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**Review Article**

# Zygomaticomaxillary complex fracture

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## Abstract

The zygomatic maxillary complex (ZMC) plays a crucial role in the structural and functional integrity of the facial skeleton. Its prominent convex shape makes it particularly susceptible to injury. Facial trauma can sometimes result in fractures confined to a single buttress of the ZMC, but more commonly leads to tetrapod fractures that involve all four buttresses. Accurate clinical diagnosis relies on a thorough head and neck examination, supplemented by an ophthalmologic consultation when necessary. Computed tomography (CT) is the gold standard for confirming the clinical diagnosis and for planning surgical intervention. Various surgical approaches to the ZMC include the hemicoronal approach to the zygomatic arch, the transconjunctival and subciliary approaches to the orbital rim, and the sublabial approach to the zygomatic maxillary suture line. Understanding the complex anatomy of the ZMC and utilizing classification systems helps in effective treatment planning, ultimately restoring both function and appearance for patients with ZMC fractures.

**Keywords:** Zygomatic complex, Tetra-pod fracture, Incisions, Miniplate fixation, Reduction

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## 1. Introduction

Zygomatico-maxillary (zygomaticomalar) complex (ZMC) fractures involve the disruption of the malar eminence at four key points: zygomaticomaxillary, frontozygomatic (FZ), zygomaticosphenoid, and zygomaticotemporal buttresses. These fractures are the second most common type of facial fractures, following those of the nasal bones. The malar eminence's prominence makes it particularly vulnerable to fractures. Additionally, the complex three-dimensional (3D) anatomy of the ZMC often poses significant challenges in its repair.[1]

The ZMC can be best understood by examining the bony anatomy of this area. The malar eminence, located roughly 2 cm below the lateral canthus, is the most prominent part of the ZMC and serves as its central point. From this central malar eminence, there are four bony connections to the skull: the superior connection to the frontal bone (frontozygomatic suture line), the medial connection to the maxilla (zygomaticomaxillary suture line), the lateral connection to the temporal bone (zygomaticotemporal suture line), and the deep connection to the greater wing of the sphenoid bone (zygomaticosphenoidal suture line). (**Figure 1**) Blunt trauma to the ZMC often results in fractures at all four suture lines, hence the term "tetrapod fracture". Some experts, however, regard the medial attachments to the maxilla and sphenoid bone as a single unit, and therefore, refer to these injuries as "tripod fractures" instead of "tetrapod fractures".[2]

### *1.1 Classification*

Several classification systems have been developed to assist in the treatment planning of ZMC fractures and to provide a concise description of each type of fracture. The first of these was the Knight and North,[3] classification, which categorizes fractures into six anatomical groups: Group I involves no significant displacement; Group II includes direct blows that cause the malar eminence to buckle inward; Group III consists of unrotated body fractures; Group IV includes

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medially rotated body fractures; Group V involves laterally rotated body fractures; and Group VI comprises complex fractures with additional fracture lines across the main fragment. Knight and North indicated that fractures in Groups II and V typically required only closed reduction without fixation, whereas Groups III, IV, and VI necessitated fixation for adequate reduction. However, Pozatek et.al.[4] later found that up to 60% of Group V cases were unstable for closed reduction.

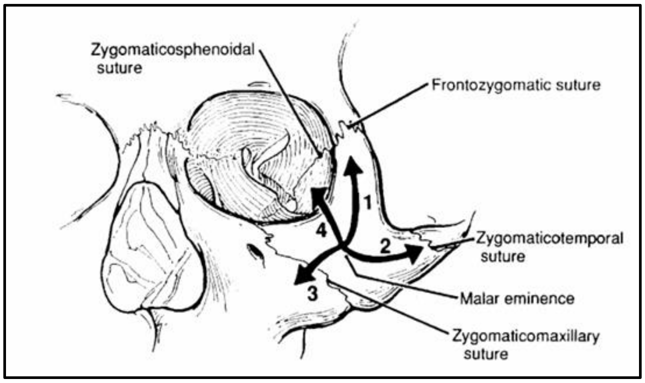


**Figure 1:** The illustration depicts the four suture lines involved in a zygomaticomaxillary complex fracture. The arrows indicate how energy is dispersed following an impact on the malar eminence[2]

