Faciomaxillary Trauma

Prof. Dr Balasubramanian Thiagarajan (drtbalu)

Fracture Nasal Bone

Introduction

Isolated fractures of nasal pyramid account for about 40% of all facial fractures.

Treatment of nasal bone fractures was first recorded 5000 years ago during the early Pharonic period in Ancient Egypt.
Edwin Smith Papyrus describes repositioning of deviated nasal bones with fingers / elevators, insertion of splints and application of external dressings.

Fractures of nasal bones are often combined with other fractures of facial skeleton.

Delays in management can result in significant cosmetic and functional deformity.

Nasal bone fractures are common because

1. Nose happens to be the most prominent portion of the face
2. Increasing number of road traffic accidents
3. Increasing incidence of domestic violence
4. Increase in the number of individuals taking part in contact sports

Anatomy

Nasal bones are paired bones. Both these bones project like a tent on the frontal process of maxilla. In the midline they articulate with one another. Just under this midline articulation lies the nasal septum

Laterally nasal bones articulate with the fronto nasal process of maxilla

Articulations of nasal bones:

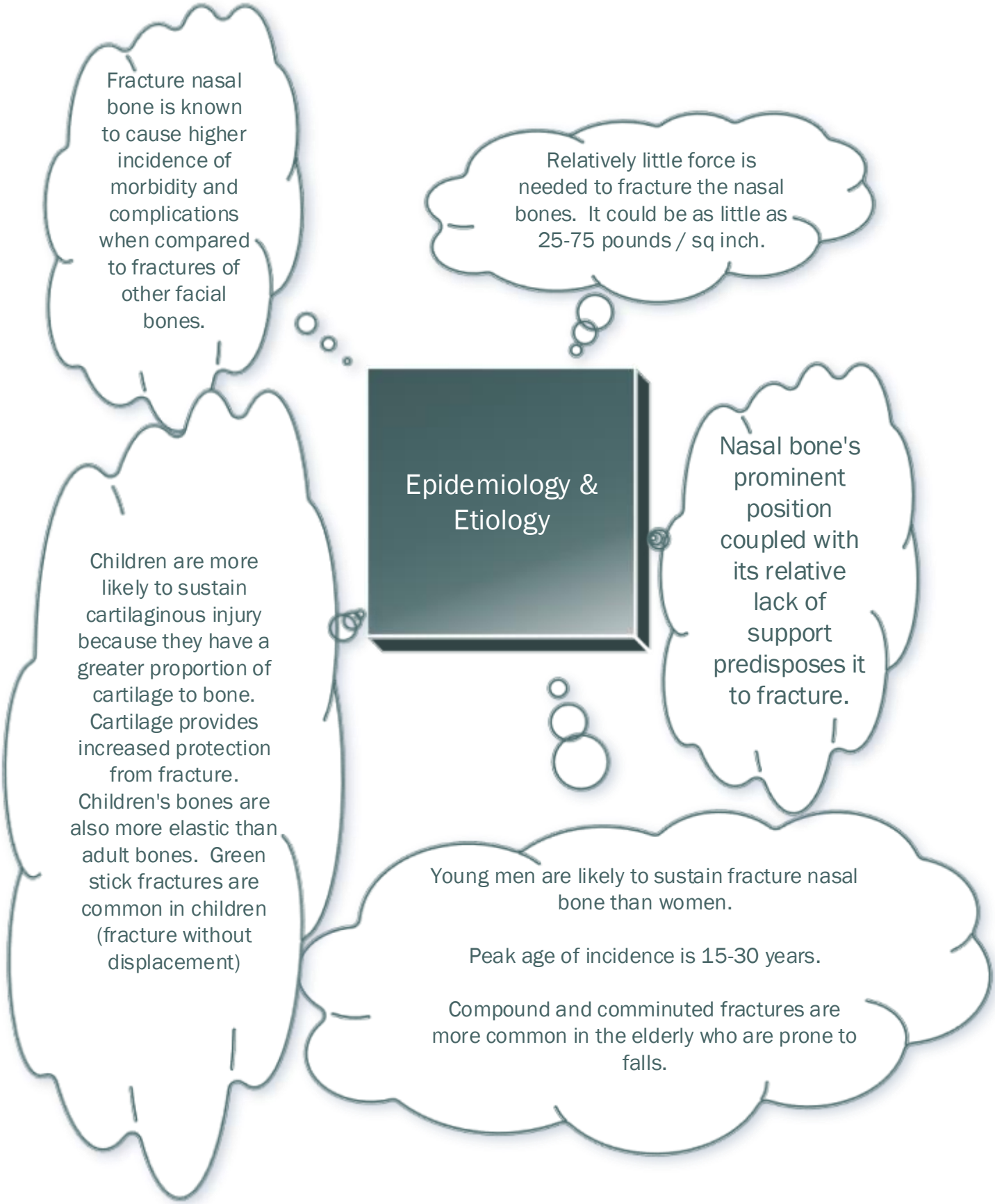
Nasal bones articulates with 4 bones.

Frontal
Ethmoid
Opposite nasal bone
Maxilla

The outer surface of nasal bones is concavo-convex from above downwards and convex from side to side. It is covered by Procerus and nasalis muscle. It is perforated at its centre by a foramen through which runs a small vein. The inner surface is concave from side to side and is traversed from above downward by a groove for the passage of a branch of nasociliary nerve.

Superiorly the nasal bones are thicker where it articulates with the nasal process of frontal bone. This area is stable and firm. Nasal bone fractures commonly occur at the transition zone between the proximal thicker and distal thinner portions. This zone precisely corresponds to the lower third of the nasal bone area.

Epidemiology & Etiology



Types of Injury

Type I injury:

Fractures due to this type of injury does not extend behind the imaginary line drawn from the lower end of nasal bone to the anterior nasal spine. In this type of injury the brunt of the attack is borne by lower cartilaginous portion of the nasal cavity and the tip of the nasal bones. This type of injury may cause avulsion of upper lateral cartilages and occasionally posterior dislocation of septal and alar cartilages

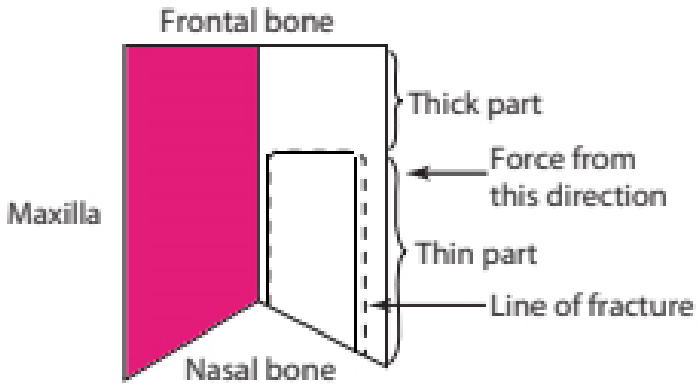
Type II injury:
This type of injury involves the external nose, nasal septum and anterior nasal spine.
Patients with this type of injury manifest with gross deviations involving the dorsum of the
nose including splaying of nasal bones, flattening of dorsum of nose and loss of central
support of the nose.

Type III injury:
This injury involves orbit and intracranial structures.

Classification & Pathophysiology

Nature of injury:
Most fractures result from laterally applied forces
Greater force is required to fracture the nose with a blow directed from the front as the nasal cartilages behave like shock absorbers.

Nasal fractures have been classified in a number of ways.
Nature of injury
Extent of deformity
Pattern of fracture



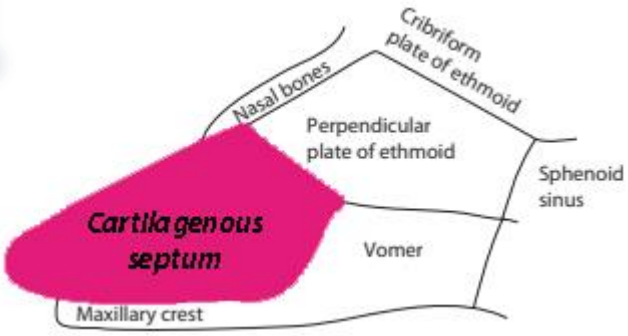
Extent of deformity

A 5 point grading system has been developed for the extent of lateral deviation of nasal pyramid.
Grade 0 - Bone are perfectly in alignment
Grade 1 - Bones deviated less than half the width of the bridge of then nose
Grade 2 - Bones deviated half to one full width of the bridge of the nose
Grade 3 - Bones are deviated greater than one full width of the bridge of the nose
Grade 4 - Bones almost touching the cheek

Pattern of Fracture

Nasal fractures can be subdivided into three broad categories.
Class 1 frctures
Class 2 fractures
Class 3 fractures

Because of the tendency of the nasal septum to heal by fibrosis which causes bizarre deviations like "C" "S" etc.



