pattern of injury clearly and direct subsequent management [8].

In a non-comminuted ZMC fracture, the zygomatic arch component of the superior transverse maxillary buttress is typically left unfixated, with the remaining buttresses used as a reference for reduction. However, if the buttresses are comminuted, the surgeon may need to expose and reduce the zygomatic arch via a scalp incision to ensure that the zygoma is adequately anteriorly projected. The typical clinical and radiologic deformity of a ZMC fracture is loss of cheek projection and a resultant increase in facial width. A frequently missed ZMC fracture is at the temporal bone portion of the upper transverse maxillary buttress [9].

In severe ZMC fractures, the orbital defect can appear minimal due to impaction of the zygoma. It is important to visualize the defect with the zygoma in its anatomic position to appreciate the true loss It is important to visualize the defect with the zygoma in its anatomic position to appreciate the true loss of bone support. CT has made preoperative assessment of the status of the bony orbit possible with a great degree of accuracy. MRI should be considered in severe and extensive cases, where thorough soft tissue evaluation is important. Studies showed its efficiency to assess orbital complications involved in ZMC fractures.

Possible structural herniation or entrapment of the infra-orbital nerve, should consider MRI to assess the involved soft tissues [10]. In fact, Ilankovan et al. [11] found MRI more to be sensitive, in comparison to CT, for the diagnosis of herniation and entrapment of soft tissues in orbital fractures.

The aims of treatment are to precise anatomical reduction of the fragment, provide stable fixation of the reduced fragment and correct the complications: diplopia, remove any interference in range of mandibular movement, relieve pressure from infra-orbital nerve

Indications for treatment of ZMC fractures depend on two features: function and esthetics. The decision to intervene surgically in patients with ZMC fractures should be based primarily on whether there is displacement of the malar complex and the existence of functional findings. The necessity of internal fixation is then judged.

Surgical treatment in generally indicated for displaced fractures should be surgically reduced and stabilized. The degree of displacement can be easily checked by assessing the status of the normal articulations of the ZMC with the craniofacial skeleton on CT scan.

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For mildly displaced ZMC fractures, especially those involving 1–2 articulations, often times the reduced segments may be stable enough to avoid fixation. It is best to complete the procedure within 2–3 weeks of the initial trauma to avoid early fibrous union of bony segments which can make reduction difficult. This method can be completed via multiple open or closed approaches depending on the fracture location and necessity for direct visualization of the segments to confirm reduction [12].

Open reduction and internal fixation of ZMC fractures is indicated in largely displaced, comminuted fractures, or in mildly displaced fractures in which stable reduction is not achieved following reduction. As described by Ellis et al., anatomically accurate reduction of the ZMC is best obtained by

direct visualization of multiple sutures if necessary. Additional fixation is not related to better outcomes if the proper reduction was not completed initially [13], [14].The issue that our study raises is how much fixation is enough fixation?

In our series all of our patients were treated with ORIF with two point fixation in the FZ suture and infra-orbital rim through a lateral eye brow incision and and mid eyelid incision respectively.

This chapter will discuss the different fixation sites in ZMC fractures and the possible surgical approaches to each one.

Hwang et al [6] carried out their surgical procedure on an average of 6.4 days after injury, and most had surgery within 1 week (58.2%). Yamsani et al. [15] treated the majority of their patients 7 days after their reporting. For some authors, the adequate time depends also on existing neuropathy: surgery is delayed until vision has stabilized or improved [16], [17], [18].

In our series, the average time of surgical intervention was of 9,5 days, most patients were treated after the 8th day, to give enough time for the edema to be resolved. The surgery is then performed under satisfactory local conditions to have better approaches and promote better healing.

The ideal surgical approach to treat fractures of the ZMC should provide enough exposure of the fractured segments, ensure less potential for further injury to facial structures, and allow for good cosmetic results. Ideas differ sharply as to the surgical approach from a surgeon to another.

In our study, prophylactic antibiotics were prescribed for all our patients for sinus coverage since we considered ZMC fractures to be open fractures. For Lee et al. [19] antibiotics are not indicated in non-displaced fractures. Andreasen et al. [20] concluded in their systematic review that infection rates were so low in isolated zygomatic fractures that prophylactic antibiotics were not recommended.

Corticosteroids are initiated by many surgeons to minimize swelling and further damage to the optic nerve. In addition, surgery is delayed until vision has stabilized or improved [21], [22], [23].

Surgical treatment in generally indicated for displaced fractures should be surgically reduced and stabilized. The degree of displacement can be easily checked by assessing the status of the normal articulations of the ZMC with the craniofacial skeleton on CT scan.