Other classification systems have also been established. Manson et.al[5] proposed a system based on computed tomography (CT) scans to classify ZMC fractures into three levels: low-energy fractures, which involve minimal displacement and incomplete fractures; medium-energy fractures, which involve moderate displacement with complete fractures across all buttresses; and high-energy fractures, which are the most severe and often associated with other midface fractures. Zingg et.al[6] developed a comprehensive classification system for all ZMC fractures, categorizing them as Type A, B, or C. Type A fractures involve only one site of the ZMC, such as the arch (A1), the lateral orbital rim (A2), or the inferior orbital rim (A3). Type B fractures affect all four suture lines of the ZMC. Type C fractures are characterized by comminuted fractures.

*1.2 Signs and symptoms*

Patients with Zygomaticomaxillary Complex (ZMC) fractures can present with a range of symptoms depending on the fracture's severity. Commonly, patients exhibit swelling, edema, subcutaneous emphysema, and ecchymosis over the malar eminence. Often, the depression of the ZMC is not apparent until the swelling and edema subside. Pain and tenderness are typically noted upon palpation along the fracture lines, and numbness can occur due to disruption of the infraorbital nerve and its branches. Some experts recommend open reduction and internal fixation to restore sensation when infraorbital nerve dysfunction is present, as this method tends to expedite nerve recovery compared to closed reduction.[7,8]

Patients may also experience trismus following a ZMC fracture, likely caused by the depressed arch impinging on the temporal muscle or coronoid process, depending on the fracture's location. Posterior displacement of the zygoma can lead to impingement on the coronoid process, resulting in trismus. Such fractures that compress the coronoid process must be repaired to avoid osteogenesis and ankylosis of the mandible, which might necessitate a coronoidectomy. The temporalis muscle can also contribute to trismus, especially if compressed by a mid to posterior zygomatic arch fracture. Patients often report significant pain when attempting to open their mouths due to the fractured bone rubbing against the temporalis muscle.[1]

Diplopia is a common symptom in complex ZMC fractures because one of the fracture sites involves the zygomaticosphenoid suture. Bone fragments can compress the extraocular muscles, leading to gaze limitation and muscle entrapment. Younger patients might develop a greenstick fracture of the orbital floor, causing a "white-eye fracture" where the inferior rectus muscle entrapment keeps the affected orbit stationary while the other eye moves normally on upward gaze (**Figure 2**). Hematomas can also cause delayed diplopia, which typically resolves as the hematoma subsides. Ellis et.al[10] reviewed over 2000 cases of ZMC fractures and found that up to 12% of patients experienced diplopia. Additionally, enophthalmos can accompany diplopia when a significant amount of orbital content herniates into the maxillary sinus, affecting 3% to 4% of patients with ZMC fractures. Repairing the orbital floor and reducing the zygomaticosphenoid fracture usually resolves enophthalmos and diplopia. Urgent or emergent repair of a ZMC fracture is necessary when muscle entrapment or an oculocardiac reflex is present, especially in children.[9]

**Figure 2:** White-eye fracture” from inferior rectus muscle entrapment in a right orbital floor fracture.[1]

## 2. Diagnosis

Currently, ZMC fractures, along with other maxillofacial fractures, are diagnosed using high-resolution and 3D CT scans. In the past, plain films were utilized to identify ZMC fractures, but the accessibility of CT scans has made them the gold standard for diagnosing these fractures and guiding treatment options.[11]

Axial images provide the best view of the zygomatic arch, vertical orbital walls, and maxillary sinus, while coronal cuts offer superior visualization of the frontozygomatic suture line, and the lateral and infraorbital rims. Additionally, 3D reconstructions of CT images enable surgeons to better visualize and repair malpositioned bones.[12]

