MAXILLARY FRACTURES

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The maxilla is a vital bone of the midface that:
- forms the roof of the mouth
- houses the upper teeth
- forms part of wall of the orbits
- forms the floor and lateral wall of nasal antrum
- It absorbs energy with impact, thus protecting the orbits, intracranial contents, and nose
- Maxillary fractures usually result from blunt trauma
- Accurate repositioning of fractured skeletal fragments is crucial for both function and facial aesthetics
- Maxillary fractures can be very complex and challenging to repair surgically
Eight Bones Regularly Articulate with Maxilla

1. Frontal
2. Ethmoid
3. Nasal
4. Zygomatic
5. Lacrimal
6. Inferior nasal Concha
7. Palatine
8. Vomer
Maxilla
- Composed of 2 halves that fuse at the intermaxillary suture line
- Forms roof of mouth and houses upper teeth
- Form part of wall of the orbit
- Forms floor and lateral wall of nasal antrum

Four Processes
1. Zygomatic
2. Frontal
3. Alveolar
4. Palatine
RIGHT ORBIT
Anatomy

- Buttress System: There are three main vertical buttresses and several horizontal buttresses that serve as structural pillars of the mid-face.
- These help to identify key areas of fracture and stabilization of the midface as they relate to function and facial aesthetics.

1. Nasomaxillary (Canine)
2. Zygomaticomaxillary
3. Pterygomaxillary
Nasomaxillary (Canine) Buttress

- Most anterior buttress
- Extends from maxillary alveolar ridge along pyriform aperture up to medial side of orbit, frontal process of maxilla, and to superior orbital rim
Zygomaticomaxillary Buttress

- Starts above 1st maxillary molar and extends to zygomatic process of frontal bone
- Bears the strongest load of the vertical buttresses
Pterygomaxillary Buttress

- Most posterior buttress
- Extends along alveolar ridge to base of the skull
- Less important than nasomaxillary or zygomaticomaxillary buttresses because less accessible surgically
Horizontal Beams

- Weaker than vertical buttresses
- Help reinforce vertical buttresses and provide width and projection to face

  - Frontal bar
    - most important horizontal beam
      - Inferior orbital rim
      - Maxillary alveolus and palate
      - Zygomatic process
      - Greater wing of the sphenoid
      - Medial/lateral pterygoid plates
      - Mandible
Buttresses: Take home points

- They help to identify key areas of fracture and stabilization
- Zygomaticomaxillary buttress bears the strongest load of the vertical buttresses
- Frontal bar most essential horizontal buttress because suspends naso and zygomaticomaxillary buttresses

No respect for the buttresses = shortened midface AKA telescoping
Rene Le Fort

- Who is he?
  - A French surgeon that specialized in pediatric and orthopedic surgery
- What did he do?
  - Created the three Le Fort classifications of midface fractures
- How did he do it?
  - Using intact cadaver heads he delivered blunt forces of varying degrees of magnitude and from different directions
- Le Fort classifications
  - Advantages: Help stage the degree of severity of the fractures
  - Disadvantages: Difficult to characterize many comminuted midface fractures
Le Fort Classifications

- Three types
  - Le Fort I: Low maxillary
  - Le Fort II: Pyramidal
  - Le Fort III: Craniofacial dysjunction
- All involve the pterygoid plates
Le Fort I

- Low maxillary fracture
- Usually caused by low A-P force
- Involves floor of the nose, lower third of the maxilla, palate, and pterygoid plates
- Upper alveolus becomes separated from upper maxilla
  - Mobile palate
Pyramidal fracture caused by superiorly directed force or A-P force along Frankfort plane
Frankfort horizontal line
- Defines horizontal plane of the skull
- Runs along upper rim of EAC and lower rim of orbit
Le Fort II

- Occurs across nasal bony superstructure, frontal process of maxilla, anterior wall of maxilla, and orbital floor including infraorbital foramen
  - Maxillary branch (V2) of CN V exits skull
- Fracture line goes through lateral wall of maxilla extending to the pterygoid plate
Le Fort III

- Craniofacial dysjunction
  - Caused by high velocity impacts
  - Extends laterally across nasofrontal suture, orbital walls and floor, zygomaticofrontal suture, zygoma, and pterygoid plate
  - Mobile zygoma
Le Fort III

- Can be devastating and involve cerebral trauma
  - May occur as staged procedure with neurosurgery
  - ORIF delayed until patient is neurologically stable
- Maxilla must be fixed between 2 stable platforms
  - Superiorly: Cranium
  - Inferiorly: Mandible
Obtain an accurate history
  - Often difficult
    - associated intracranial, abdominal, or intrathoracic injuries
    - Inebriated, under the influence