Because of the close association between nasal bone and the cartilaginous portions of nose and nasal septum it is unusual for pure nasal bone fractures without affecting these structures.

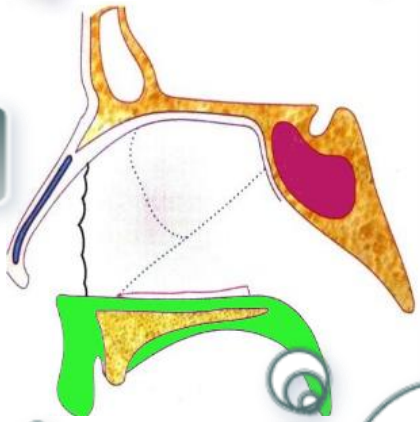
This classification has practical utility as each category of fracture requires a different treatment approach.

Class I Fracture

Simplest form of class 1 fracture is depressed fracture of nasal bone. The fractured segment usually remains in position due to its inferior attachment to the upper lateral cartilage which provides an element of recoil. The nasal septum is not involved.

This is caused due to low to moderate degrees of force and the extent of deformity is usually not marked.

This type is known as Chevallet fracture



In more severe variant both nasal bones and septum are fractured. The fracture line runs parallel to the naso maxillary suture ipsilateral to the side of the applied force to a point approximately two thirds along the length of the nasal bone, where the bone becomes much thicker.

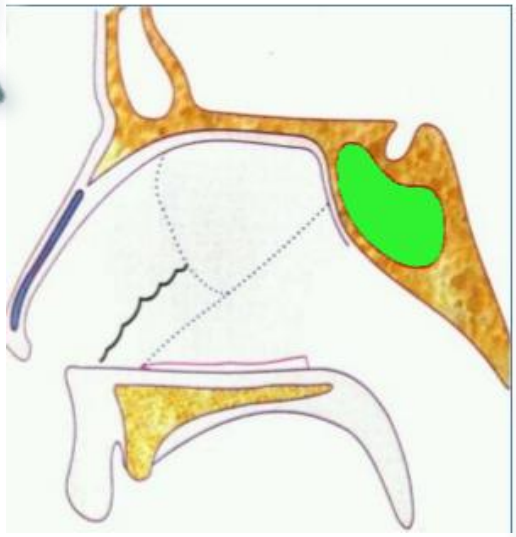
Class 1 fractures tend not to show gross lateral displacement of the nasal bones and may not even be perceptible.
Deformity generally results form a persistently depressed fragment which is due to impaction of the flail segment beneath the residual nasal bone.
In children these fractures may be of green stick variety, and significant nasal deformity may only develop at puberty when nasal growth become accentuated.

Class 2 Fractures

Also known as Jarjaway fracture

A frontal impact tends to comminute the nasal bones and cause gross flattening and widening of the dorsum. Lateral impact produces a high deviation of nasal skeleton.

The pattern of deformity is determined by the direction of force applied.



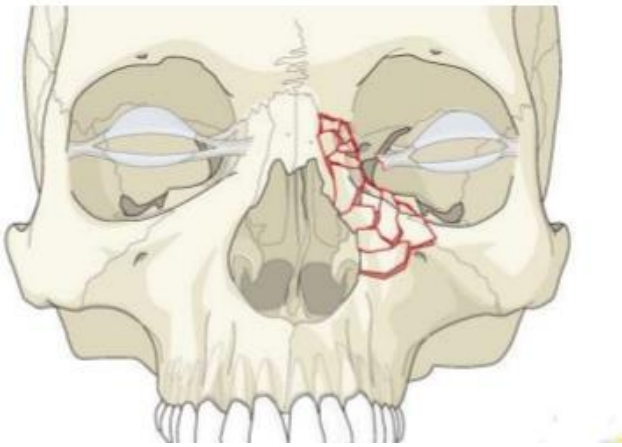
If the nasal dorsum is deviated laterally greater than half the width of the nose then associated septal fracture (Grade 2 deformity) should also be present. Septal fracture dislocations tend to happen at points of weakness. These points of weakness is at the point of insertion of quadrangular cartilage inserts into the cartilaginous dorsum, the bony septum and the maxillary crest. Both the nasal bone and septal fractures need to be reduced together in order to achieve a satisfactory cosmetic result.

Class 2 fractues are caused by greater force and are associated with significant cosmetic deformity. In addition to fracturing of the nasal bones, the frontal process of the maxilla and septum are also involved. The adjacent ethmoidal labyrinth and orbital structures remain intact.

Quadrangular cartilage could appear dislocated from the bony septum due to C shaped fracture that extends from the quadrangular cartilage beneath the nasal tip, posteriorly through the perpendicular plate of ethmoid to the anterior border of vomer and then forward through the lower part of perpendicular plate of ethmoid into the inferior part of the quadrilateral cartilage.

Class 3 Fracture

Class 3 fractures are caused by high velocity trauma. They are also termed naso-orbital-ethmoid fractures. Often associated with fractures of maxillae. The external buttresses of the nose give way and teh ethmoid labyrinth collapses on itself. This causes the perpendicular plate of the ethmoid to rotate and the quadrilateral cartilage to fall backwards.



Two categories of class 3 fractures have been identified:
Raveh type I - Anterior skull base, posterior wall of frontal sinus and optic canal remain intact

Raveh type II - There is disruption of posterior frontal sinus wall, multiple fractures of the roof of ethmoid and orbit extending posteriorly to the sphenoid and parasellar regions. Multiple dural tears, CSF leak, pneumocranium and cerebral herniation could complicate this type of injury.

Pig like deformity of the nose is seen in class 3 fractures.
There is telecanthus, which may be exaggerated further by disruption of medial canthal ligmament from the crest of the lacrimal bone.

History & Clinical features

Clinical pointers towards diagnosis of fractures of nasal bone:
Injuries middle third of face
History of bleeding from nose following injury
Oedema over dorsum of nose
Tenderness and crepitus over nasal bone area
Eyelid oedema
Subcutaneous emphysema involving eyelids
Periorbital ecchymosis

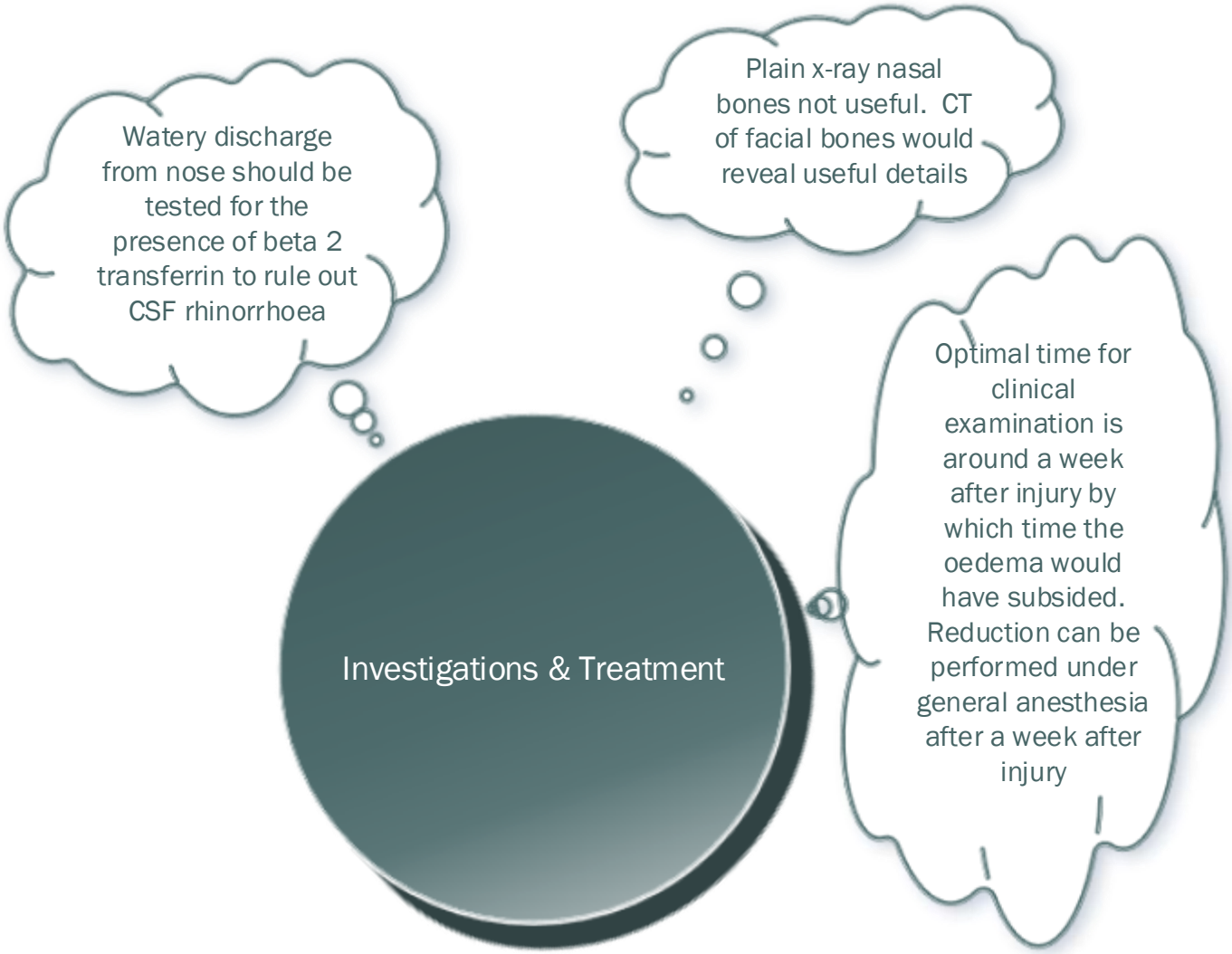
Key issues during patient examination:
Deviation depression and step deformities of nose
Mobility, crepitus and tenderness over nasal bone area
Generalized swelling
Skin / mucosal laceration
Septal fracture/hematoma/abscess/ perforation