3D CT scans are particularly useful for ZMC and midface fractures.[13,14] However, they do not replace 2D imaging entirely, as 3D CT scans are limited to bone visualization and do not adequately assess soft-tissue deformities. Orbital fractures are also less clearly seen on 3D reconstructed images. Despite these limitations, 3D CT scans remain valuable in operative planning and decision-making. With technological advancements, these scans are becoming increasingly accessible and of higher quality.[15]

## 3. Discussion

The primary aim in managing ZMC (zygomaticomaxillary complex) fractures is to achieve a precise, stable reduction while minimizing external scars and preserving function. These goals are often more attainable a few days post-injury, after swelling has decreased and any remaining deformity is more noticeable. Antibiotics should be started before surgery and continued for 24 hours after the procedure.[16]

*3.1 Surgical approaches[17]*

*3.1.1 Frontozygomatic buttress (**Figure 3**)*

Lateral Brow Incision

1. Length: 2-3 cm, placed parallel to the lateral brow margin.
2. Benefits: Concealed but risks alopecia and brow asymmetry.

Upper Blepharoplasty Incision

1. Length: 2-3 cm, hidden in the eyelid crease.
2. Benefits: No disruption to hair follicles and generally heals with minimal scarring.

*3.1.2 Hemicoronal Incision*

1. Provides extensive exposure, suitable for complex fractures.
2. Risks: Potential injury to the temporal branch of the facial nerve.

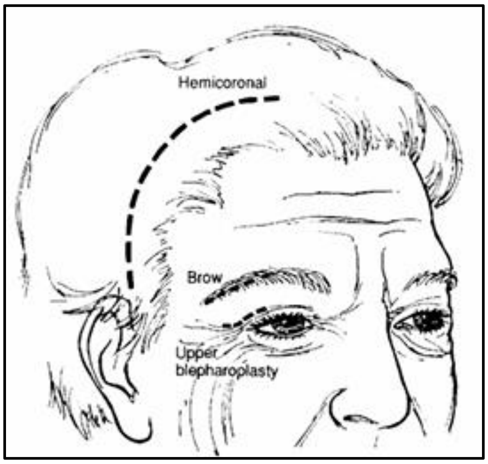


**Figure 3:** Approaches to the frontozygornatic buttress: hernicoronal, brow, and upper blepharoplasty incisions.[2]

*3.2 Inferior Orbital Rim (**Figure 4**)*

*3.2.1 Transconjunctival Incision*

1. Concealed, low risk of ectropion, sufficient exposure.
2. Approaches: Preseptal or retroseptal dissection.

*3.2.2 Subciliary Incision*

1. External incision with a higher risk of ectropion.
2. Provides direct and extensive exposure.

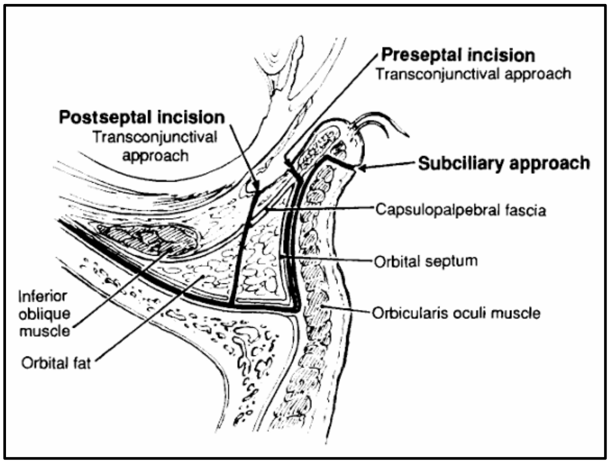


**Figure 4:** Surgical approaches to the orbital floor[2]

## 4. Zygomatic Arch

*4.1 Direct percutaneous approach:*

Percutaneous methods make use of a minimal facial skin incision, usually right over the zygoma or the lateral brow (Dingman's method) through which instruments may be inserted to manipulate and elevate the displaced zygoma.

