**Oral and Maxillofacial surgery/Fifth year**

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**Fractures of the middle third of the facial skeleton**

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he facial skeleton can be divided into an upper, middle and lower third. The lower third is the mandible. The upper third is formed by the frontal bone. The middle third is the region extending downwards from the frontal bone to the level of the upper teeth, or if the patient is edentulous the upper alveolus.

The middle third of facial skeleton is formed by bones which articulate with each other in immobile sutures. The bones are:

* Two maxillae
* Two nasal bones
* Two zygomatic bones
* Two palatine bones
* Two inferior conchae
* The ethmoid and its attached conchae
* Vomer bone
* Sphenoid bone

The bones of the midface constitute a series of vertical and horizontal bony struts or ‘buttresses’, these buttresses of the faceconsist of thicker bone that transmits the chewing forces tothe supporting regions of the skull.These are the **pterygomaxillary**, **zygomaticomaxillary**, and **nasomaxillary**buttresses. These vertical pillars are further supported by the horizontal buttresses; the **supraorbital** or frontal bar, **infraorbital rims**, and **zygomatic arches**. Joining these buttresses together is lamellar thin bone. This framework results in fairly predictable patterns of fracture.

The skeleton of the midface has been described as a (crumple zone) that acts as a cushion, absorbing the energy of any cranially directed impacts coming from an anterior or anterolateral direction thereby protecting the brain and conferring a survival advantage.

**The Le Fort classification**

In 1901, René Le Fort described the classical fracture patterns of the midface and determined three main levels of fractures as interruption of buttresses and lamellar bone structures in the midfacial architecture. These fracture patterns are charac­teristic of a unidirectional, low-energy injury rather than the multivector, high-energy mechanisms commonly observed today. However, this system is popular because it provides a simple, anatomically differentiated system for the general classification of midfacial injuries.

**Le Fort I fracture** (also called Guerin fracture or low level fracture)iscaused by a force delivered above the apices of the teeth. The fracture occurs at the level of the piriform aperture and involves the anterior and lateral walls of the maxillary sinus, lateral nasal walls and pterygoid plates at the junction of the lower one-third with the upper two-third. A unilat­eral maxillary fracture may also occur, with the fracture coursing through the palatal suture line or adjacent to it.

**Le Fort II fracture** is also referred to as a pyramidal or sub-zygomatic fracture. This fracture involves the nasofrontal suture, nasal and lacrimal bones, infraorbital rim in the region of the zygomaticomaxillary suture, maxilla, and pterygoid plates half way. It can be unilateral or bilateral.

**Le Fort III fracture** is also called craniofacial disjunction; it starts at the frontonasal suture, runs through the frontomaxillary suture, over the lacrimal bone, the lamina papyracea of the ethomoid bone and towards the optic foramen to reach the inferior orbital fissure, the fracture line divides into two lines. One line passes around the frontozygomatic suture to separate the zygomatic bone from the frontal bone. The other line passes posteriorly to fracture the pterygoid plates at the root, thus separating them from the cranial base.

**Clinical features**

**Le Fort I fracture**

* Examination should include firmly grasp­ing the maxillary arch with the finger and thumb facially and palatally and attempting displacement of the maxilla in three dimensions, as well as compression and expan­sion of the maxillary arch.
* Malocclusion and mobility of whole of dentoalveolar segment of upper jaw may be noted.
* Hypoesthesia of the infraorbital nerve may be caused by the rapid development of edema.
* Palatal ecchymosis (Guerin sign) is usually noted.
* Ecchymosis and tenderness of the zygomaticomaxillary buttress area.
* ‘Cracked pot’ percussion sound from upper teeth.
* Fractured cusps of teeth.

**Le Fort II fracture**

* Grasping the anterior maxilla and attempting anteroposterior displacement facilitates evaluation of the nasofrontal suture and infe­rior orbital rims.
* Edema is often present overlying the frac­ture sites.
* Mobility of the upper jaw.
* Step deformity in the infraorbital rim.
* Bilateral cirumorbital edema and ecchymosis and subconjunctival hemorrhage may be noted, it results from the bleeding at the site of fracture, which escapes in different tissue planes.
* Cerebrospinal fluid (CSF) rhinorrhea may be encountered as the result of a dural tear, although a classical Le Fort II fracture does not include the cribriform plate of ethmoid so CSF rhinorrhea does not take place, unless there is associated fracture of cribriform plate of ethmoid.
* Epistaxis is common.
* Tenderness over the nasal bridge area and possible nasal deformity.
* Hypoesthesia of the infraor­bital nerve is also common because of direct trauma or rapid edema formation.
* Malocclusion is often present in the form of an anterior open bite and gagging of posterior teeth.
* ‘Cracked-pot’ sound on tapping teeth.
* Difficulty in opening mouth, and sometimes inability to move the lower jaw
* Possible diplopia and enophthalmos in severe cases.

