

MIDFACE FRACTURES – AN OVERVIEW

Correspondance to: Dr. Visalakshi kaleeswaran¹, Post graduate in the department of oral and maxillofacial surgery, Sree balaji dental college and hospital, pallikaranai, chennai-100.

Author Details:

Dr. Visalakshi kaleeswaran¹, Dr. Balakrishnan Ramalingam²,

Post graduate in the department of oral and maxillofacial surgery, Sree balaji dental college and hospital, pallikaranai, chennai-100.

professor in the department of oral and maxillofacial surgery, Sree balaji dental college and hospital, pallikaranai, chennai-100.

1. INTRODUCTION

Fractures of the midface pose a significant medical problem as for his or her complexity, frequency and their socio-economic impact. Inter disciplinary approaches and up-to-date diagnostic and surgical techniques provide favorable results in the majority of cases though. Traffic accidents are the leading cause and male adults in their thirties are affected most often. Treatment algorithms for nasal fractures, maxillary and zygoma fractures are widely prescribed whereas trauma to the sinus and therefore the orbital apex are matter of current debate. As for the fractures of the sinus a robust tendency towards minimized approaches are often seen. Obliteration and cranialization seem to decrease in numbers. Some critical remarks in terms of high dose methyl prednisolone therapy for traumatic optic nerve injury seem to be appropriate. Intraoperative cone beam radiographs and pre shaped titanium mesh implants for orbital reconstruction are new techniques and essential aspects in midface traumatology. Fractures of the anterior skull base with cerebrospinal fluid leaks show very promising results in endonasal endoscopic repair.

The main focus is placed on bony injuries. Lesions of the soft tissue are mentioned only if they are important for the respective pattern of injury. Of course, it is very important to treat them appropriately because even in cases of perfectly reconstructed bony skeleton, scars may lead to deformities and dysfunctions that can only be corrected secondarily with significant difficulties [1], [2].

Trauma of the midface regularly lead to lesions of soft tissue, teeth, and bony structures of the skull including the maxilla, the zygomatic bone, the naso-orbital and naso-ethmoid (NOE) complex as well as supraorbital structures. Not rarely, those lesions of the midface are combined with injuries of other parts of the body [3]. Patients with midfacial fractures who do not undergo successful or appropriate treatment may suffer from significant long-term consequences such as disfiguring scars, bony deformities, or even loss of vision [4]. Relevant emotional and psychological problems may result from trauma[5],[6]. The successful treatment and rehabilitation of patients with lesions of the midface requires a profound knowledge of the anatomy, fractures, and techniques of osteosynthesis. Additionally, special knowledge in the field of occlusion, physiology of the eye, and skull base surgery are essential.

2. EPIDEMIOLOGY OF MIDFACE TRAUMA

ETIOLOGY: The etiology of midfacial trauma are mainly due to domestic accidents on the other hand, sports accidents are found more often in younger people [7].

SITE : Injuries of the lateral midface (63%) occur more frequently than central ones.

SEX PREDILICTION : males are affected more often than females.

AGE: There is a peak age in the 2nd and 3rd decade of life. Street accidents occur more often than sports accidents[8].