Clinical features

If oedema prevent accurate assessment then it should be deferred till swelling subsides

History of injury
History of nasal obstruction
Persistent pain indicates the presence of septal hematoma
Enquiry about change in shape of nose
History of previous injuries to nose and face
History of epiphora
History of diplopia
History of loose teeth
History of watery rhinorrhoea
History of anosmia
History of altered bite / trismus

Management



Indication for surgical intervention:

Significant cosmetic deformity
Nasal obstruction due to septal hematoma
Majority of these patients don't require active treatment
Soft tissue swelling can produce a misleading appearance of deformity

Medical management:
Indicated in acute phase
Nasal decongestants
Analgesics
Control of epistaxis by nasal packing
Reassurance

Closed Reduction

Mobilization of fracture fragments first by increasing and then decreasing the degree of deformity. An initial slight increase in deformity away from the side of the blow to disimpact the fragments followed by steady movement back towards and often slightly beyond the mildine is usually required. This can be achieved by firm digital pressure. Walsham forceps is used for this purpose.

If the bones are fixed as in the case of old fractures, then osteotomies are necessary. While performing osteotomies care should be taken not to enter the orbit or breach the skull base.

Class 1 and most class 2 fractures can be managed with closed reduction.

Splints and nasal packing is needed to hold the reduced bone in position

Open Reduction

Indications for Open reduction:

Bilateral fractures with dislocation of nasal dorsum and significant (pre-existing or recent) septal deformity.

Infraction of dorsum of the nose

Fractures of cartilaginous pyramid with or without dislocation of upper lateral cartilage

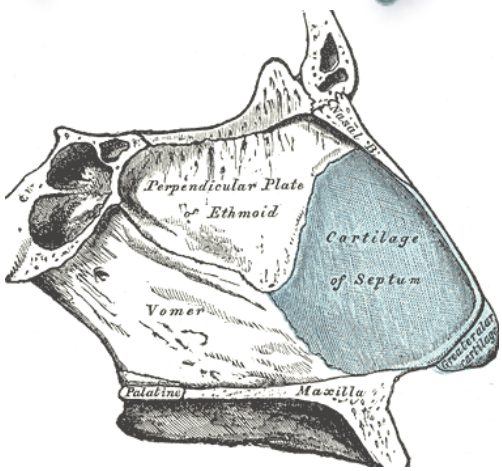
Kirschner wires can be used to stabilize bone and cartilages in patients with depressed tip / flail lateral fractures that are unstable despite closed reduction techniques. The K wire is inserted under fluoroscopic guidance into the depressed fragment as well as neighbouring uninvolved bone (maxilla or frontal bone) and the wires are screwed together externally to maintain the position. The wires can be removed after 2 weeks.

More aggressive approach to the treatment like use of rhinoplasty techniques like release of upper lateral cartilages, hump removal and camouglaging cartilage grafts can be used.

Management of nasal septum

Fractures involving nasal septum is often missed and is the reason for poor functional and cosmetic results. If a significant septal fracture dislocation is present then it is wise to reduce this at the same time as the nasal bones. Satisfactory reduction of nasal bones is not possible without improving the position of nasal septum.

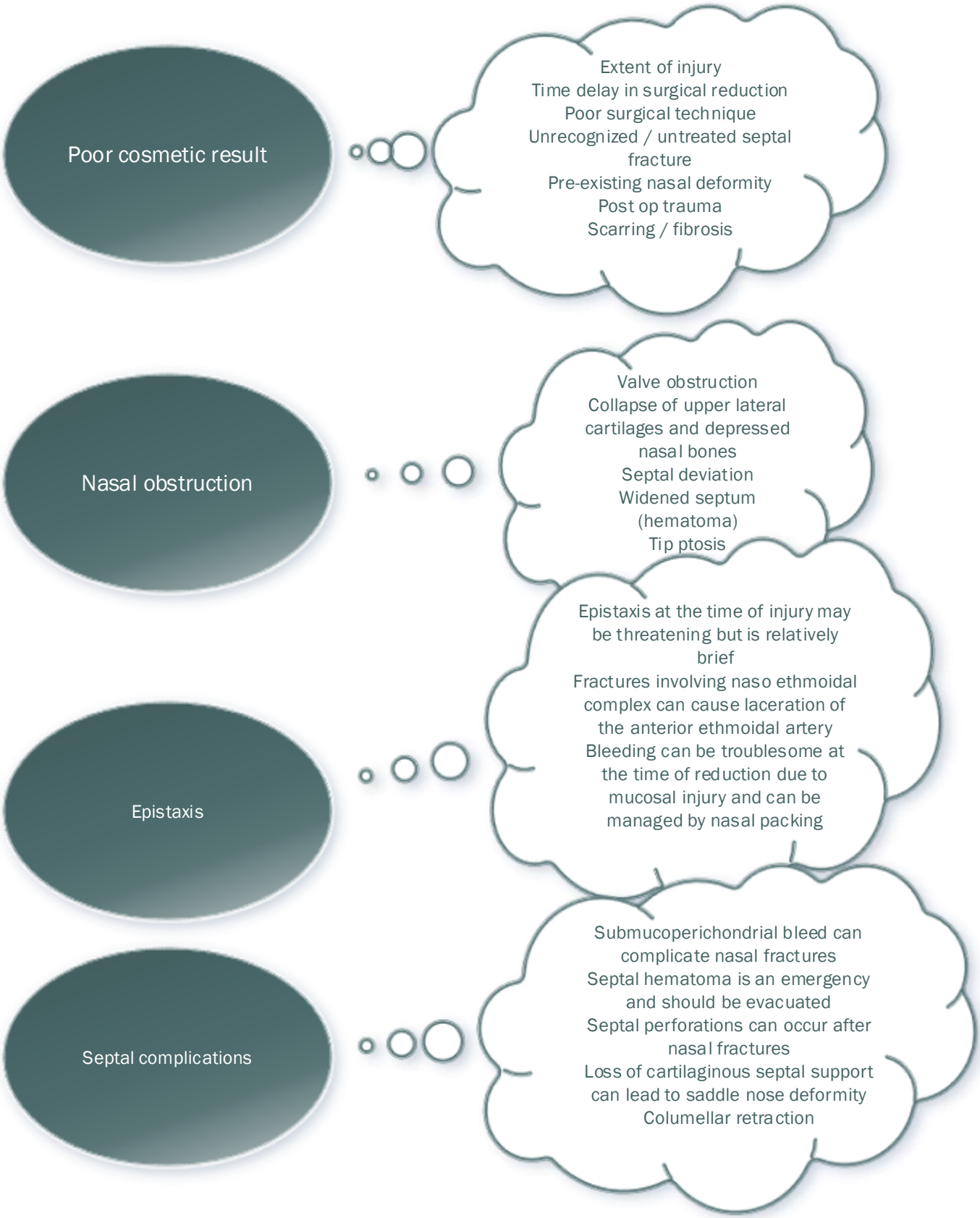
Septal reduction can be performed with Ashe forceps



Septal reduction can be performed using Killian / hemitransfixation incision, elevation of mucosal flaps to expose the cartilage and bone. Removal of fractured fragments and repositioning the flaps would suffice.

Quilt sutures should be given to prevent dead space formation and blood collecting in it.

Complications



Fracture Zygoma

Bony architecture of this bone is unique enabling it to withstand blows of significant impact without being fractured. At the most it gets disarticulated along its suture lines.

