

Facial Fractures: The Upper Face

Outline

- ▶ Facial Fracture Basics
 - ▶ Nasal Fractures
 - ▶ Naso-orbital-ethmoidal Fractures
 - ▶ Frontal Sinus Fractures
 - ▶ Zygomatic Fractures
 - ▶ Maxillary Fractures
 - ▶ Orbital Fractures
- 

Emergency Management

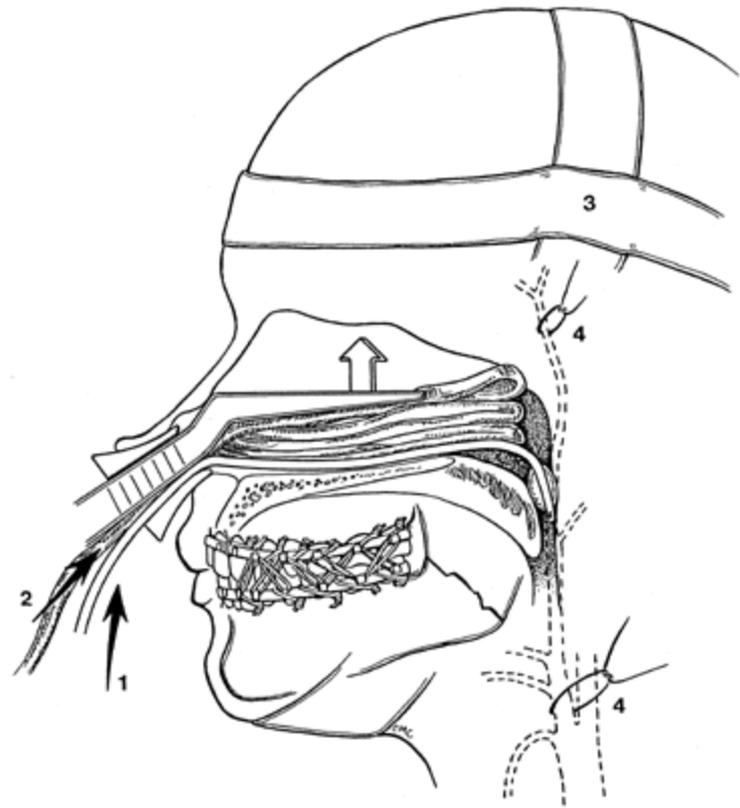
A – Airway

B – Breathing

C – Circulation / Hemorrhage

Emergency Management Hemorrhage

- ▶ Local Pressure
- ▶ Dressings / Packing
- ▶ Reduction Of Facial Fractures
- ▶ Endovascular Consultation
- ▶ Ligation Of Vessels
 - IMAX



Emergency Management

- ▶ C–Spine Injury
 - 10% C–Spine Fracture
- ▶ Head Injury
 - 50% – Loss of Consciousness
 - 5% Significant Intracranial Injury
- ▶ Ocular Injury
 - 25% – Some Degree of Injury

Signs And Symptoms

- ▶ Pain / Tenderness
 - ▶ Crepitus From Bony Fractures
 - ▶ Hypoesthesia
 - ▶ Paralysis
 - ▶ Malocclusion
 - ▶ Visual Disturbances
 - ▶ Deformity
 - ▶ Obstructive Respiration
 - ▶ Lacerations
 - ▶ Bleeding
 - ▶ Contusions
 - ▶ Facial Asymmetry
- 

Soft Tissue Injuries

- ▶ Tetanus Prophylaxis
- ▶ Structures
 - Facial Nerve
 - Trigeminal Nerve
 - Parotid Duct
 - Lacrimal System

Principles Of Craniomaxillofacial Fracture Management

- ▶ Precise anatomic diagnosis
- ▶ Direct fracture exposure
- ▶ Reduction / rigid internal fixation
 - Mandible fracture stabilization
 - Reconstruction of horizontal and vertical facial buttresses
- ▶ Primary bone grafting
- ▶ Periosteal and soft-tissue suspension and repair

Nasal Fractures

Anatomy

- ▶ Upper Vault
 - nasal bones, ethmoid, superior edge of septum, vomer
- ▶ Middle Vault
 - upper lateral cartilages, most of septum, maxilla
- ▶ Lower Vault
 - alar cartilages, inferior edge of septum