Physical Exam
  - Full ENT exam
  - Dental evaluation
  - Palpate face for bony crepitus, step offs, mobile palate/zygoma
  - Neuro exam
  - Ophthalmic exam
    - EOMs
    - Pupillary reflex
    - Visual acuity
    - FORCED DUCTION TEST
Forced Duction Test

- Performed if there is diminished or absent movement of the eye due to neurological or mechanical restriction
- Anesthetized conjunctiva is grasped with forceps and globe is moved in direction of restricted movement
  - No Passive movement = Mechanical Restriction
Physical Exam
- A few characteristic signs:
  - Periorbital ecchymosis
  - Massive tissue swelling
  - Subconjunctival hemorrhage if infraorbital rim involved
  - Bony crepitus of midface
    - Common in severely comminuted fractures
    - Sign of ethmoid sinus fracture
  - Subcutaneous emphysema
Exam – Ophthalmic Manifestations

- Maxilla forms anterior floor of orbit
  - Herniation of orbital soft tissues (orbital fat and inferior rectus muscle) into maxillary sinus = visual changes (i.e. diplopia)
- Oculocardiac reflex
  - Traction to extraocular muscles or compression of the globe
    - bradycardia, junctional rhythm, or asystole
  - Cardiac exam, check cardiac monitor, vitals
Fracture of the inferior medial orbital area
- May involve lacrimal sac and duct
- Epiphora
  - Overflow of tears onto the face
Enophthalmos

- Due to volume changes of the bony orbit relative to globe and soft tissues
- Globe becomes displaced posteriorly

Right eye appears smaller and "sunken in"
AMARUROSIS

- Partial or total vision loss
- May occur if fracture involves optic canal
  - Direct injury or damage to optic nerve
- Progressive blindness in presence of fracture of optic canal = immediate indication for orbital decompression
Exam - Nasal Manifestations

- Obvious deformity
- Nasal obstruction
  - Congestion and edema after injury
  - Derangement of nasal bones and septal structures
  - Bleeding
    - From ostia of maxillary or ethmoid sinuses
    - From nasal cavity lacerations
  - Posterior inferior displacement of maxillary segments by the pull of the medial pterygoid-masseter “sling”
Posterior inferior displacement of maxillary segments by the pull of medial pterygoid and masseter muscle “sling”
Displacement of maxilla = malocclusion

- Most common abnormality is an open-bite deformity
  - Caused by medial pterygoid and masseter “sling” distracting posterior part of maxilla inferiorly
- Dish face deformity from blow to the front

Type II Malocclusion
Airway compromise is the number #1 priority

- Emergency airway may be necessary
  - Orotracheal intubation – poor option
    - Poor visualization
    - Aggravation of cervical spine injury
  - Nasotracheal intubation – poor option
    - Accidental passage into the brain
  - Cricothyroidotomy
  - Tracheostomy
Results when fracture extends through cribiform plate or roof of ethmoid sinuses
- Salty taste in mouth
- Clear nasal discharge

Beta-2-transferrin
- Isoform of transferrin
- Almost exclusively found in CSF
  - 3-5 day wait for results
Exam - Miscellaneous

- Nasal or pharyngeal hemorrhage
  - May be massive!
  - May go unnoticed!
    - If patient in supine position
- Mobile palate
  - Disarticulated palate may be immobile if midface is impacted
  - Excruciating pain with biting down
- X-rays
  - Historical
- CT has become the standard to delineate extent and severity of midface fractures
  - Axial and coronal views
  - Fast, relatively inexpensive
  - Excellent for evaluation of bony structures
- MRI
  - Better soft tissue evaluation
  - Limited benefit in acute setting
    - Cerebral trauma
    - Optic nerve trauma

Why CT and not MRI?
Treatment - Initial

- Starts with ABC’S (before H+P)
  - Airway
  - Breathing
  - Circulation

- Appropriate imaging
  - Only if hemodynamically stable

- If patient is hemodynamically unstable and rushed to the OR without imaging:
  - Tracheostomy
  - Intermaxillary fixation

Occlusion is the base to any reconstruction, can bring some fragments into place
Medical Treatment - Antibiotics

- Prophylactic antibiotics are controversial
  - Both preoperative and postoperative setting
  - Both mandibular and non-mandibular fractures
    - Efficacy
    - Timing
    - Duration
    - Choice of antibiotic
- To date no large, multicenter RCTs

- Literature review of 5 studies with the highest level of evidence
- Conclusion: Not enough data to evaluate efficacy of antibiotic use in non-mandibular fractures
- There is evidence that postoperative antibiotics are not beneficial
- Limited data regarding choice, duration, or timing of antibiotic
When to repair a maxillary fracture surgically?