Zygoma plays a vital role in maintaining facial contour Zygomatic region is a prominent portion of the face next only to the dorsum of the nose predisposing this bone to trauma.

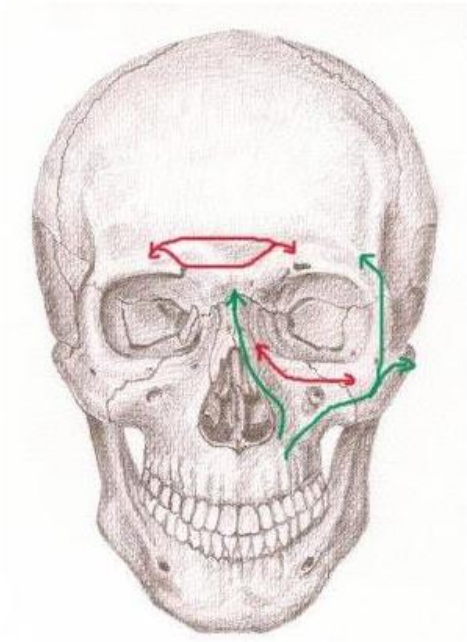
Accurate assessment of position of the fractured bone should be performed in relation to skull base posteriorly and midface anteriorly.

Fractures can involve any of the four articulations of zygoma which include zygomatico maxillary complex, zygomatic complex proper and orbitozygomatic complex. Fractures involving zygoma should be repaired at the earliest as it can cause both functional and cosmetic defects.

One important functional defect due to fracture zygoma is restriction of mouth opening due to impingement on the coronoid process.

Facial Buttress system

The buttress system of midface is formed by strong frontal, maxillary, zygomatic and sphenoid bones and their attachments to one another. The central midface contains many fragile bone that could easily crumble when subjected to strong forces. These fragile bones are surrounded by thicker bones of the facial buttress system lending it some strength and stability.



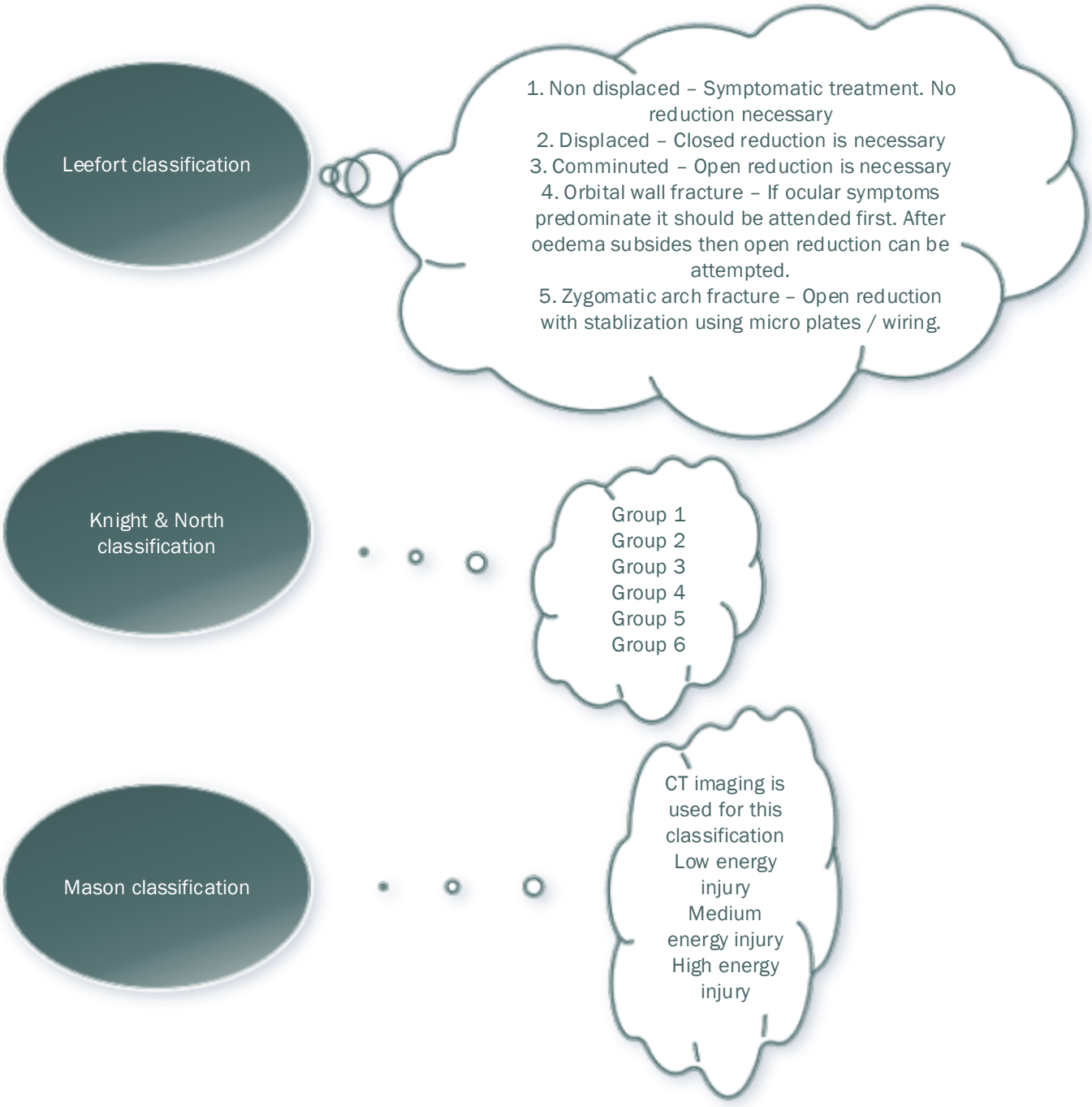
Horizontal buttresses:
They interconnect and provide support for the vertical buttresses.
They include:
Frontal bar
Infraorbital rim and nasal bones
Hard palate & maxillary alveolus

Vertical Buttresses:
Nasomaxillary
Zygomaticomaxillay
Pterygomaxillary
Vertical mandible
Majority of the forces absorbed by midface are masticatory in nature. Hence the vertical buttresses are well developed in humans.

Components of Buttress system:

Vertical buttresses
Horizontal buttresses

Classification of fracture zygoma



Knight & North classification

Group 1

In these patients fracture lines in zygoma could be seen only in imaging. There is absolutely no displacement. These patients could ideally be managed conservatively by observation and by asking the patient to eat soft diet.

Group 2

This group includes isolated fractures of the arch of zygoma. These patients present with trismus and cosmetic deformities.

Group 3

This include unrotated fractures involving body of zygoma.

Group 4

This involves medially rotated fractures of body of zygoma.