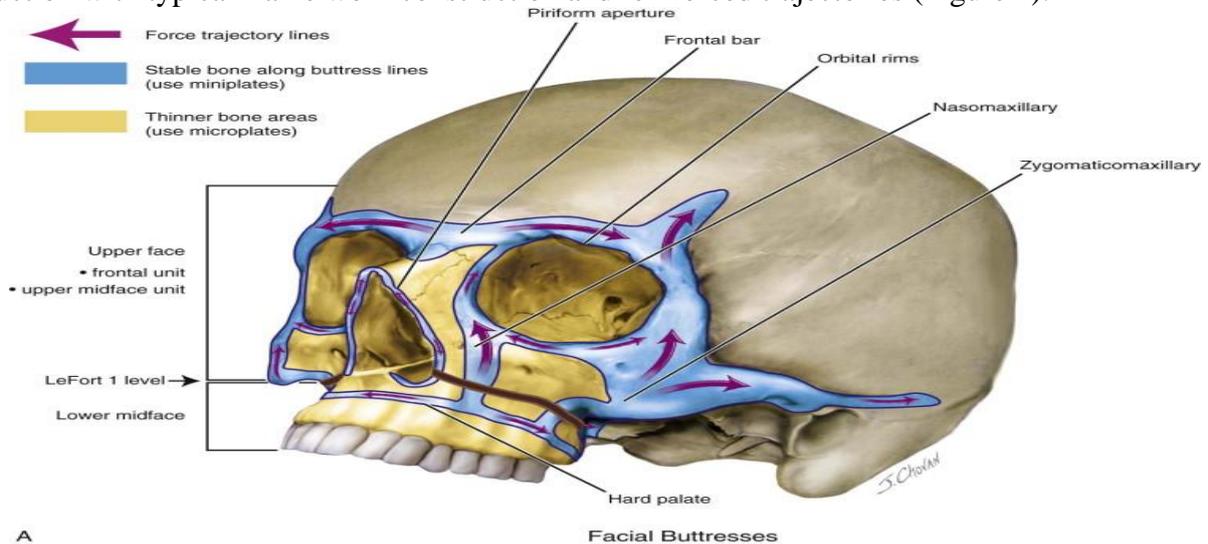
ANATOMY

The mid face consists:

nasal bones

lacrimal bone,

ethmoid,
sphenoid,
maxilla,
zygomatic bone and
palatine bone[9]. These aforementioned bones merge to the facial skull in a particular kind of light weight construction with typical frame work construction and reinforced trajectories (Figure 1).



The vertical trajectories, i.e. the supporting pillars of the midface are

- nasomaxillary buttress
- zygomaticomaxillary buttress and
- pterygomaxillary buttress

these buttresses are responsible for transmitting the masticatory forces to the skull base and the bony structures of the neurocranium.

The transversal trajectories of the midface are

- supra orbital bone margins
- infra orbital bone margins and
- the alveolar process of the maxilla

these offers resistance against horizontally transmitted forces

3. CLASSIFICATION OF MIDFACE FRACTURES

- central midface
- lateral midface

CENTRAL MIDFACE:

1. Le Fort I fracture

Other names: Guerin fracture, subzygomatic fracture , horizontal fracture, low level fracture and floating fractures

FRACTURE LINE: extends from the piriform aperture through the zygomatico-maxillary crest to the maxillary tuberosity to fracture the pterygoid plates into lower 1/3rd and upper 2/3rds transversely.

The maxilla is separated from the skull in a horizontal plane above the teeth apices and the hard palate.

Clinical features of lefort 1:

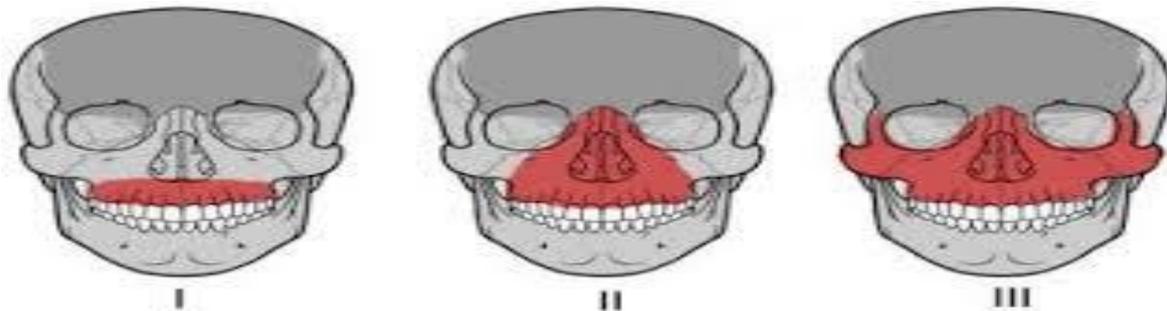
- swelling of upper lip and cheek
- ecchymosis in the maxillary buccal sulcus due to shearing of soft tissues or periosteal tear
- nasal block due to mucosal tear of maxillary or ethmoidal sinus

- **Guerin sign** – b/l ecchymosis of the palate in the region of greater palatine foramen
- Occlusion- anterior open bite, posterior gagging of occlusion which is a severe threat to airway
- Palatal fractures which can be -alveolar, sagittal , parasagittal, para-alveolar, transverse and complex.
- Cracked pot sound on percussing the maxillary teeth
- Floating maxilla – mobility of dentulous maxillary fragment
- Step deformity