- Dependent on nature of injury
  - Extent of injury
  - Complexity of injury
- Dependent on patient
  - Comorbidities
  - Goals and desires
    - Function versus aesthetics
- Dependent on surgeon
  - Judgement
  - Comfort level
“Hard” indications for surgery

- Significant enophthalmos (>2mm)
- EOM entrapment
  - Especially if causing oculocardiac reflex with hemodynamic instability
- Persistent diplopia
- Large orbital wall defect (>2.5cm^2)
- Large orbital floor defect (>50%)
  - Will usually lead to enophthalmos
Displaced fractures may require disimpaction before placement in intermaxillary fixation.

Rowe-Killey disimpaction

- Straight blade placed along nasal floor
- Curved blade along palate
Dentulous
- Arch bars and intermaxillary fixation to resestablish pretrauma occlusion

Edentulous patients
- Splints or dentures with arch bar fixed to maxilla
  - These require circummandibular wires or drop wires from zygoma or pyriform rim for stabilization
Surgical Approaches

- Multiple approaches depending on location
  - Sublabial
  - Subciliary
  - Transconjunctival-lateral canthotomy
  - External Lynch
  - Extended coronal
  - Supratarsal (AKA upper blepharoplasty)
- Most Le Fort fractures are combinations of complex fractures
  - May require multiple or combined surgical approaches
Surgical Approaches

- **Sublabial incision**
  - Used for isolated Le Fort I fracture
  - Exposure of zygomaticomaxillary buttresses and pyriform apertures
  - **Advantages**
    - Easy approach
  - **Disadvantages**
    - Risk damaging infraorbital nerves
Surgical Approaches

- Subciliary incision
  - Used for Le Fort II fracture involving infraorbital rim
  - Incision made just below the eyelashes
  - Advantages
    - Great exposure of infraorbital rim
    - Scar well camouflaged
  - Disadvantages
    - High incidence scleral show
    - High incidence of ectropion
Surgical Approaches

- **Transconjunctival-lateral canthotomy incision**
  - Another option for Le Fort II fracture involving infraorbital rim
  - Lateral canthotomy followed by transconjunctival incision
  - Exposure of infraorbital rim
  - **Advantages**
    - No visible scar
  - **Disadvantages**
    - Risk of ectropion
    - Limited exposure
External lynch incision

- Historically used for external ethmoidectomy
- Lateral nasal incision that allows for exposure of nasoethmoid complex in extensive Le Fort II fractures

Advantages
- Also allows exposure to anterior/posterior ethmoid arteries

Disadvantages
- Less commonly used
Extended coronal incision

- Exposure of nasoethmoid complex in extensive Le Fort II fractures
- Incision line variable depending on hair pattern

Advantages

- Avoids visible facial scars
- Also excellent exposure of medial orbit, frontal sinus

Disadvantages

- Limited to upper facial skeleton
Supratarsal (Upper blepharoplasty incision)

- Option for Le Fort III fracture involving zygomatic process of maxilla
- Exposure to frontozygomatic suture line
- Incision in lateral half of upper lid

Advantages
- Scar well concealed

Disadvantages
- Limited exposure
Goals of Surgery

- Goals
  - Reestablish buttresses
  - Restore functional elements
    - Correct orbital volume
    - Orbital contents free of entrapment
    - Patent nasal airway and maxillary ostia
    - Reestablish occlusion
  - Restore aesthetic landmarks
    - Orbital rims
    - Nasal dorsum
    - Malar eminences
    - It may be impossible to approximate every small maxillary fragment!
Titanium Plates

- Titanium plates and screws are considered the “gold standard” to immobilize displaced fracture segments

**Advantages**
- Small, inexpensive, suitable for rigid fixation

**Disadvantages**
- May need 2\textsuperscript{nd} operation to remove hardware
- Children: May inhibit bone growth
- Children: Bone may grow around plate, bone deformity
Absorbable Plates

- Alternative to titanium plates
- Retain strength until absorbed – no 2\textsuperscript{nd} operation needed

Advantages
- Children
  - Do not impede bony facial growth at suture lines
- Adults
  - Can be less painful
  - Eliminate palpable plate along lateral and infraorbital rim

Disadvantages
- Durability remains questionable
Looked at therapeutic efficacy and safety of titanium versus absorbable plates

Analyzed 78 patients with blow-out fractures
- 36 treated with absorbable mesh plates
- 42 with titanium plates

Complications:
- Enophthalmos
- EOM impairment
- Diplopia

Conclusions:
- Good results both groups
- Equally effective and safe for orbital wall reconstruction
• Silk screw made from silk worm silk
• Currently undergoing animal testing at Tufts University
• Strong, malleable
• Silk proteins dissipate within the body
Post-Op

- Pain control
- Prophylactic antibiotics controversial
- If rigid fixation is stable, IMF can be removed at end of operation or within 1-2 weeks
- If stability is in question, leave IMF for 6-8 weeks to maintain occlusion while bone healing occurs


National Geographic, the magazine. (October 2014). Silk screws.

Peltier, J. UTMB Department of Otolaryngology Grand Rounds Archives,