**Le Fort III fracture**

* Bimanual palpation reveals abnormal mobility at the frontonasal and frontozygomatic sutures.
* Classic dish face deformity and mobility of the zygomaticomaxillary complex. As the facial bones are disarticulated from the cranial base the elongation of the face takes place leading to long face syndrome.
* Facial edema.
* Circumorbital ecchymosis and subconjunctival hemorrhage.
* CSF leakage due to the involvement of the cribriform plate leading to dural tear and CSF rhinorrhea.
* ‘Cracked-pot’ sound on tapping teeth.
* There may be gagging of the occlusion in the molar area.

**Detection of CSF Rhinorrhea**

Clinical detection of CSF rhinorrhea may be complicated by the presence of lacrimal fluid, blood and nasal secretions. When the blood clots and dries and the flow of CSF continues, it produces a classical **(tramline pattern)**. It also forms classical ring around the clotted blood on the pillow. If the patient is in supine position it passes in the pharynx giving salty metallic taste.

Traditional methods for detecting CSF leak include testing for glucose or protein, but these are neither sensitive nor specific. Testing the discharge for beta-2 transferrin, a brain specific variant of transferrin, is accepted as the best available diagnostic method.

**Imaging**

Plain radiographs have only limited role and they are indicated when three-dimensional imaging (CT scan) is not available, these may include:

**Occipitomental projection**

The occipitomental view (Water’s view) is useful plain radiograph. Two projections angled at 10° and one at 30° are desirable. These views will demonstrate uncomplicated middle third fractures with sufficient detail to determine a treatment plan. For interpretation of occipitomental radiographs systematic examination along lines where bone disjunction can be expected if a fracture has occurred. To facilitate interpretation 5 curved lines (Campbell-Trapnell lines) are frequently used.

The occipitomental view may demonstrate the major areas of fracture discontinuity including the zygomaticomaxillary buttress, the zygomaticofrontal suture and the inferior orbital rim in addition to haziness of maxillary sinus due to hemorrhage.

**Lateral projection**

Le Fort type fractures at each level (I, II and III) can be detected on this view where the fracture line can be seen passing across the pterygoid plates. It is often the only plain view that clearly demonstrates a Le Fort I fracture. It also aids recognition and assessment of any extension of fractures into the frontal sinus.

**CT scan**

A CT scan or cone beam CT (CBCT) with multiplanar and 3-D reconstruction is indicated for visualization and delineation of the magnitude and comminution of the midfacial fractures and for the identification of adjacent fractures, such as those of the maxilla, the naso-orbito–ethmoidal complex and the skull base.

**Treatment**

**Observation**

Observation is indicated in:

* Non-mobile or minimally mobile linear Le Fort I fracture with unaffected occlusion.
* Le Fort I, II or III fractures in edentulous patients with atrophic maxilla provided that they are nondisplaced stable fractures.
* In edentulous patients with minor displacement.
* In cases when general medical conditions do not allow surgical intervention.

A soft diet is advisable for several weeks. Close follow-up is required and patients should be compliant.

**Surgical treatment**

**Reduction**

Effective reduction of maxillary fractures depends on the degree of mobility of Le Fort fractures following injury; in some situations it may be possible to reduce low level maxillary fractures simply by finger manipulation alone otherwise paired **Rowe's disimpaction forceps** can be used to manipulate the fracture into place, also **Hayton-Williams forceps** can be used for the same purpose. The guidance for proper reduction is achievement of satisfactory occlusion and correction of facial deformity.

**Fixation**

Applying IMF using interdental wiring or arch bars alone is insufficient to stabilize the middle third of the facial skeleton because of the mobility of the lower jaw. After using the mandible as a guide to accurate occlusal reduction, the middle third must be immobilized by attaching it to the adjacent facial bones superior to the fracture line. This can be achieved by either internal wire suspension or external suspension. These methods, however, have been superseded by ORIF method.