2. Le Fort II fracture

Other names: pyramidal fractures, subzygomatic fractures

THE FRACTURE LINE : extends from the frontonasal suture via the fronto-maxillary suture through the lacrimal bone to the floor of the orbit. From there, it extends through the infra orbital margin via the facial wall of the maxillary sinus to the zygomatico maxillary crest. The further course of the fracture line extends around the maxillary tuberosity into the pterygoid process, from there through the perpendicular plate of the palatine bone and the medial wall of the maxillary sinus via the ethmoid to the medial orbital wall into the nasion. From the nasion, the fracture goes through the nasal septum in caudal direction and ends at the posterior edge of the vomer. The integrity of the orbit is destroyed in the context of such a pyramidal fracture [10].



Clinical features of lefort 2 :

- Gross oedema of middle third of face – ballooning or moon facies
- Subcutaneous emphysema – crepitus felt on palpation due to direct communication between the sinus wall and soft tissues of the face
- Telecanthus
- Epistaxis
- Epiphora
- B/L circumorbital / periorbital ecchymosis + oedema = racoon eyes
- Subconjunctival haemorrhage restricted to medial aspect
- Chemosis/oedema of conjunctiva
- CSF rhinorrhoea
- Step deformity at the infraorbital margin and nasofrontal junction
- Enophthalmos , restricted ocular mobility and diplopia
- Anaesthesia or paraesthesia of the cheek due to involvement of infraorbital nerve
- Retro positioning of whole maxilla and posterior gagging of occlusion
- Elongated appearance of the face
- When the maxillary alveolus is grasped anteriorly the midfacial skeleton moves as a pyramid and movement can be detected at the infraorbital margins and nasal bridge.

3. Le Fort III fracture

Other names: suprazygomatic fracture , craniofacial dysjunction , high level fracture

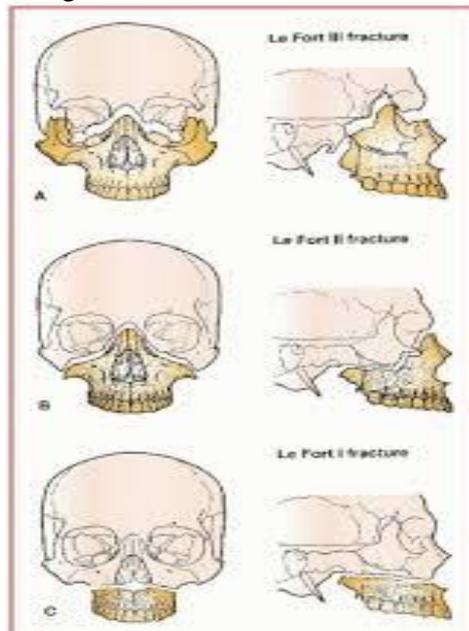
THE FRACTURE LINE: extends from the naso frontal suture via the medial wall and the floor of the orbit to the inferior orbital fissure. From there, is fracture line extends through the lateral orbital wall to the zygomatico-frontal suture and through the zygomatic archs. From the nasofrontal suture, the fracture line

draws inside through the ethmoid and the lamina perpendicularis of the palatine bone to the pterygopalatine fossa. The pterygoid process is also fractured and the vomer can be severed at the transition of the sphenoid bone. In the context of Le Fort II and III fractures, the cribriform plate might be injured because of fractures in the area of the ethmoid bone leading to a possible CSF leak. The frontal and sphenoid bones may also be affected.

The facial skeleton is separated from the cranial skull.

Clinical features of lefort 3:

- Racoon eyes
- Dish face deformity
- Lengthening of face
- Hooding of eyes – due to alteration of the globe level due to damage to suspensory ligament of lockwood
- Enophthalmos, hypoglobus and diplopia
- CSF rhinorrhoea, otorrhoea
- Severe posterior gagging of occlusion
- Step deformity @ lateral orbital rims bilaterally , zygomatic arch and nasal bridge
- Posterior nasal bleed / pharyngeal bleed from nasopharyngeal tear
- Mobility of entire midfacial skeleton as single unit with simultaneous mobility felt at Fronto zygomatic suture and nasal bridge.