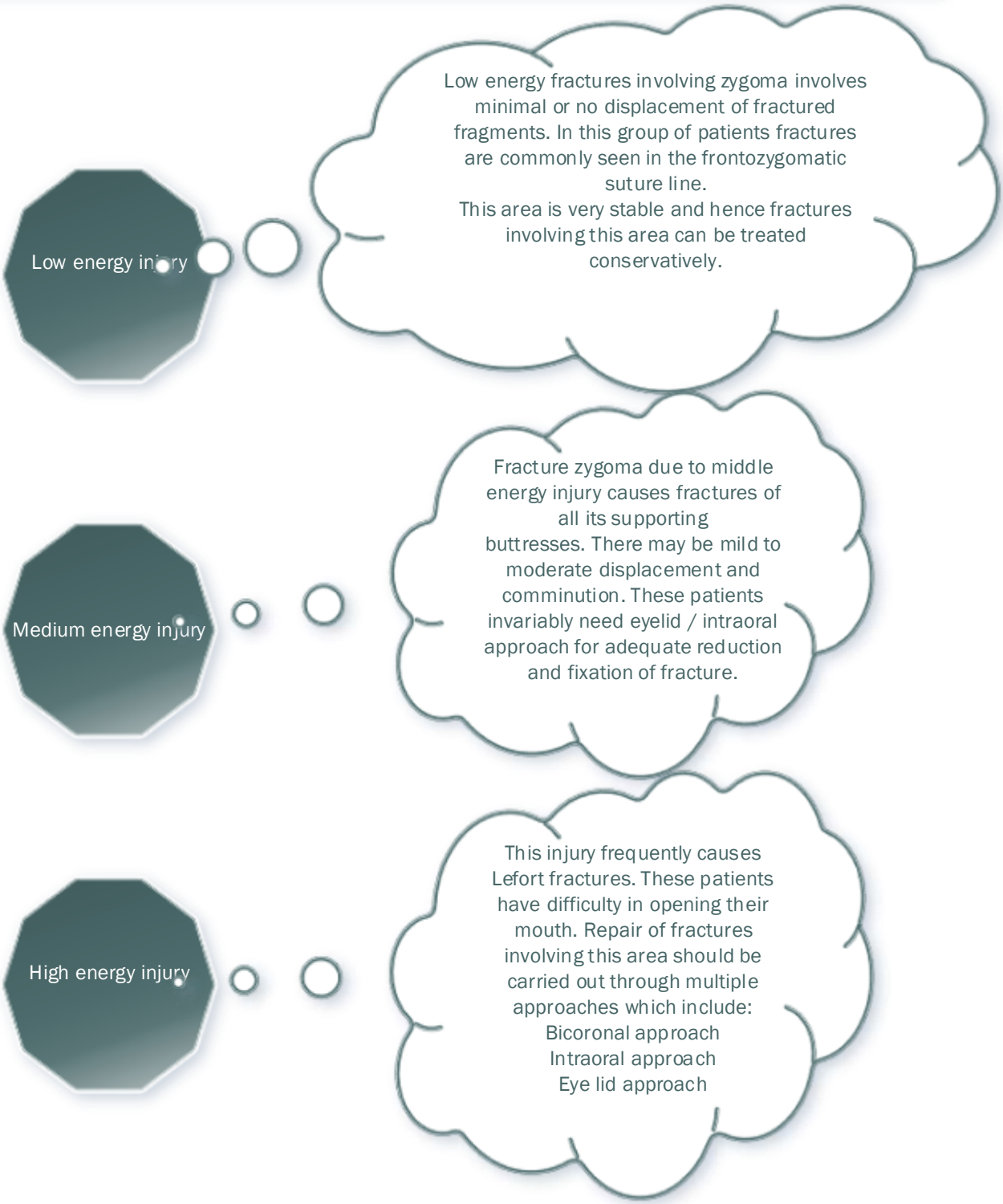
Group 5

This involves laterally rotated fractures of body of zygoma. This type of fracture is very unstable and cannot be managed by closed reduction. Open reduction will have to be resorted to.

Group 6

This is complex fracture. It has multiple fracture lines over the body of zygoma. This condition is difficult to manage by closed reduction. Open reduction and microplate fixation is indicated in these patients. This type of fracture should not be managed by closed reduction alone because the presence of oedema / haematoma would mask the cosmetic deformity giving an impression that reduction has occurred. After reduction of oedema and
followed by the action of masseter the fractured fragment may distract making the cosmetic deformity well noticeable.

Mason's Classification



Clinical Features

Clinical features

1. Anaesthesia / Paraesthesia of that side of the face
2. Inability to open the mouth
3. Flattening of zygomatic area
4. Diplopia
5. Subconjunctival haemorrhage
6. Eye lid oedema
7. Periorbital haemorrhage
8. Lateral canthal dystopia
9. Ipsilateral epistaxis
10. Buccal sulcus haematomas
11. Enopthalmos in orbital floor fractures

Lateral aspect of the face is best examined from the front, above and behind the patient.

Opthalmic examination is a must if any of the opthalmic manifestations of fracture of zygoma is seen. In the presence of ruptured globe, retinal detachment and traumatic optic nerve atrophy management of ophthalmic manifestations take precedence over fracture reduction procedure

Ruler test

Ruler test:
This is a rather useful clinical test to identify patients with fracture of zygoma.
Two rulers are used as shown in the figure below to perform this test. These rulers are
placed in front of the ears. Ruler is found to deviate on the side of fracture.

Management

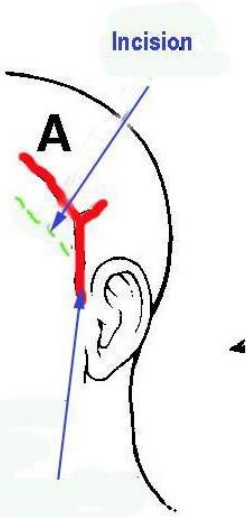
CT scan is diagnostic and should be obtained in al cases with subjective diplopia

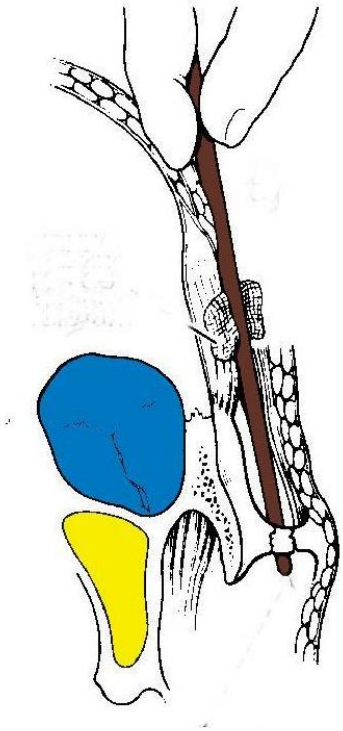
Minimally displaced fractures may be managed conservatively and patients should not blow their nose for a period of 3 weeks. Patient should be reviewed after 10 days when swelling has resolved.

Displaced fractures require reduction with / without fixation.

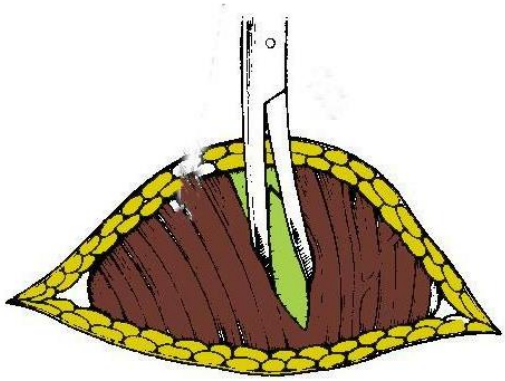
Approach	Indication	Advantage	Disadvantage
Gillies	Medially displaced body fractures, zygomatic arch fractures	Elevating site distant from fixation site	Requires skin incision, may be conspicuous in the bald patient
Dingman	Medially displaced body fractures	Uses common skin incision to that of frontozygomatic access	May be difficult to plate frontozygomatic suture and elevate simultaneously Incision may become stretched
Poswillo hook	Posteriorly displaced fractures Not arch fractures	Good mechanical advantage, quick, only one suture required	Access point of hook is prominent on the lateral cheek prominence and may be noticeable
Keen	Medially displaced fractures, arch fractures	Avoids cutaneous scars	Does not address displacement at the frontozygomatic suture Elevation and plating at this site are difficult simultaneously Theoretical contamination of the fracture site with oral microorganisms
Coronal	Laterally displaced arch fractures	The only approach for this rare fracture	Extensive surgical exposure

Gille's Approach

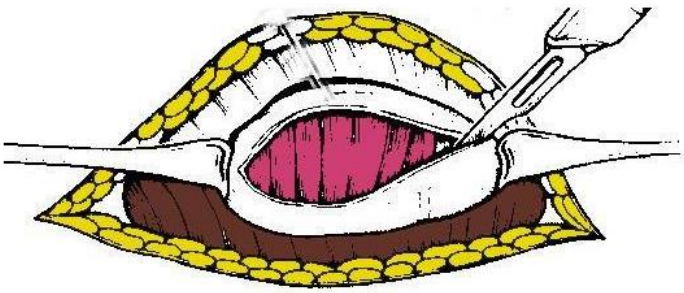




Periosteal elevator is inserted through the incision and the fractured fragment is elevated. A gauze piece is used as a leverage



Auricularis superior muscle is cut along the line of its muscle fibers



Temporalis fascia is cut with a knife

Other surgical approaches

POSWILLO HOOK

The point of application of the hook is the intersection of a line drawn vertically from the lateral orbital margin and a horizontal line drawn from the inferior margin of the nose. The hook is inserted through a stab incision and the zygoma lifted back into position.

INTRA-ORAL OR KEEN APPROACH

A mucogingival incision is made in the buccal sulcus in the molar/premolar region. An elevator may be passed behind the zygomatic body to elevate the fracture.

Post op care

Patient should not blow their nose for first 12 hours.

Retrobulbar hemorrhage should be looked out for the signs of which include:
Decreased visual acuity
Diplopia
Ophthalmoplegia
Proptosis
Tense globe
Dilated pupil
Loss of direct light reflex

Zygomatic complex fractures

Zing classification:

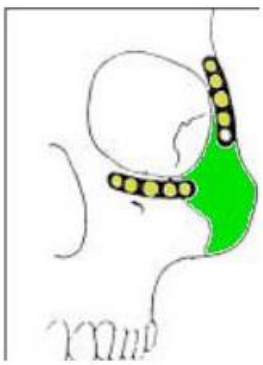
Type A

Type B

Type C

Type A :
This type is associated with one component of the tetrapod structure.
This type is subdivided into three subgroups:
Type A1 zygomatic arch alone is fractured.
Type A2 fracture of lateral orbital wall
Type A3 fracture of inferior orbital rim

Type B fracture:
This type of fracture involves all 3 buttresses. Also known as Tripod fracture. This fracture will have to be treated by two point fixation / three point fixation techniques.
Type C fracture:
These are comminuted fractures involving zygoma.
Orbital floor is the weakest component of the zygomatic-maxillary complex. Type A3, B and C are associated with fracture of the floor of orbit with risk of injury to orbital contents.