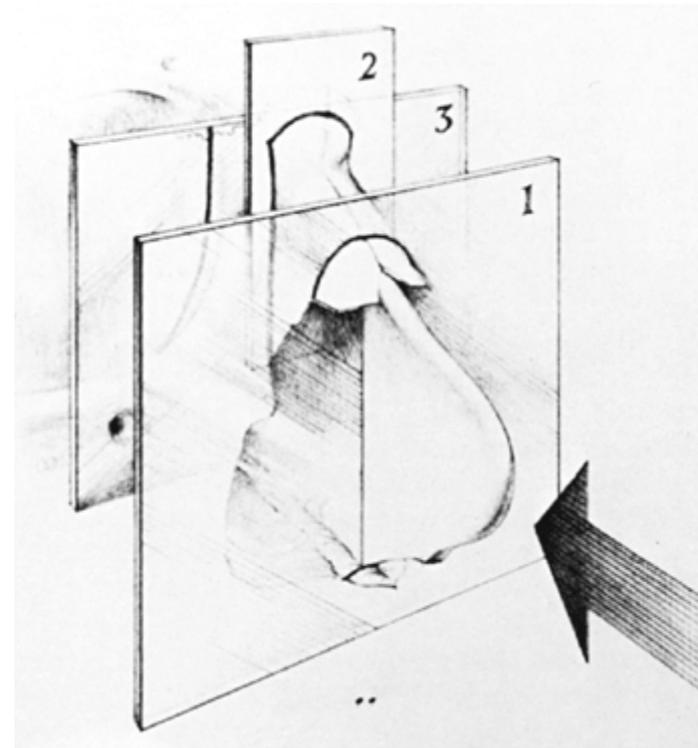
Physical Exam

- ▶ Edema
 - ▶ Crepitus
 - ▶ Periorbital Ecchymosis
 - ▶ Epistaxis
 - ▶ Internal And External Lacerations
 - ▶ Widened Nasal Bridge
 - ▶ Septal Hematoma
- 

Classification

Stranc and Robertson

- ▶ Lateral Impact Injuries
 - Unilateral vs. Bilateral
- ▶ Frontal Impact Injuries
 - Plane I
 - Plane II
 - Plane III



Treatment

Lateral Impact Injuries

- ▶ Early Versus Delayed Treatment
- ▶ Closed Reduction (Local vs. General)
- ▶ Drainage of Septal Hematoma
- ▶ Simple Repositioning of Deviated Nasal Bones and Septum
 - Completion Of The Fracture
- ▶ Internal Packing and External Splint

Treatment

Frontal Impact Injuries

▶ Plane I

- edema / ecchymosis distal nasal bridge and tip
- possible septal distortion
- closed reduction with internal support
- possibly may require secondary septorhinoplasty

Treatment

Frontal Impact Injuries

▶ Plane II

- Increased Comminution of the Nasal Pyramid
- Bilateral
- Possible “Saddling”
- Initial Closed reduction
- May Require Delayed Septal Reconstruction With Grafts

Treatment

Frontal Impact Injuries

▶ Plane III

- Extend Into Pyriform Aperture And Medial Orbital Rim
 - ie. Naso-Orbital-Ethmoidal Fractures
- Open Reduction and Internal Fixation of Frontal Process of Maxilla
- Transnasal Reduction of Medial Canthal Ligaments