- Lower eyelid approach:

There are three basic approaches through the external skin of the lower eyelid to give access to the inferior, lower medial, and lateral aspects of the orbital cavity:

+Subciliary (lower blepharoplasty), it can be extended laterally to gain access to the lateral orbital rim.

+Subtarsal (lower or mid-eyelid)

+ Infraorbital (inferior orbital rim)

The course of the incisions is aligned to the slope of the natural skin creases which become more apparent with age. The skin of the eyelid is the thinnest in the human body. It has little or no dermis and almost no subdermal fat.

- Upper eyelid approach
- Superolateral approach :

In most cases one of these approaches will be the only incision necessary for treatment, given the relative strength of the ZF pillar, which typically makes it the last buttress to be displaced. If indeed this displacement is seen on the preoperative CT scan, then consideration can be given to making a lateral eyebrow or upper-lid incision to visualize this buttress [24].

• Supraorbital approach : lateral eyebrow

- Transconjunctival approach The typical inferior fornix transconjunctival approach can use two different routes to access the infraorbital rim:
- Hemicoronal approach : This approach is used to expose the anterior cranial vault, the forehead and the upper and middle regions of the facial skeleton. The coronal incision is well described for access to the zygomatic complex especially the zygomatic arch [25].
- Endoscopic approach :

More recently, endoscopic technique has been used successfully at various centers in the management of zygomatic arch fractures via small periauricular incision [26], [27]. This minimally invasive approach negates the need for coronal incisions and appears to be a promising tool that augments

The first step is accurate reduction of the fracture body. It can be done indirectly using the temporal approach, the Keen's approach or the percutaneus approach as it is the case in our series; where we used Ginstet hook to reduce the fractured fragment. It can also be done directly through the earlier explained approaches (open reduction). Fixation can be achieved in 1 to 4 fracture sites in the ZMC, with different combinations. Multiple methods are described in literature. This varies according to the experience of the surgeon, the associated clinical findings and the available technology in the operating room (intraoperative CT, navigation, etc.).

<u>**1 point fixation**: </u>According to literature one point fixation is usually used when no orbital reconstruction is needed, for displaced simple non-comminuted fractures. It is a less invasive technique if fragment "snaps" into place with reduction. ZMB is the most popular fixation site, as it is the most commonly affected buttress of the ZMC[28][29].It is the most used when it comes to only inserting one point fixation and that through a gingivobuccal sulcus incision [30].

The reason that this surgical approach is chosen as the first point of exposure is two-fold. First, the scar is hidden within the oral cavity so the chance of an iatrogenic deformity is nil. Second, the ZMB is a key point for alignment of the displaced zygoma [31].

A study that compared 1 point fixation in the ZMB area to 2 point fixation in the ZMB and FZ area in selected patients with tripod fractures, showed that 1 point fixation at the ZMB avoid unsightly scars and give high satisfaction with surgical outcomes [32].For other authors, the adequate first point fixation is the FZ suture, as is the case for the Academic Centre for Dentistry of Amsterdam team's protocol [33].

2 point fixation: is used when anatomic reduction cannot be confirmed using one point. It allows the visualization of an additional fracture site and a better stabilization to the ZMC.

- ZMB+ ZF: Zhang et al.[34] used these two areas for fixation in all of their patients. Additional incisions were added only when necessary. This means in most patients lateral eyebrow incision plus maxillary vestibular incision was enough to accomplish reduction and fixation.
- ZMB+infraorbital rim: When the ZMC is considered unstable after placing a titanium miniplate along the fracture line at the ZMB or if this area is grossly comminuted then a plate may be placed extraorally through the skin incision at the infra orbital rim as it would also provide orbital floor revision according to Courtney et al. [35].
- ZF+infraorbital rim: Lee et al. [36] used a single transconjunctival approach to access both the ZF suture and infraorbital rim, they believe it is a very useful technique for the treatment of zygomatic complex fracture which is not severely comminuted, because it provides excellent exposure and postoperative stability of the zygoma with a lower incidence of complications, including visible scarring and ectropion. For Shumrick et al. [37], the infraorbital rim is rarely a major contributor to the ultimate stability of a ZMC or midface fracture as stability comes from the ZMB, ZF suture, and zygomatic arch.In our series we used these two areas to fixate the ZMC through the lateral eyebrow approach and the subtarsal approach. We believe that these two points provide a 3-plane fixation in space to ensure the stability of the ZMC with good exposure to the orbital floor and lateral orbital wall in case reconstruction is needed.