Surgical intervention

Le Fort fractures are treated either in a closed or open reduction. The surgical treatment should be performed within atleast 2 weeks. The interval between 7 and 10 days is considered as optimal because at that time typically the swelling is clearly reduced [11].

Approaches:

Incision/approach	Exposition/presentation
1. TRANS / INTRA ORAL APPROACH	
Superior vestibular sulcus incision(OSI)	Le fort 1 level Facial wall of maxillary sinus Zygomaticoalveolar crest Inferior nasal aperture

	Nasal floor and septum
2. TRANS CONJUNCTIVAL INCISIONS	
A. Inferior fornix	Inframedio orbital walls
B. Trans/pre caruncular	Medial orbital wall
C. Retro canthal	Lateral orbital wall
Combination of the above	Inferior circumference of internal orbit
Lateral canthotomy	Inferior circumference of internal orbit 210°
3. INTRA NASAL	Pterygoid cartilage Septum Nasal bridge
4. TRANSCUTANEOUS ANTERIOR	
Sub ciliary Infra orbital incision	Infraorbital Medio inferio lateral orbital walls
Lateral eyebrow incision	Frontal bone pillar Supero lateral orbit
Modified superior blepharoplasty incision	Frontal bone pillar lateral orbital wall zygomatico sphenoid suture
Glabella incision	Frontal sinus Nose Supra orbital region Medio superior orbital walls Ethmoid and medial canthal structures
POSTERIOR	
Coronal incision With extension in pre or retro auricular direction	Temporo parietal region infero orbital walls Ethmoid and medial canthal structures Frontal sinus Nose Supra orbital region Superior circumference of the internal orbit about 300°

Treatment

The basic principle of treatment consists of an accurate, anatomically correct reconstruction and securing of the bony structures in all three dimensions.

Closed reduction : In cases of closed treatment, the dislocated fracture fragments are repositioned without exposing the fracture lines and after reduction they are fixed in their position by maxillomandibular fixation (MMF) and/or suspension wiring [12].

Technique of wire suspension is only rarely applied in today.

INDICATIONS:

- The closed reduction by MMF and elastic tractions is regularly applied in minimally displaced Le Fort fractures and in patients with reduced operability.
- The closed reposition can also be indicated in acute situations for reduction of bleedings and CSF leaks, especially in the context of severely dislocated Le Fort II and Le Fort III fractures.

maxilla has the tendency to deviate in distal direction because of the traction of the pterygoid muscles. Even MMF cannot safely inhibit that the maxillary deviation in distal position leading to class III malocclusion. The muscular forces can be strong enough to move the mandibular joints dorsally into the external articular

canal. Hence it is important to mobilize the midfacial fragment in a way that the maxilla is passively positioned in the correct position using Rowe's forceps, Stroh meyer's hook, and other mobilization instruments.

Open reduction: In cases of Le Fort I fracture, generally an intraoral incision to expose the fracture line is applied and the maxilla is stabilized after reposition in correct occlusion using 4 miniplates in the area of the anterior midfacial pillars (lateral to the piriform aperture, on the zygomatico-alveolar crest).

In case of larger bony defects following comminuted fractures, bone transplants have to bridge the defects in the area of the trajectories.

In Le Fort II fractures, the fracture lines are exposed in the area of the zygomatico-alveolar crest, in the area of the orbital rim, and if needed also in the area of the naso frontal region and fixed by means of miniplates. Intraorally, the fracture area is reached via the maxillary buccal vestibular incision and the infraorbital edge is exposed via different trans facial or transconjunctival incisions. The nasofrontal region can be exposed by trauma given access, an incision in the area of the glabella, or the coronal incision. surgical treatment of a dislocated Le Fort II fracture consists of the exposing fracture areas, reduction and fixation using osteo synthetic plates. Finally the occlusion has to be verified. for surgical treatment of Le Fort III fractures, the facial skull in the naso frontal and zygomatico-frontal area must be secured to stable bony structures of the neurocranium after reposition [13]. For the correct sagittal position of the mid face there construction of the zygomatic bone structures is of great significance. For exposition and osteosynthesis in these areas, a coronal access may be required.