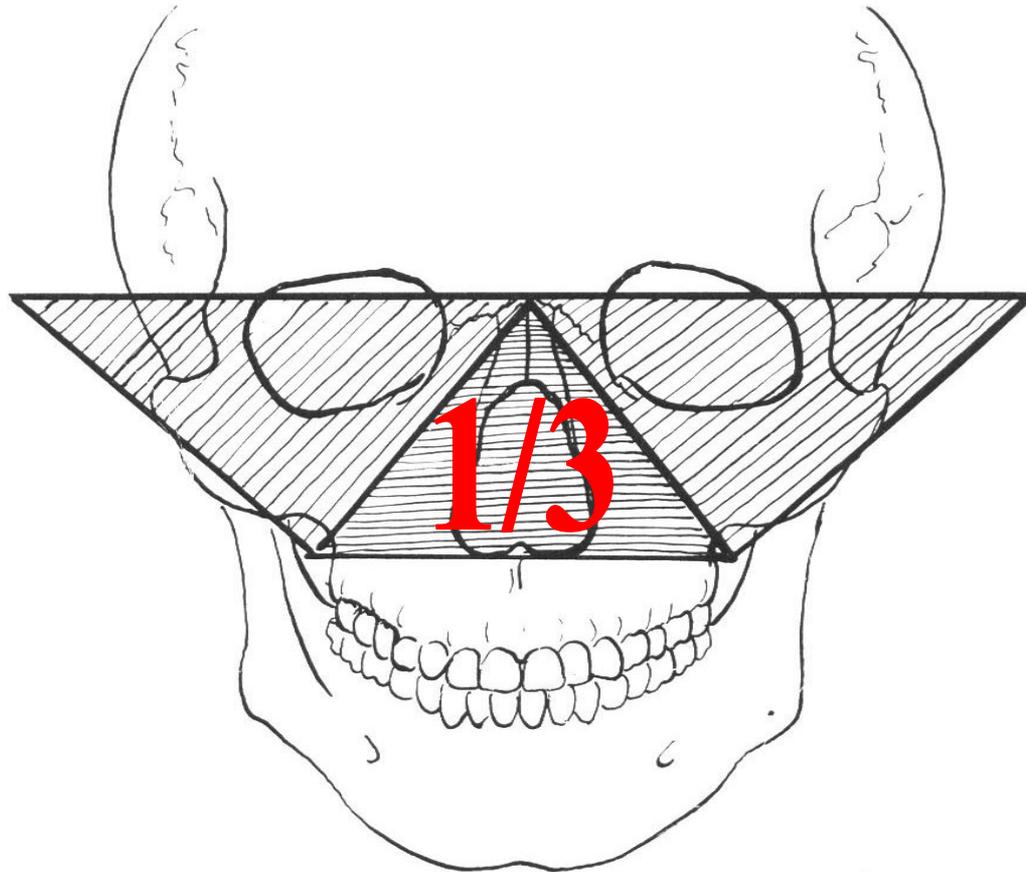
Complications

- ▶ Occur In Up To 70%
 - Deviated Nasal Pyramid
 - Nasal “Hump”
 - Septal Deformity With Respiratory Obstruction

Naso-Orbital-Ethmoidal Fractures

Naso-Orbital-Ethmoidal Fractures

Anatomy



Naso–Orbital–Ethmoidal Fractures

Anatomy

▶ Interorbital “Space”

- two ethmoidal labyrinths
- superior and middle turbinates
- perpendicular plate of ethmoid

▶ Medial Orbital Wall

- anteriorly – lacrimal bone and lamina papyracea
- posteriorly – body of sphenoid

Naso–Orbital–Ethmoidal Fractures

Anatomy

- ▶ Interorbital space displaced backwards
- ▶ **Medial Canthal Tendon** and **Lacrimal Apparatus** frequently injured
- ▶ May extend into:
 - cribriform plate and anterior cranial fossa
 - optic foramen
- ▶ Associated Orbit and Midface Fractures Common

Naso–Orbital–Ethmoidal Fractures

Physical Exam

- ▶ Flat nose
- ▶ Swollen medial canthal area
- ▶ Telecanthus (12–20%)
- ▶ Lack of skeletal support on palpation of nose
- ▶ CSF leak
- ▶ Positive eyelid traction test

Naso–Orbital–Ethmoidal Fractures

Telecanthus

- ▶ Normal intercanthal distance (Stranc)
 - White males: 33–34mm
 - Females: 32–33mm
- ▶ Consider >35 mm abnormal (Manson)

Naso-Orbital-Ethmoidal Fractures

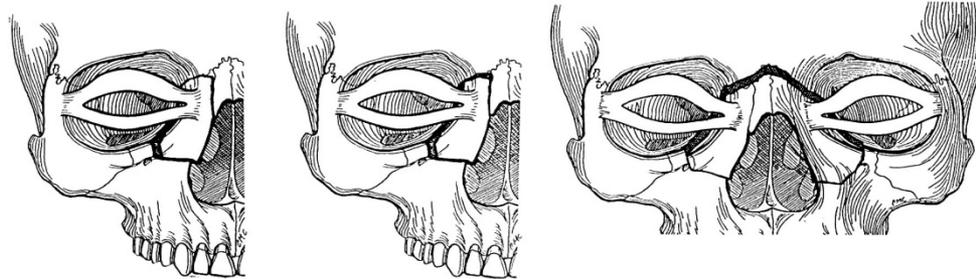
Classification – Markowitz

- ▶ Type I – Single central segment
- ▶ Type II – Comminuted central segment
- ▶ Type III – Avulsed medial canthal tendon