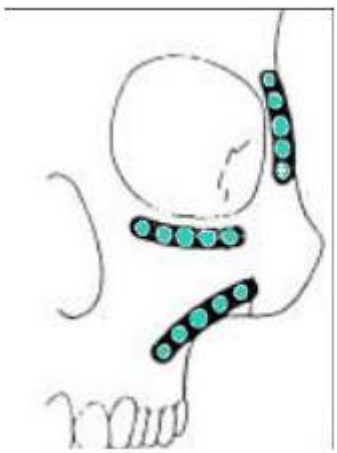


Figure showing two point fixation points

Blow out fracture

Blow out fracture is defined as a clinical syndrome in which there is fracture of orbital walls with intact rim. When rim is not involved it is known as pure orbital blow out fracture. If orbital walls and rims are also involved in the fracture then it is known as impure orbital blow out fracture.

Blow out fracture of orbit was first described by Lang in early 1900's. The exact description of the fracture and the terminology (blow out fracture) was first coined by Converse and Smith. It was infact Smith who first described inferior rectus entrapment in between the fractured fragments, causing decreased ocular mobility.

Classification

Orbito zygomatic

. Naso - Orbito - Ethmoid (NOE)

. Internal blow out

. Complex (Any of the above combinations)

Etiology

Orbital fractures are commonly caused by road traffic accidents. Pure blow out fractures involving the orbit are sustained by impact injuries to orbit and upper eyelid caused by an object which is fairly large enough to cause fracture and does not penetrate the orbit. These types of injuries are common in boxers, base ball players, cricket players etc.

The exact mechanism causing blow out fracture is yet to be elucidated. Two theories have been going around for quite sometime. They are:

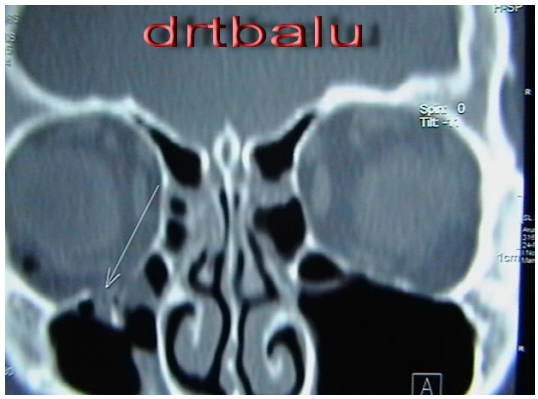
1. Buckling theory

2. Hydraulic theory

Buckling theory: This theory proposed that if a force strikes at any part of the orbital rim, these forces gets transeferred to the paper thin weak walls of the orbit (i.e. floor and medial wall) via rippling effect causing them to distort and eventually to fracture. This mechanism was first described by Lefort.

Hydraulic theory: This theory was proposed by Pfeiffer in 1943. This theory believes that for blow out fracture to occur the blow should be received by the eye ball and the force should be transmitted to the walls of the orbit via hydraulic effect. So according to this theory for blow out fracture to occur the eye ball should sustain direct blow pushing it into the orbit.

Clinical features of blow out fracture



Full ophthalmic exam is a must

Intraocular pain

. Numbeness of certain regions of face

. Diplopia

. Inability to move the eye

. Blindness

. Epistaxis

Patient may also show signs of:

. Enophthalmos

. Oedema

. Haematoma

. Globe displacement

. Restricted ocular mobility

. Infraorbital anesthesia

Proptosis in these patients is sinister because it indicates retrobulbar / peribubar hemorrhage.

Pupillary dysfunction associated with visual disturbances indicate injury to optic nerve and it is an emergency. Patient must be taken up for immediate optic nerve decompression to save vision.

Indications for repair

Indications for operative repair:

1. Diplopia within 30 degrees of primary gaze

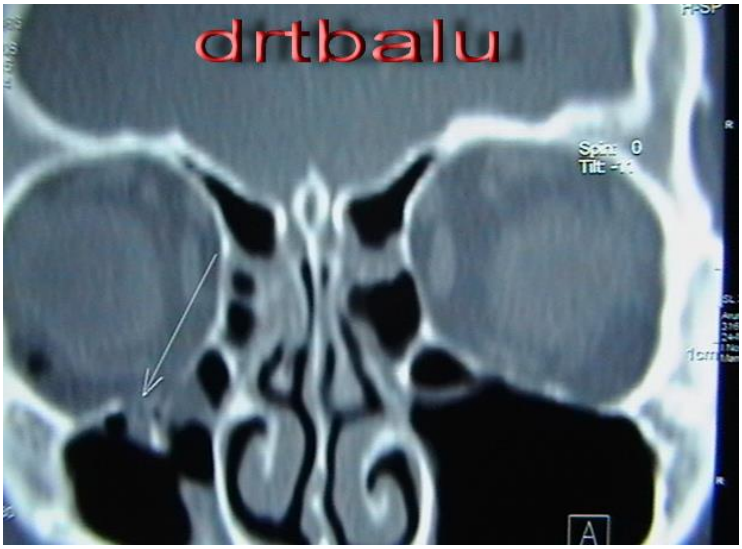
2. Extraocular muscle entrapment

3. Enophthalmos greater than 2mm

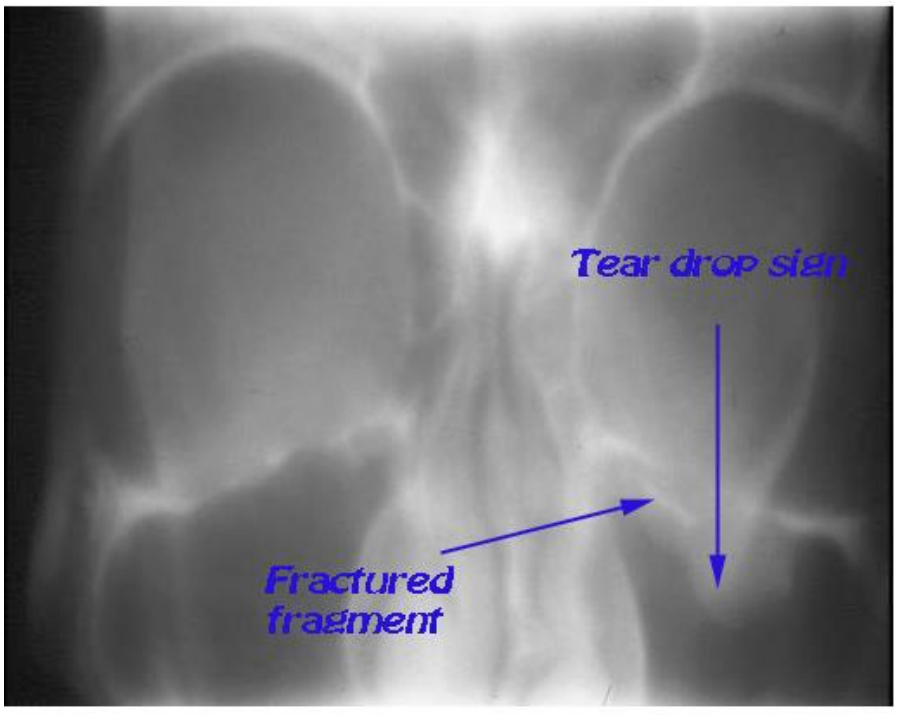
Applied anatomy of infraorbital wall:
In adults the orbital floor is contributed by maxillary, zygomatic and palatine bones. It is infact the shortest of all the orbital walls. It does not reach up to the orbital apex, but terminates at the level of posterior edge of maxillary sinus. It is infact the weakest portion of the orbital walls made still more weak by the infra orbital groove.

Timing for surgical intervention:
This is highly controversial. Some of the authors prefer a waiting period of atleast 2 weeks for the oedema to resolve before proceeding with surgical reduction of the fracture. Early intervention is indicated only in white eyed blow out fracture which is common in children. In children the bones are flexible and does not break easily but bends. Significant amounts of orbital tissue may get entrapped in between the fractured fragments causing a compromise in their blood supply. This condition is known as the white eyed blow out fracture. These patients should under go immediate reduction.

Investigations



CT PNS is diagnostic. Fracture could be clearly seen through which orbital fat protruding. This is also known as the classic tear drop sign. This also helps in identification of other associated orbital and skull base injuries.