## 5. Temporal (Gillies) Approach

It involves an incision made within the hairline, which effectively prevents visible scarring. This technique is highly reliable for applying consistent force during reduction and can be utilized for adjusting both the zygomatic arch and the zygoma. It leverages the anatomical plane between the temporalis fascia and the temporalis muscle, providing direct access to the zygomatic structures. However, it is contraindicated if there is a concurrent fracture of the temporal bone. The incision is typically made approximately 2 cm above the helix of the ear, following the path of the anterior branch of the superficial temporal artery and remaining well within the hairline. The dissection proceeds through the skin, subcutaneous tissue, and galea aponeurotica (temporoparietal fascia or TPF) to reach the temporalis fascia. (**Figure 5**)

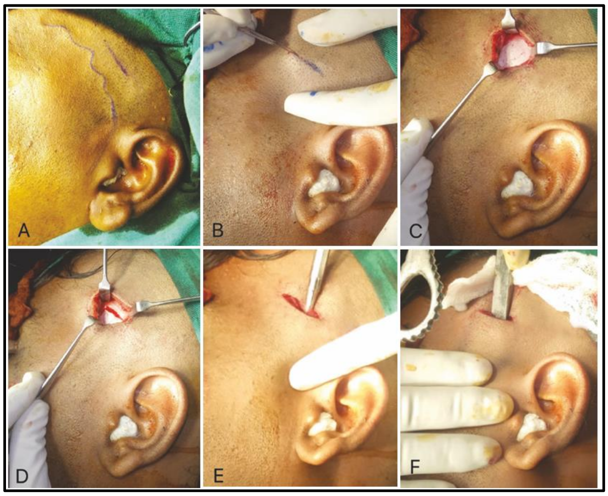


**Figure 5:** Gillies temporal approach. **(a)** Marking of incision parallel to frontal branch of superficial temporal artery. **(b)** Placement of incision. **(c)** Exposure of deep temporal fascia. **(d)** Incision through deep temporal fascia exposing temporalis muscle. **(e)** Developing plane of elevation with periosteal elevator. **(f)** Placement of Rowe's zygomatic elevator for elevation.

## 6. Hemicoronal Approach: (Figure 6)

Direct method involves reduction of the fracture under direct visualization.

Open method is resorted to when the ZMC fracture is:

1. Severely displaced
2. Complex or comminuted
3. When stable reduction is doubtful
4. There is a need for internal orbit reconstruction.

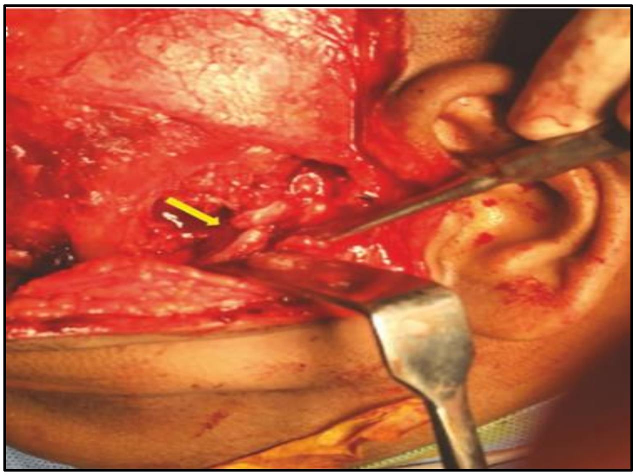

**Figure 6:** Direct reduction.

## 7. Zygomaticomaxillary Buttress

*5.1 Transverse buccal sulcus incision*

1. Placed 1.5-2 cm above the gingiva, offers direct exposure.
2. Risks: Intraoral contamination and limited access to posterior fractures.