Methods of internal wire suspension include:

* Pyriform fossa wiring.
* Infraorbital rim suspension wiring.
* Circumzygomatic wiring.
* Supraorbital rim suspension wiring.

In case of Le Fort II fractures the pyriform fossa wiring suspension and infraorbital rim wirings cannot be used for treating as the fracture line passes above these points. In Le Fort III fractures internal suspension is not effective as the fracture line is very high and only supraorbital rim is available for internal suspension.

**Open reduction and internal fixation (ORIF)**

The current method of choice is internal fixation with miniplates, microplates, three-dimensional meshes, and screws. With this method, it is possible to fix even the smallest fragments and to stably bridge areas of comminuted fragments in the buttress regions until the fractures have consolidated.

**Le Fort I fracture**

Surgical exposure is achieved through a vestibular incision, this approach allows visualization of the lateral antral wall and zygomatic buttresses. A Rowe or Hayton-Williams forceps can then be used to complete the reduction, if necessary. The patient is first placed in IMF to reestablish the pretraumatic occlusal relationship. Fixation with miniplates along the **pyriform (nasomaxillary)** and **zygomaticomaxillary buttresses** is routinely provided for stability of this fracture pattern.

**Le Fort II fractures**

In cases of mobile Le Fort II fractures, the additional fixation of the **nasofrontal suture** and the **orbital rim** is required. Occasionally exposure can be sufficient using a vestibular incision, but usually an approach to the orbital rim is required, this is achieved by one of the following:

* Infraorbital incision.
* Subciliary incision.
* Subtarsal or mid–lower lid incision.
* Transconjunctival Incision

Alternatively a midfacial ‘degloving’ approach can be considered for more complex fractures if appropriate, the technique combines an intraoral vestibular approach with degloving of the lower half of the nose to allow wide exposure of the whole maxilla including the nasal skeleton.

**Le Fort III fractures**

In Le Fort III cases, besides buttress reconstruction, the fixation of the frontozygomatic and frontonasal sutures is required, as well as the stabilization of the outer orbital frame and the zygoma. Access to the upper and midface from the cranial base to the maxillary occlusal level is obtained by using a coronal scalp flap with an intra-oral vestibular incision. Additional bilateral approaches to the infraorbital rims and orbital floors are usually needed.

**Palatal fractures**

Isolated fractures of the palate are rare, but up to 8% to 13% of Le Fort fractures are complicated by concomitant palatal fractures.

Clinical examination may reveal laceration of the lip and concurrent gingival and palatal lacerations. Often, a change in occlusion is also noted. Diagnosis is confirmed by a maxillofacial CT with axial and coronal cuts.

**Classification**

Several classification systems have been suggested for palatal fractures. A simplified classification system classifies the palatal fractures into:

* Type I: Sagittal; if the fracture is located at the midline, it is considered the median type. The paramedian type describes a fracture that parallels the midpalatal suture
* Type II: Transverse
* Type III: Comminuted

**Treatment**

Surgical treatment planning depends on the type of fracture, presence or quality of the dentition, and concomitant facial fractures.

Treatment of the palatal fracture in dentate patients should center on occlusal reduction with IMF and ORIF through facial vestibular approach. Occlusal splints can be extremely helpful in the comminuted palatal fracture.

**The zygomatic complex fractures**

The zygomatic complex usually fractures in the region of the frontozygomatic, the zygomaticotemporal and the zygomaticomaxillary sutures. It is unusual for the zygomatic bone itself to be fractured, but occasionally it may be especially due to high energy injuries. Sometimes the bone may even be comminuted. The arch of the zygoma may be fractured in isolation from the rest of the bone.

Fractures of zygomatic complex can be classified as:

* **Fractures of the zygomatic body involving the orbit**

1. Minimal or no displacement.
2. Inward and downward displacement.
3. Inward and posterior displacement.
4. Outward displacement.
5. Comminution of the complex as a whole.