Surgical Management of Blow out fracture

The main aim of surgery is open reduction and fixation of the fractured fragments.
The main support for the anterior projection of eye ball comes from the posterio medial and posterio lateral walls of the orbit. These areas diverge like a fan / cupped hand holding the globe forwards. Both these walls are paper thin and are commonly damaged in blow out fractures. It has been clinically shown that repair is easy if these supporting walls are intact. If this key area is involved, it should be reconstructed first.

Surgical access to the floor of the orbit:

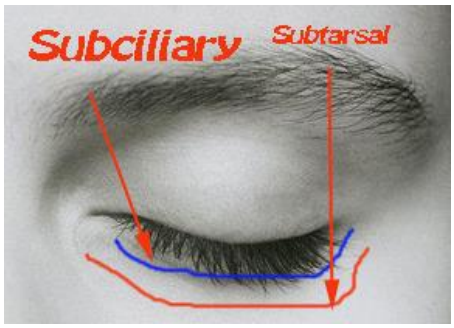
Orbital floor can be accessed by any of the following incisions:

1. Subciliary / lower blepharoplasty

2. 2nd crease / subtarsal

3. Transconjunctival

The major advantage of these incision is that it is cosmetically acceptable. There is also no risk of lower eyelid shortening or inversion.

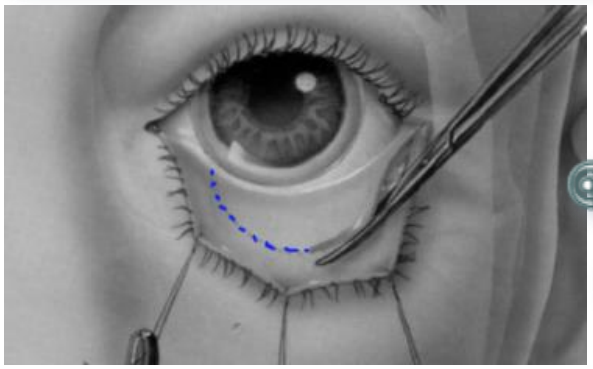


Surgery Contd..

The incision is made through skin only. The skin is reflected down by blunt dissection until it is free from the pretarsal portion of the orbicularis oculi muscle. The muscle fibers of orbicularis oculi are spread to expose the periosteum of the lateral border initially. The submuscular dissection is continued till the orbital septum is seen. Care must be taken not to incise / damage the orbital septum as it can cause troublesome prolapse of orbital fat. Damage to orbital septum can also lead to lower eye lid shortening.

Infra orbital rim is now identified. Periosteum is incised and the prolapsed contents of the orbit is elevated to visualise the floor of the orbit. The fracture can now be visualised. It can be reduced and immobilised using micro plates and screws.

Transconjunctival approach



In cases of extensive destruction of the floor of orbit then reconstruction of the floor must be resorted to using implants. These materials include autologous bone grafts and titanium plates / meshes.

In this method the lower eye lid is pulled forward. To increase the laxity a lateral canthotomy should be performed.

Two methods can be performed via this incision. 1. Preseptal method and 2. Retroseptal method.

Preseptal method: In this method incision is made at the edge of the tarsal plate to create a space infront of the orbital plate to reach the orbital rim.

Retroseptal method: In this method an incision is sited 2mm below the tarsal plate to reach the orbital rim.

The major advantage of this procedure is there is virtually very minimal scar formation. It is very quick to perform and involves no skin, muscle dissection. The only disadvantage is the limitation of access to the medial portion of the orbital floor.

In cases of blow out fractures involving the medial portion of the floor of the orbit Caldwel luc procedure can be performed to reduce the fracture fragment. Nasal endoscope can be introduced through the caldwel luc fenestra to improve visualisation.

Naso-orbito-ethmoid fracture

Naso-orbito-ethmoid fractures involve the anatomical confluence of the nose, orbits and ethmoids. This is a highly complex area where injuries are often overlooked. Recosntruction at a later date is extremely difficult.

Classification	
Type I	Single large central fragment bearing the canthal ligaments
Type II	Fragmentation of the central fragment, medial canthal ligaments attached to bone
Type III	Comminution of the central fragment with no bone attached to canthal ligaments

Signs & symptoms:
Loss of nasal projection
Tipping up of the end of the nose
Splaying of nasal root and telecanthus indicates gross comminution
Blunting of the canthal angle and movement of medial canthus can be elicited by displacement of lateral palpebral ligament

Management:

Type I fractures can be stabilized using miniplates. Surgical access is via a coronal flap, intraorally and lower eyelid incisions.

Type II and III fractures are repaired with miniplates, but require a transnasal canthopexy to reduce telecanthus and hold the position of medial canthal ligament. This is done by plates / wire. Lacrimal integrity should be assesed pre and peri operatively and stented primarily if damaged.

Fracture frontal bone

Frontal bone fractures can cause:
Meningitis
Mucopyocele
Encephalitis
Cerebral abscess

Frontal bone fractures is dangerous because of its proximity to brain and orbit and the cosmetic defects it can produce.

Fractures of frontal bone is rare because of its protected location.
It is protected from trauma by the nasal pyramid prominence

Causes of frontal sinus injuries:
1. Road traffic accident
2. Assault
3. Industrial accidents
4. Recreational accidents

Classification of frontal bone Fracture:
Anterior table fracture
1. with / without displacement
2. with / without outflow tract injury
Posterior table fracture commonly occurs in combination with anterior table fracture
1. with / without displacement
2. with / without dural injury / CSF leak
3. with / without outflow tract injury
Displacement is considered to be present if it is about the width of one table of the frontal bone.

Anatomy of Frontal sinus

Among the para nasal sinuses frontal sinus shows the maximum variations. It could be absent in 5% of individuals. Drainage channel of frontal sinus is highly variable.

Posterior wall: corresponds to the anterior wall of the anterior cranial fossa.
Floor: is formed by the upper part of the orbits. Frontal sinus appear very late in life. In fact they are not seen in skull films before the age of 6.
The sinus drains into the anterior part of the middle meatus through the fronto nasal duct.
Frontal outflow tract shows conglomeratization of air cells.
Types of frontal sinus air cells include:
I – Type I frontal cell (a single air cell above agger nasi)
II – Type II frontal cell (a series of air cells above agger nasi but below the orbital roof)
III – Type III frontal cell (this cell extends into the frontal sinus but is contiguous with agger nasi cell)
IV – Type IV frontal cell lies completely within the frontal sinus

Clinical features of frontal sinus fractures

Clinical presenting features:
These include:
1. Cosmetic defect
2. Headache
3. CSF leak (in patients with posterior table fractures)

Assessment of patient with injury to frontal sinus:
1. All suspected patients should undergo a complete ophthalmic examination to rule out injury to the eye.
2. All these patients must undergo CT scan of brain and skull for compete evaluation
3. The patient's consciousness should be monitored carefully to rule out intracranial complications
4. Other associated injuries must be looked for because the force necessary to cause fracture of frontal bone is enormous.

Treatment goals:
1. Protection of intracranial structures
2. Control of CSF leak
3. Prevention of late complications like secondary mucoceles
4. Deformity correction

Anterior table fractures

Caused by low energy trauma. Displaced fractures cause cosmetic defects. Isolated non displaced fracture of anterior table can be managed conservatively by observation. It there is displacement of fractured fragments then open reduction with internal fixation is needed.
If there is associated damage to frontal outflow tract then frontal sinus obliteration is needed.

While performing open reduction with internal fixation care should be taken to avoid entrapment of mucosa within the bone fragments as this could cause mucocele formation at a later date. CT scan need to be performed to assess frontal sinus outflow tract.

Three vital areas that should be addressed while managing fractures of frontal bone:
1. Anterior table
2. Posterior table. Associated with CSF leak
3. Frontal sinus outflow tract

Tips for frontal bone fracture repair:
1. All depressed fractures of more than one table width should be reduced
2. Titanium mini plates are very useful with good success rate
3. In comminuted fractures titanium mesh is ideal

Fracture midface

Clinical features:
Malocclusion
Reduced sensation over infraorbital nerve distribution
Swelling over cheek.
Panda facies due to circumorbital ecchymosis

Fractures of midfacial skeleton can be subdivided into lateral (zygmomatic) or central (maxillary, nasal and nasorbitoethmoidal fractures.

Maxilla acts as a bridge between the skull base superiorly and the dental occlusal plane inferiorly. This bone is associated intimately with oral cavity, nasal cavity and orbits. This makes maxilla an important structure both functionally and cosmetically.

Classification of middle third of face fractures

Le Fort I fractures (horizontal) also known as Guerin's fracture /floating fractures may result from a force of injury directed low on the maxillary alveolar rim in a downward direction. It separates the palate from the remainder of the facial skeleton.
The fracture extends from the nasal septum to the lateral pyriform rims, travels horizontally above the teeth apices, crosses below the zygomaticomaxillary junction, and traverses the pterygomaxillary junction to interrupt the pterygoid plates.