5. LATERAL MIDFACE

Fractures of the zygomatic bone

zygomatic complex fractures are frequent because of the prominence of the zygomatic bone. They result from direct trauma to the zygoma.

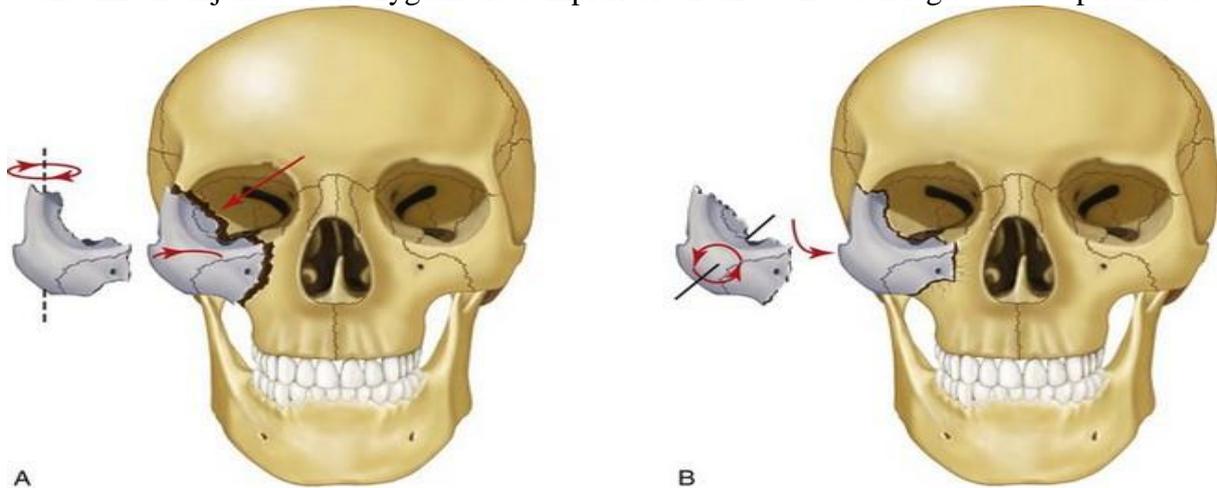
Etiology : Among the most important origins of trauma, violence and traffic or sports accidents are more common [14].

Types: Depending on the direction of the impact vector, rotation and/or caudal and dorsal dislocation of the zygoma results [15].

Direction of dislocation: The dislocation of the zygoma occurs in direction of the impact and then secondarily due to traction of the masseter muscle [16].

Fracture line: In cases of isolated zygomatic bone fractures, the fracture line extends through the zygomatico-frontal suture along the lateral orbital rim and from there in caudal direction along the lateral and anterior orbital floor to the infraorbital edge. From the infraorbital edge the fracture line passed through the anterior wall of the maxillary sinus and in general through the infra orbital foramen to the zygomatico-alveolar crest. From there, the fracture line reaches the inferior orbital fissure cranial to the lateral and posterior wall of the maxillary sinus. The greater wing of sphenoid at the zygomatico sphenoid suture is involved as well [17] as the zygomatic arch. The orbital floor is nearly always affected in cases of fracture of the zygomatic bone. After an impact of high violence, also a comminuted fracture of the zygomatic complex may result and parts of the zygomatic bone may dislocate into the maxillary sinus.

Concomitant injuries of the zygomatic complex often affect the ocular globe and optic nerve.



Clinical symptoms

The symptoms depend largely on the pattern and the extent of the fracture of the zygomatic complex.

- pain
- buccal swelling
- flattening of the zygomatic prominence
- peri orbital ecchymosis and hematoma
- hyposphagma
- epistaxis
- subcutaneous emphysema in the region of cheek and orbit
- palpable step in the area of orbital rim
- disturbed sensitivity in the area of infra orbital nerve(hypoesthesia, anaesthesia , paraesthesia)
- impaired eye movement
- diplopia (mainly in up gaze)
- enophthalmos
- impaired vision
- impaired opening of mouth

Points to remember

The patient should be informed as soon as possible that he must not blow his nose because it may lead to emphysema due to laceration of the mucosa of the maxillary sinus and increased pressure in the paranasal sinuses. The emphysema can extend via the neck into the mediastinum. The emphysema is clinically relevant especially because of the massive swelling of the soft tissue that makes initial examination of the eye difficult and leads to delayed surgery. Usually it is completely absorbed during the first postoperative days though. It may be of highest clinical relevance to early detect neurological and ophthalmological complications that require immediate surgical intervention.