* **Fractures of the zygomatic arch alone not involving the orbit**

1. Minimal or no displacement.
2. V-type in-fracture.
3. Comminuted.

**Clinical features of zygomatic complex fractures**

* Flattening of cheek
* Flattening over the zygomatic arch
* Swelling of cheek
* Limitation of mouth opening due to impingement of the depressed zygomatic bone on the temporal muscle and/or coronoid process, limiting mandibular excursions and due to muscle spasm.
* Anesthesia of cheek, temple, upper teeth and gingiva
* Periorbital (circumorbital) ecchymosis and edema
* Sub-conjunctival hemorrhage
* Epistaxis due to disruption of maxillary sinus mucosa caused by fracture of the sinus wall.
* Crepitation from air emphysema; fracture through a sinus wall with tearing of the lining mucosa allows air to escape into the facial soft tissue.
* Tenderness and palpable separation at frontozygomatic suture
* Step deformity and tenderness of infraorbital margin
* Ecchymosis and tenderness intra-orally over zygomatic buttress
* Limitation of ocular movement
* Diplopia; bin­ocular diplopia that develops following trauma can be the result of soft tissue (muscle or periorbital) entrapment, neuromuscular injury, intraorbital or intramuscular hematoma or edema, or a change in orbital shape, with displacement of the globe causing a muscle imbalance. The presence of entrapment of orbital contents by the fracture through the orbital floor can be determined with a **forced duction test**.
* Displacement of the palpebral fissure and unequal pupillary levels; due to inferior displacement of Whitnall's tubercle with the attached Lockwood's suspensory ligament that leads to alteration in the level of the globe.
* Enophthalmos defined as the posterior displacement of the globe that is often due to increase in orbital volume secondary to interruption of the skeletal integrity of the bony orbit.

**Imaging**

* Occipitomental (Waters’) view; it generally delineates the fracture pattern and displacement of the zygomatic complex, including isolated fractures of the zygomatic arch.
* Submentovertex view is helpful for evaluation of the zygomatic arch and zygomatic projections.
* CT scan; axial and coronal plane CT is the gold standard for radiographic evaluation of zygomatic fractures. It allows for detailed evaluation of buttresses of the midfacial skeleton including the orbit.

**Treatment**

Zygomatic complex fractures with minimal displacement that are not causing symptoms do not necessarily require treatment.

The indications for treatment are as follows:

1. To restore the normal contour of the face both for cosmetic reasons and to re-establish skeletal protection for the globe of the eye.
2. To correct diplopia.
3. To remove any interference with the range of movement of the mandible.
4. When pressure on the infraorbital nerve results in significant numbness or dysesthesia.

**Reduction**

Many zygomatic complex fractures are stable after reduction without any form of fixation, especially when:

* The displacement is a medial or lateral rotation round the vertical axis without separation of the frontozygomatic suture.
* Recent fractures are more stable than those that are more than 2 weeks old.

Fractures in which there is disruption of the frontozygomatic suture and those that are extensively comminuted are usually unstable after reduction.

Indirect reduction of a zygomatic fracture can be achieved by:

**The temporal approach (Gillies approach)** is popular and straightforward. The operation depends on the fact that the deep temporal fascia is attached along the superior surface of the zygomatic arch, while the temporalis muscle passes beneath the arch to be attached to the coronoid process and anterior ramus. It consists of an incision made in the temporal region and the temporal fascia is incised, then an instrument is passed superficial to the surface of the temporalis muscle and deep to the zygoma. The zygomatic bone or arch can then be elevated into a correct position using Rowe's or Bristow's elevator. The position of the bone is confirmed by palpation of the infraorbital rim and the cheek prominence using the uninjured side for comparison.

**The percutaneous approach** is a rapid method most useful in non-comminuted fractures with medial displacement and no distraction of the frontozygomatic suture. The location of the stab incision for insertion of the bone hook is at the intersection of a perpendicular line dropped from the outer canthus of the eye and a horizontal line extending posteriorly from the alar rim of the nostril.

**Buccal sulcus approach (Keen approach 1909);** an incision is made in the upper buccal sulcus immediately beneath the zygomatic buttress and a curved elevator is passed supra-periosteally to engage the deep surface of the zygomatic bone.

**Lateral coronoid approach (Quinn 1977);** it is a simple method for isolated fractures of the arch, this approach consists of intraoral incision made along the anterior border of the ramus, through which an elevator is inserted lateral to the coronoid process, and the arch is elevated while the surgeon palpates extraorally along the arch.

**Open reduction and internal fixation**

It is indicated in:

* Displaced fractures that are not stable after reduction.
* Comminuted fractures.
* Fractures that are more than 2 weeks old.
* When orbital exploration is required due to the presence of diplopia or enophthalmos.