3 point fixation: is mainly indicated when the fracture is displaced and/or comminuted requires more than 2 point exposure to verify reduction and need for orbital reconstruction. According to the biomechanics of the facial skeleton's investigation discussed by Rudderman and Mullen [38], fractured zygomatic segment has six possible directions of motion: translation across x, y and z axis; rotation about x, y and z axis. Therefore, the most favorable fixation situation can be created by choosing three fixation points that are not collinear. Pearl [39] agreed to this theory and concluded that it is essential to reposition the zygoma at a minimum of three locations to achieve correction in three dimensions. He further opined that reduction at the FZ suture and inferior orbital rim can still leave persistent lateral rotation in the region of the anterior maxillary buttress leading to intra-orbital volume expansion behind the axis of globe. Choi et al. [40] demonstrated that using the preauricular approach is more useful than the conventional method that uses the coronal approach when adopting 4 point fixation.

4 point fixation: is indicated for complex zygomatic fractures where exposure of the ZA is necessary to ensure proper reduction of the ZMC. The ZA is considered to be the fourth point upon the reduction. ZA destruction due to trauma changes the antero-posterior direction of the zygomatic body and expands the facial area [41]. Thus, appropriate diagnosis of the relationship of the ZA with the basal skull posteriorly and with the facial center anterior is considered most important in the treatment of midfacial trauma, posttraumatic disfigurement, and a ZMC fracture [42]. The fourth point is used as an extensible approach to fixing the ZA via a coronal incision using the incision line behind the hairline. The exact reduction of the ZA area showed good outcomes in patients with a ZMC fracture.

However, complications such as a longer scar on the scalp, extended hair loss of the incised site, injury of the temporal branch of the facial nerve, numbing or tingling of the supraorbital and supratrochlear nerves, and atrophy of the temporal fat pad may occur. Furthermore, a longer operation time and hospitalization period may be required.

Postsurgical enophthalmos usually results from not reconstructing the orbital floor/walls when indicated, or doing so inadequately [43]. Studies have shown that post-traumatic enophthalmos is most commonly caused by an increase in the size of the bony orbit [44]. Lateral positioning of the ZMC is one of the most common methods for increasing orbital volume because of the cross-sectional area of the orbit at the level of the displaced ZMC. In our series we used Prolene mesh for small bone defects. This choice is due to the absence of other options, but it gives a good outcome according to our experience.

CONCLUSION

At the end, ZMC should be surgically treated based on both clinical and radiographic signs, with minimal incisions to avoid unnecessary scaring. Thus intra oral incisions should be prioritized, for the solidity of ZMB and nonexistence of scars. If stability isn't achieved an upper eye lid incision should be made to expose the FZ suture. Then a third point at the infraorbital rim through subtarsal incision, to achieve optimal stability when it's not achieved by the 2 first points.

Figure 1: Per operative image showing the used approaches in our study

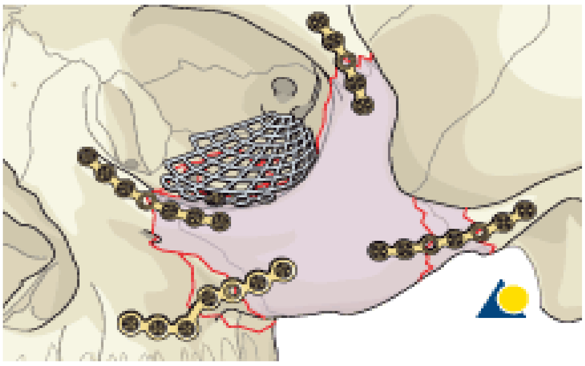

Figure 2: 4 point fixation with orbital reconstruction

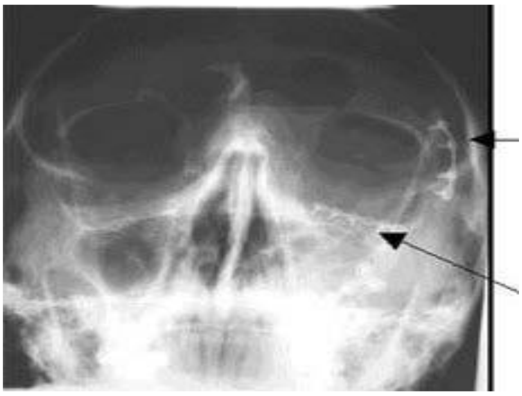

Figure 03: Control Water's radiograph, osteosynthesis at the FZ suture and IOR

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