Le Fort II fractures (pyramidal/Subzygomatic fractures) may result from a blow to the lower or mid maxilla. Such a fracture has a pyramidal shape and extends from the nasal bridge at or below the nasofrontal suture through the frontal processes of the maxilla, inferolaterally through the lacrimal bones and inferior orbital floor and rim through or near the inferior orbital foramen, and inferiorly through the anterior wall of the maxillary sinus; it then travels under the zygoma, across the pterygomaxillary fissure, and through the pterygoid plates.

Le Fort III fractures (transverse/Suprazygomatic fracture), also termed Craniofacial Dysjunctions/"Dish-Face"deformity, and may follow impact to the nasal bridge or upper maxilla; usually as a consequence of superiorly-directed blows to the nasal bones.

Management

Airway patency to be ensured
Control of bleeding
Treatment of hypovolemia
Patient should be placed in 30 degree head up position to encourage drainage of blood, saliva and CSF away from the airway.

After patient stabilizes then CT scan needs to be performed
DEFINITIVE MANAGEMENT
Goals of treatment –
1) Precise anatomical reduction to cranial base above and to the mandible below.
2) Stable fixation of reduced fragments
3) Preservation of blood supply to fractured site.
4) Restoration of function.
REDUCTION OF MAXILLA
1. Manual reduction.
2. Reduction with wires.
3. Reduction using disimpaction forceps.
4. Reduction by means of traction(elastics)
Closed reduction can be done in
1) Non displaced fracture
2) Grossly comminuted fractures
3) Fractures exposed by significant loss of overlying soft tissues.
4) Edentulous maxillary fractures
5) In children with developing dentition.
Open reduction to be done in
1) Displaced fractures
2) Multiple fractures of facial bones
3) Fractures of edentulous maxilla with severe displacement.
4) Edentulous maxillary fracture opposing an edentulous mandibular fracture.
5) Delay of treatment and interposition of soft tissues between non-contacting displaced fracture segments.
6) Specific systemic conditions contraindicating IMF.

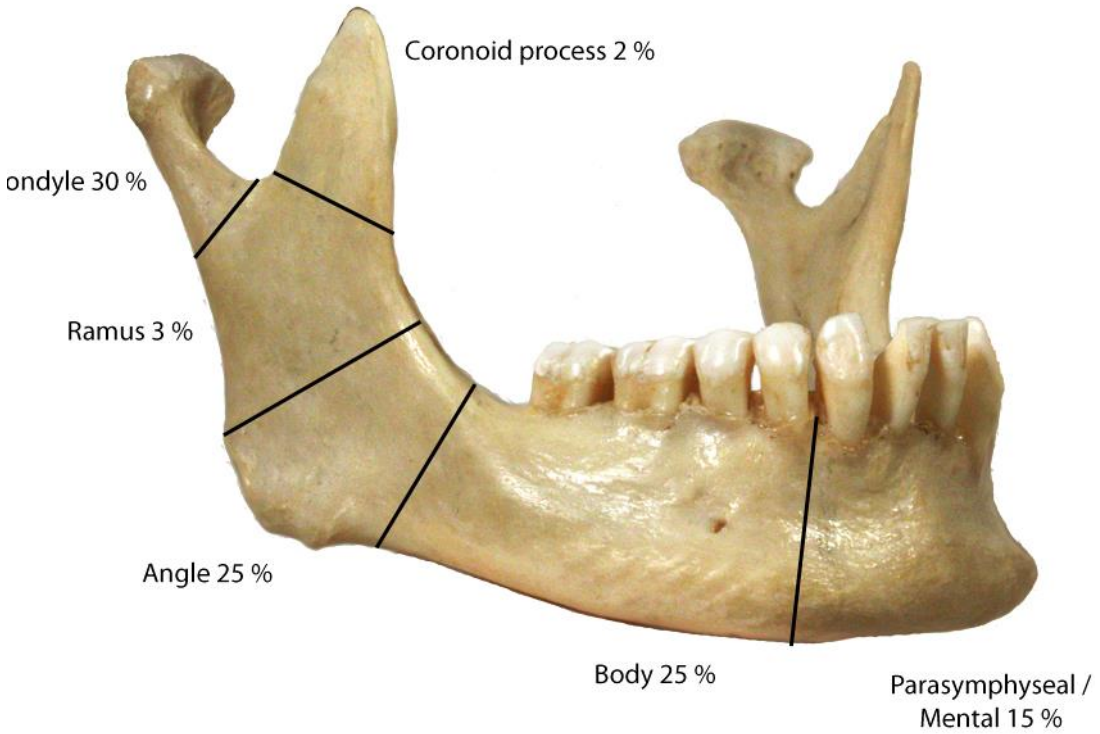
Fracture Mandible

Common use of miniplates and extended subperiosteal exposure of the craniofacial skeleton has made closed reduction techniques a thing of the past.

Mandible a parabolic shaped bone with complex articulation that consists of paired synovial joints (TM joints). Movements of this joint in part is guided by the dental occlusion.

Fracture mandible requires accurate reduction, adequate fixation and immobilization.

Anatomy of Mandible



Mandible will fracture when subjected to direct and indirect force. The type of fracture depends on the direction and magnitude of the applied force and whether the teeth ar in or out of occlusion at that time.

Fractures occur at points of potential weakness where the bone is relatively thin. The angles of mandbile may be weakened by unerupted wisdom teeth, the parasymphysis by the long root of lower canine and the condylar neck by its slender anatomy. It is also common for the mandible to fracture at more than one place. This can happen at the parasymphysis (site of direct violence) and condylar neck (site of indirect violence). Displacement of fracture depends on the pull of attached muscles.

Fracture Mandible Signs & Symptoms

Signs & Symptoms:

Depends on the site of fracture.
Fractures of the body, angle and symphysis are associated with:

1. Step deformity palpable externally / intraorally

2. Asymmetry of lower dental arch and derangement of the occlusion

3. Pain and paradoxical movement and crepitus on distraction of fractured fragments

4. Hematomas in the buccal sulcus / floor of the mouth

5. Blood stained saliva

6. Anesthesia of lower lip

Fracture of condylar neck is associated with:

1. Tenderness over TM joint

2. Deviation of the jaw towards the injured side on opening the mouth

3. Deviation of jaw to the fractured side at rest with an anterior open bite secondary to gagging of the molar teeth in fracture dislocation

4. Symmetrical anterior open bite in bilateral fractures of the necks of the condyles.

Fracture Mandible Management

Closed reduction techniques:

Intermaxillary fixation can be used in undisplaced fractures with no neural deficits, in those who want to avoid complex surgery, and in unilateral condylar fractures. A simple tie wire is placed around the teeth on either side of a displaced fracture can reduce pain, bleeding from bone ends. This makes nursing easier in the hours / days before a planned open reduction and internal fixation is performed.

Intact dental arch:
Eyelet wires can be used. It is rather simple to use and is possible in those situations where there are two adjacent teeth in contact. Main disadvantage is that it is difficult to combine eyelet wires with elastic traction and it can be awkward to thread wire through tight interdental contact points.

Incomplete dental arch:
Arch bars can be used. An arch bar is a strip of metal that is wired to each jaw using several individual teeth. The bar may be prefabricated using a model made from preoperative dental impression. Arch bars can span short gaps within each jaw, but will not cope with large gaps or when there is no posterior tooth. Arch bar provides a simple means of stabilizing more complex fractures by providing indirect fixation.

Intermaxillary bone pins:

This is a rapid method of intermaxillary fixation. A mono-cortical screw is placed through the mucosa between the canine and the first molar on side of the jaw. The screws are then wired together or connected with elastic bands. It is important to ensure that the path of the screw is the bone and the dental roots area are avoided. These specially designed screws are brittle and care should be takne when inserting them as they could break.

Contd..

Internal fixation:

Intraoral incision:
When possible bone plates should be placed through an intraoral approach. Mucogingival incisions are made so that the resultant flap includes the periosteum. It is essential that a sufficient cuff of mucosa is raised so that the plate is completely covered after closure. Mental nerve should be protected.

Extraoral incisions:

External incisions are used for the lower border of the mandbile and condylar neck. Lower border plates are ideal when there is gross comminution or tissue loss. They are also preferable in fractures of grossly resorbed edentulous mandible. In these situations, it is better to use bicortical screws and thicker plate that can provide superior fixation. The incision is made two finger breadths below the lower border of the mandible in order to avoid damage to the mandibular branch of facial nerve.

Condylar neck fractures:

Are difficult to manage. Open reduction and internal fixation is advisable.