The open reduction is followed by fixation of the fracture segments using transosseous wiring or miniplates and/or microplates. The wires or plates can be fixed at **frontozygomatic suture**, **infraorbital rim**, the **zygomaticomaxillary buttress** and rarely at the **zygomaticotemporal suture**. The fractures should be fixed at minimum two points.

**Incisions for the surgical exposure of the zygomatic complex**

**Approaches to the frontozygomatic suture**

* Lateral eyebrow (also called supraorbital eyebrow).
* Supratarsal fold (upper eyelid) approach gives an excellent cosmetic result and good exposure of the fronto-zygomatic suture.

**Approaches to the lateral orbital rim, body and arch of zygoma**

* Lateral canthal incision in a suitable skin crease lateral to the eye (‘crow's foot’ crease).
* Extended preauricular approach to expose the whole zygomatic arch and the lateral aspect of the orbital rim.

**Approaches to the inferior orbital rim and orbital floor**

* Midtarsal incision is placed in a natural crease approximately half way between the lash margin and the orbital rim.
* Subciliary (lower blepharoplasty) incision is placed in a suitable skin crease parallel to the free edge of the lid 2–3 mm away from the margin.
* Transconjunctival approach through the lower fornix has the obvious advantage of an invisible scar.

**Approaches to the medial orbital wall**

* Paranasal approach (Lynch incision); is straightforward approach to the medial orbit is through a small curved incision over the frontal process of the maxilla.
* Transcaruncular approach; it is designed as an extension of a transconjunctival incision.

**Orbital floor fractures**

The orbits are described as conical or pyramidal in shape that consists of 7 bones, the normal orbital volume is about 30 mL, of which the globe occupies 6.5 mL. The orbit consists of an outer and inner frame; the outer frame is the orbital rim; inferiorly it is composed of the zygoma laterally and maxilla medially. Superiorly it is composed of the frontal bone.

The inner frame is composed of the orbital walls:

* Floor; roof of the maxillary sinus and orbital plate of palatine bone;
* Medial wall; ethmoidal and lacrimal bones anteriorly, lesser wing of sphenoid with optic canal posteriorly
* Lateral wall; zygoma and greater wing of sphenoid
* Roof; frontal bone.

Both the lateral wall and the roof are relatively thick; the most common areas of fracture are the floor and medial orbital walls. Isolated orbital wall fractures are termed **blow-out** or **blow-in**fractures. Blow-out fractures are further described as **pure**, for those that occur in the presence of an intact orbital rim, and **impure**, for those with a concomitant fracture of the orbital rim.

In blow-out fractures, the fragments of bone are displaced downwards into the antral cavity and the periorbital fat tends to herniate through the defect, this has the effect of interfering with the action of the inferior rectus and inferior oblique muscles preventing upward movement and outward rotation of the eye with resulting **diplopia** in these directions of gaze. If a large enough amount of orbital fat is displaced through the orbital floor defect it may result in **enophthalmos**.

Blow-in fractures are rare; the orbital wall bone fragments are displaced or buckled inwards.

**Clinical features**

* Periorbital (circumorbital) ecchymosis
* Subconjunctival hemorrhage
* Diplopia; diplopia is a relatively common early clinical finding after orbital trauma, often simply as a result of edema affecting the extra-ocular muscles.
* Limitation of eye movement especially in upward gaze.
* Globe retraction on upward gaze
* Enophthalmos; enophthalmos may not be clinically apparent immediately following injury because of swelling of the orbital contents. True extent of enophthalmos is revealed at around 2–4 weeks following injury when this swelling has resolved. Enophthalmos clinically obvious to most patients when exceeds 2mm.
* Surgical emphysema of eyelids
* Paresthesia within distribution of infraorbital nerve

The tethering of the inferior muscles can be further demonstrated by the forced duction test, which may be carried out under local or general anesthesia. Fine toothed dissecting forceps are inserted under the globe of the eye via the inferior conjunctival fornix and the insertion of the inferior rectus is gently grasped enabling the globe to be forcibly rotated upwards and its freedom of movement compared with the opposite side. Any increased resistance is readily appreciated and is diagnostic of muscle tethering.

It is essential to measure this interference with orbital movement by means of a Hess chart and to monitor any improvement, or lack of it, by repeating the test during the first 7–10 days after injury.