## 8. Fracture Reduction and Fixation

*6.1 Fixation techniques*

Three basic fixation methods are available for ZMC fractures

*6.2 Temporary support*

Provide support to reduced fragments

*6.3 Indirect fixation*

1. Indirectly fixed using anchorage from a distant site
2. Indicated in Comminuted fractures and when unable to visualise fracture site

Modalities: Trans-osseous pins (K wire, Steinmann pins), External fixators **(Figure 7**)

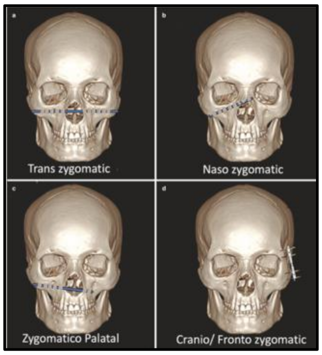


**Figure 8:** Techniques for indirect fixation

*6.4 Direct fixation*

1. Fracture is visualized by surgical exposure and directly fixed
2. Modalities:

*6.5 Trans-osseous wiring*

*Miniplates and screws-* The principal method of fixation is miniplate osteosynthesis.

Miniplates are chosen based on rigidity requirements, anatomical site involved, presence of bone deficits, and biological considerations pertaining to protection of adjacent vital structures.

The number of fixation points is directly proportional to the requirements of stability. Five different possibilities exist (

**Figure 8**)

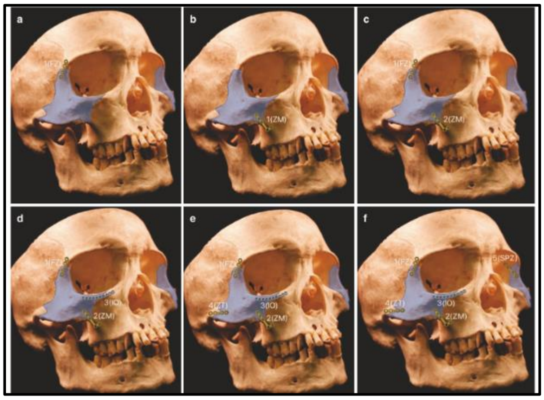

**Figure 9:** Types of fixation using miniplates. **(a)** One-point fixation at FZ suture; **(b)** one-point fixation at ZM buttress; **(c)** two-point fixation; **(d)** three-point fixation; **(e)** four-point fixation; and **(f)** five-point fixation.

***Microcompressive screws***- Micro screws are 2 mm screws which are used to fix sagittal zygomatic fractures by using the lag screw technique.

Achieving a stable, precise reduction of ZMC fractures involves selecting appropriate surgical approaches, minimizing scarring, and preserving function. Preoperative antibiotics, meticulous surgical techniques, and suitable fixation methods are critical for successful outcomes.

## 9. Conclusion

The primary objective in managing Zygomatic maxillary Complex (ZMC) fractures is to achieve precise and stable bone alignment while minimizing visible scars and preserving function. This is often best accomplished several days post-injury, once swelling subsides and deformities are more noticeable. Understanding the intricate anatomy of the ZMC and utilizing appropriate classification systems are essential for planning effective treatment.

High-resolution and 3D CT scans are crucial for accurate diagnosis and surgical planning. Different surgical approaches, each with specific advantages and risks, are selected based on the fracture's location and complexity. Administering preoperative antibiotics and employing meticulous surgical techniques are vital to prevent infections and ensure successful outcomes.

The choice of reduction and fixation techniques, such as wire and miniplate fixation, depends on the fracture's characteristics and the need for stabilization. Key principles in managing ZMC fractures include adequate exposure, precise reduction, and accurate stabilization. Using existing lacerations for incisions and careful soft tissue management also contribute to better surgical outcomes.

By selecting the appropriate surgical approach and fixation method, and adhering to these principles, surgeons can effectively restore both function and appearance, achieving the best possible results for patients with ZMC fractures.

## 10. Source of Funding

None.

## 11. Conflict of Interest

None.

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