The zygomatic complex is involved in the bony structures of the orbital floor, the infraorbital rim, and the lateral orbital funnel. Hence, each zygomatic bone fracture may damage the eye. So it is essential to perform primary careful examination of vision. The spectrum of lesions of the eyes reaches from injury of the globe and the eye muscles to lesions of the optic nerve with associated blindness.

Surgical indications

In case of non-dislocated zygomatic bone fractures without functional disorders, there is generally no need for surgical therapy.

Frequently, fractures of the zygomatic complex lead to impairment of the infra orbital nerve which can be temporary or permanent. The nerve can be damaged directly because of the trauma or by pinching in its bony canal when the fracture passes through the infraorbital foramen and if fragments are dislocated. In case

of non-dislocated fractures of the zygomatic bone after direct violent trauma, there is explicitly no indication for surgery because the exposition of the fracture could lead to further damage of the nerve. In case of suspected pinching of the infraorbital nerve caused by dislocated bone fragments, there is an indication for surgery, however, also closed reposition of the zygomatic bone complex may be possible [18]. The involvement of the zygomatic arch and according dislocation in medial direction can lead to an impairment of the coronoid process of the mandible and thus to impaired opening of the mouth. In those cases, a clear indication for open or closed reposition of the fractures is given.

According to “AO Surgery Reference” guide of the AO foundation Osteosynthesis of zygomatic bone fractures is classified as 1-point, 2-point, 3-point, and 4-point fixation.

1-point exposition and fixation

Indications: separation of the zygomatico-frontal suture and intact orbital floor. Not comminuted, simple fractures of the zygomatic complex may be sufficiently fixed with only one miniplate.

Access: an intra oral approach with good overview and control of the zygomatico - alveolar crest and the infra orbital rim.

The 1-point fixation is controversially discussed in the area of the zygomatico-frontal suture. From a biomechanical point of view, a fixation seems to be reasonable because it gives resistance to the traction forces of the masseter muscle. On the other hand, the internal aspect of the lateral orbit (zygomatico-sphenoid suture) must be exposed for good control of the result.

2-point exposition and fixation

Beside visualization of the zygomatico-alveolar crest, the exposition of the lateral orbital rim together with the zygomatico-sphenoid suture is useful. The exposition of those two points allows a good control of the correct 3-dimensional reposition of the zygomatic bone as well as a stable osteo synthetic fixation. Alternatively to the lateral orbital rim, the infra orbital rim can be exposed as second point and stabilized by means of a plate.

3-point exposition and fixation For 3-point fixation, the lateral orbital rim, the infra orbital edge, and the zygomatico- alveolar crest are exposed and stabilized by means of osteosynthesis. The exposition of 3 points allows a reliable control of the 3-dimensional position of the zygomatic bone and at the same time a stable fixation of osteo synthesis of all 3 fractured areas. Besides a good control of the zygomatic bone, treatment of a fracture of the orbital floor may be an indication of 3-point exposition.

Isolated zygomatic arch fractures

Fractures of the zygomatic arch that are associated with fractures of the zygomatic complex are treated in the context of repositioning and fixation of the zygomatic bone[19]. Isolated fractures of the zygomatic bone have different appearances. M- or V-shaped impression. Generally those fragments remain stable without further fixation. For the closed repositioning, also a transoral (according to Keen) or a temporal procedure (according to Gillies) can be chosen. If the repositioned zygomatic arch is likely to sink back into the dislocated position, an attempt is possible to stabilize the zygomatic arch in its position by means of an external splint to which the zygomatic fragments are fixed with deep sutures. An external splint that is fixed of the repositioned zygomatic arch also protects the fracture area. It is helpful to assess the result of repositioning to perform intra operative radiological 3D controls. More complex and very instable fractures of the zygomatic arch may require an open exposition of the fracture and osteosynthesis.

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