**Imaging**

* Plain radiographs may show evidence of orbital floor or wall fractures, but are unreliable in excluding such an injury or determining its extent. Occipitomental view may demonstrate the classical **(hanging drop)** appearance of a large orbital floor defect with herniation of orbital contents.
* CT has the advantage of better bone visualization. Coronal, axial and sagittal views may be required to determine the extent of the defect. Enophthalmos is more likely to develop where there is loss of the ‘posteromedial bulge’ of the orbital floor, best seen in sagittal views. The posterior limit of the defect also gives an indication of difficulty of repair.

**Treatment**

When orbital fractures occur with other fractures of the midface, the latter must be repaired first. This is because safe orbital dissection and repair of orbital defects are dependent on repositioned key landmarks and a correctly positioned infraorbital rim to support an implant. This will not be possible if the peripheral bones are significantly displaced.

**Indications**

1. Significant restriction of eye movement (diplopia) with CT confirmation of entrapment.
2. Significant enophthalmos.
3. Large ‘blowout’ defect
4. Significant orbital dystopia

**Relative contraindications**

1. Visual impairment
2. Anticoagulant medication
3. Patient unconcerned
4. Proptosis
5. An already ‘at risk’ globe

It is generally accepted that treatment of orbital floor fractures should be delayed for 7-10 days allowing time for edema to subside and the true ophthalmic situation to be revealed. The exception to delayed treatment is in children and young people with diplopia where exploration should be performed as soon as possible to prevent persistent problems.

Treatment consists of direct exploration of the orbital floor through a suitable lower eyelid or transconjunctival approach, gentle retrieval of the herniated soft tissues and reconstructing the bony defect with suitable implant or graft material that is of a sufficient size to be supported at its periphery on sound bone. If stabilization is required this can be performed by using microplates or by simple wiring to the orbital rim.

**Reconstructive options for orbital defects**

* Autografts of fascia, bone and cartilage.
* Allograft.
* Xenograft.
* Alloplastic materials; these can be resorbable or non-resorbable such as titanium mesh and sheets of Silastic (medical grade silicone polymer), Medpor (porous polyethylene) and PDS (polydioxanone).

**Complications**

1. Retrobulbar hemorrhage
2. Lower eyelid retraction and ectropion
3. Persistent edema of lower eyelid
4. Persistent enophthalmos
5. Persistent globe depression
6. Persistent diplopia in vertical gaze
7. Tissue reaction to implant
8. Extrusion of implant
9. Infection and chronic fistula formation
10. Dacryocystitis
11. Blindness

**Nasal bone fractures**

The nasal bone is one of the most commonly fractured due to its prominent position and little protection and support. The nasal bones are relatively thick superiorly where they are attached to the frontal bone, but are thinner inferiorly where the upper lateral cartilages are attached. Hence they are more susceptible to fractures lower down.

According to the force applied, nasal complex fractures can be divided into three planes:

1. The first plane involves the nasal tip only.
2. The second plane involves the whole of the external nose anterior to the orbital rim.
3. The third plane is a much more severe injury involving the medial orbital wall and sometimes the anterior cranial fossa. These latter injuries are distinguished as fractures of the naso-orbito-ethmoid complex.

**Clinical features**

* Edema over the bridge of the nose.
* Bilateral circumorbital ecchymosis and possibly subconjunctival hemorrhage, more marked on the medial aspect.
* Deviation of the nose to one side following a lateral injury while an anterior fracturing force produces a saddle-type depression of the bridge.
* Epistaxis due to injury to nasal mucosa and Kiesselbach’s plexus or Little’s area which is an area of arterialanastomosis present at anterior inferior nasalseptum, linking branches of greaterpalatine, superior labial, sphenopalatineand anterior ethmoid arteries.
* Septal hematoma can sometimes develop as a result of bleeding into the subperichondrial space. This appears as a dark red swelling on the septum and results in partial nasal obstruction, usually within the first 24–72 hours.
* Nasal obstruction due to blood clot, edema of nasal mucous membrane and the deviated nasal septum.

**Imaging**

Isolated nasal bone fractures can be visualized on soft tissue radiographs of nose, lateral nasal radiograph and CT scans. The septal deviations are visualized on occipitomental view or CT scans.

**Treatment**

Septal hematoma requires incision and drainage which should be performed urgently under topical or local anesthesia. If untreated it can become infected leading to a septal abscess, with a risk of intracranial extension, it may also result in avascular necrosis with loss of cartilage and a septal perforation.

The vast majority of nasal fractures can be treated by closed manipulation and simple splinting.

**Reduction**

This can be achieved by digital manipulation in simple fractures. Otherwise **Walsham's forceps** are used for manipulating the nasal and the frontal process of the maxilla bone fragments, the external blade of the forceps is ideally padded with rubber or plastic tubing. The vomer and the perpendicular plate of the ethmoid are then manipulated with the **Asche's septal forceps.**

**Methods of immobilization**

* Ribbon gauze packing; such as bismuth iodoform paraffin paste (BIPP) is lightly packed in the nasal cavity to impart support and to achieve hemostasis. The disadvantages of packing are that it obstructs airway, acts as a source of infection and over-packing may cause displacement of the nasal bones.
* Plaster of Paris (POP) splints; it consists of 6–8 layers of POP bandage cut to produce a strip of plaster across the bridge covering either side of the nose, with an extension up to the forehead. When it is firm it is fixed into position with strips of adhesive tape across the forehead and across the nasal bridge. The first splint should be replaced by a new more accurately fitting splint few days later when the postoperative edema over the nasal region has subsided. A nasal splint should be left in situfor about 10–14 days in total.

**Open reduction and internal fixation (ORIF)**

ORIF of isolated nasal fractures is a procedure that is rarely advocated. Indications may include; grossly displaced fractures where closed treatment is usually unsatisfactory and when there is an extensive overlying laceration.

**Naso-orbito-ethmoidal complex fractures**

The naso-orbital-ethmoid (NOE) fracture represents a significant diagnostic and reconstructive challenge. This region houses the lacrimal apparatus, medial canthal ligament, and ante­rior ethmoidal artery.

The NOE fractures are typically noted to be unilateral, bilateral, simple, or comminuted and are likely to have with different fracture presentations bilaterally. They may occur as an isolated injury or in conjunction with other major facial fractures.

**Classification**

A commonly used classification system of NOE fractures is based on their rela­tionship to the central fragment at the site of medial canthal tendon attachment:

**Type I;** the simplest form of NOE fracture involves single central fragment bearing the canthal ligament.

**Type II;** comminuted central segment with medial canthal ligament still attached to a bone fragment.

**Type III;** comminuted central segment with detached medial canthal ligament.

**Clinical features**

* Bruising or laceration of skin of the nose
* Bilateral circumorbital ecchymosis and edema
* Subconjunctival hemorrhage.
* Epistaxis
* Deformity of nose and inter-orbital area
* Crepitus of bones of nasal complex
* Unilateral or bilateral telecanthus, generally speaking, an inner intercanthal measurement greater than 35 mm is indicative of canthal displacement.
* Rounding of the medial canthus of the eye.
* Airway obstruction
* Septal deviation
* Cerebrospinal rhinorrhea
* The damage to the cribriform plate of ethmoid results in damage to the branches of the olfactory nerve and loss of smell sensation (anosmia).

**Imaging**

Plain radiographs provide insufficient detail of damage. CT scans (axial and coronal views) provide a much more complete picture and are an essential investigation for the accurate assessment of this type of injury.

**Treatment**

Effective treatment depends primarily on accurate replacement and fixation of the medial canthal ligaments and restoration of the nasal bridge anatomy.

Closed reduction by manipulating the fragments and external splinting using acrylic buttons or small lead plates held in place with transnasal wires are usually unsatisfactory. Secondary deformity is difficult to correct owing to scarring and displacement in the medial canthal area.

ORIF using transosseous wiring or miniplates and microplates offers the best option of restoring the anatomy of this area; the surgical procedure includes the following steps:

1. Surgical exposure.
2. Identi­fication of the medial canthal tendon and tendon-bearing bone fragment.
3. Reduction and reconstruction of the medial orbital rim.
4. Reconstruction of the medial orbital wall.
5. Transnasal canthopexy.
6. Reduction of septal fractures.
7. Nasal dorsum reconstruction and augmentation.
8. Soft tissue adaptation.

Occasionally the canthal ligament may be avulsed from the bone, or the fragment may be too small to plate in position. In this situation a **transnasal canthopexy** should be carried out using fine wire or a braided stainless steel suture. Where the medial wall of the orbit is missing or extremely comminuted it is advisable to combine this with a bone graft or titanium mesh to help anchor the soft tissue.

**Approaches for surgical exposure of the NOE fractures**

1. Through existing laceration
2. Local skin incisions for exposure of the nasal bridge and frontonasal region:

* H-shaped incision across the bridge.
* Z-shaped incisions in the medial canthal areas.
* Midline vertical incision from the forehead across the glabella.
* Extended W-shaped incision from above or beneath the medial aspect of one eyebrow across the nasal bridge to above or beneath the opposite eyebrow.

Disadvantages of local incisions:

* May result in unsightly scar
* Limited access
* Fracture lines may extend beyond the area of the surgical exposure and accurate reduction can be compromised.

1. Coronal flap

The coronal flap gives excellent exposure of the whole of the upper part of the facial skeleton and has largely replaced the local incisions because of the good visualization it gives of the frontal bone, naso-ethmoid region, superior orbital margins, lateral orbital margins and both zygomatic arches.

**Complications of fractures of the middle third of the facial skeleton**

**Early complications**

1. **Epistaxis** post-reduction bleeding from the nose can occur, which is usually managed by simple anterior nasal packing.
2. **Ophthalmic complications**
3. Extensive orbital edema or Retrobulbar hemorrhage after reduction of a fractured zygomatic complex; both can result in a compartment syndrome of the orbit and loss of eyesight if untreated by compression and spasm of the posterior ciliary vessels that supply blood to the optic nerve. It is an emergency that require immediate management.

Signs and symptoms:

* Pain
* Decreasing visual acuity
* Diplopia with developing ophthalmoplegia
* Proptosis
* Tense globe
* Sub-conjunctival edema/chemosis
* Dilated pupil
* Loss of direct light reflex (Relative afferent pupillary defect)

Treatment

Medical treatment: involves administering intravenous 20% mannitol (1 gm/kg) and 500 mg acetazolamide to reduce intra-ocular pressure, and 3-4 mg/kg intravenous dexamethasone to reduce edema and vascular spasm.

Surgical treatment: it aims to decompress the orbit through an access incision has been used for initial treatment of the fracture or through lateral canthotomy made with sharp scissors. Small soft drain should be inserted without repair of the incision performed.

1. Blindness due to direct injury to the optic nerve.
2. Abrasion of the cornea during surgery; protective shells should be inserted routinely at the beginning of an operation or a temporary tarsorrhaphy suture inserted.
3. **Inaccurate reduction**; especially when treatment is not by ORIF.
4. **Nerve damage** involving the infraorbital nerve, zygomatico-temporal and zygomatico-frontal nerves. Also coronal approach may result in damage to the sensory and motor supply of the forehead.

**Late complications**

1. **Delayed or non-union** is uncommon, it occurs in fractures treated by IMF alone. Treatment is by applying miniplates across the fracture site with or without a bone graft.
2. **Malunion** causing cosmetic and functional deformity; depressed malunion of the zygomatic complex may cause cosmetic deformity and interference with the coronoid process of the mandible and restriction of mouth opening. Malunion of orbital fractures may result in Expansion of orbital volume which produces enophthalmos that is sometimes accompanied by diplopia. In Le Fort I, II and III fractures, the patients may be left with long face or flattening of the entire profile (dish-face deformity). It may also cause malocclusion such as retrusion of upper dentition and anterior or lateral open bite.
3. **Residual ophthalmic complications** such as enophthalmos and diplopia; these may result from:

* Deformity of the bony orbit.
* Neurological damage such as damage to the oculomotor and abducent nerves.
* Damage to the globe itself and its surrounding soft tissue

1. **Complications associated with paranasal sinuses**; fractures of the middle third of face are usually associated with comminution of the walls of the paranasal sinuses, particularly the frontal and maxillary. This may lead to obstruction of the ostium and disturbance of drainage leading to chronic infections.
2. **Complications associated with the lacrimal system**; partial or complete obstruction of the nasolacrimal duct may be a late complication of Le Fort II type and NOE fractures. The patient complains of epiphora and may develop dacryocystitis. If the natural pathway for tears cannot be re-established by dilation of the duct a dacryocystorhinostomy operation is done as a planned procedure.
3. **Loss of sensation**; such as anosmia or anesthesia or paresthesia within the distribution of the maxillary division of the trigeminal nerve.
4. **Late problems with internal fixation**; Plates or transosseous wires may become infected, palpable or visible as projections. In such situations they need to be removed.