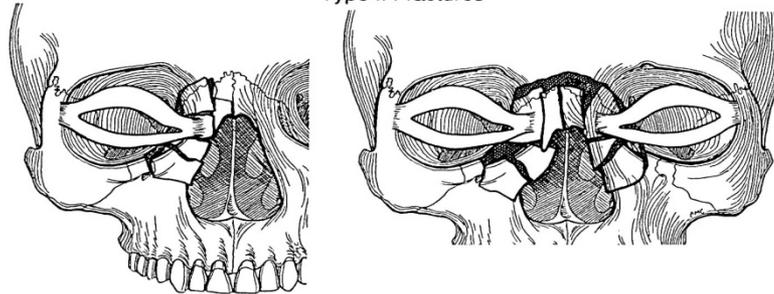
Naso-Orbital-Ethmoidal Fractures

Classification

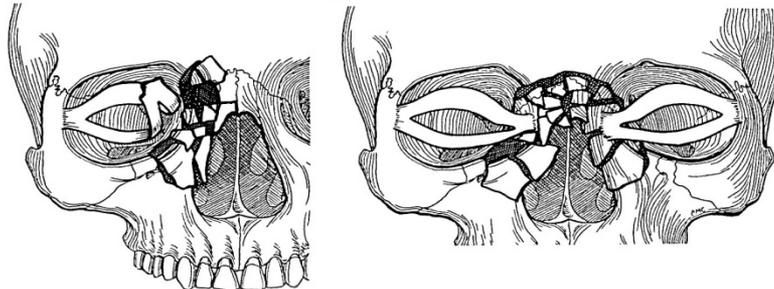
Type I Fractures



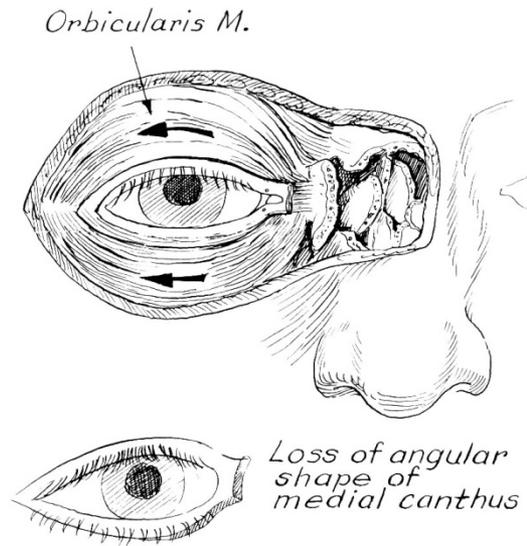
Type II Fractures



Type III Fractures



Naso-Orbital-Ethmoidal Fractures



Naso-Orbital-Ethmoidal Fractures

Classification – Gruss

- 1 Isolated injury to bony naso-orbital region
- 2 Associated fractures of the central maxilla
- 3 Associated LeFort II and III
- 4 Naso-orbital fractures with orbital dystopia
- 5 Naso-orbital fractures with bone loss

Naso–Orbital–Ethmoidal Fractures

Management

- ▶ Early open reduction
- ▶ **Four Objectives:**
 - correct epicanthal folds
 - restore bony contour
 - reestablish lacrimal system continuity
 - medial canthoplasty / canthopexy

Naso–Orbital–Ethmoidal Fractures

Management

▶ **Wide Exposure**

- coronal incision
- “open sky” – transverse across root of nose
- vertical midline nasal
- subciliary
- buccal sulcus
- extend existing lacerations

Naso–Orbital–Ethmoidal Fractures

Management

- ▶ Correct nasofrontal separation
 - Elevate nasal bones
- ▶ Reduce comminuted nasal bones
- ▶ Bone graft where needed
- ▶ Explore septum
- ▶ Stabilize nasomaxillary buttresses

Naso–Orbital–Ethmoidal Fractures

Management

- ▶ **Medial Canthus Repair**
 - **Transnasal Wires**
 - Through central fragment
 - Posterior and Superior to lacrimal apparatus
 - Three sets of wire
 - bone reduction
 - medial canthus reattachment
 - reapproximate skin to nasal skeleton

Naso–Orbital–Ethmoidal Fractures

Lacrimal System Injury

- ▶ Incidence
 - <20%
- ▶ Routine exploration not justified
- ▶ Persistent dacryocystitis of obstruction
 - Dacryocystorhinostomy

Naso–Orbital–Ethmoidal Fractures

Complications

- ▶ Telecanthus
 - related to inadequate / delayed treatment
- ▶ Lacrimal system obstruction / infection
- ▶ Meningitis

Frontal Sinus Fractures

Frontal Sinus

Embryology

- ▶ Begin to Develop At 2 Years of Age
 - Extension of the Ethmoid Air Cells
- ▶ Radiographically Evident At ~ 8 Years
- ▶ Do Not Reach Adult Size Until 12 or Older
- ▶ 10% – Unilateral Development
- ▶ 4% – Absent All Together
- ▶ Drain Into Middle Meatus

Frontal Sinus

Anatomy

- ▶ Usually Small
 - 5 cm³ in adults
- ▶ Anterior Wall Thicker Than Posterior
- ▶ Close To Other Structures
 - Posteriorly (cribiform plate, dura mater, frontal lobes)
 - Inferiorly (orbit, nasofrontal duct)

Frontal Sinus

Anatomy

- ▶ Supraorbital / Temporal vs Frontal Sinus
 - ▶ Anterior Wall and/or Posterior Wall
 - ▶ Nasofrontal Duct
- 

Frontal Sinus

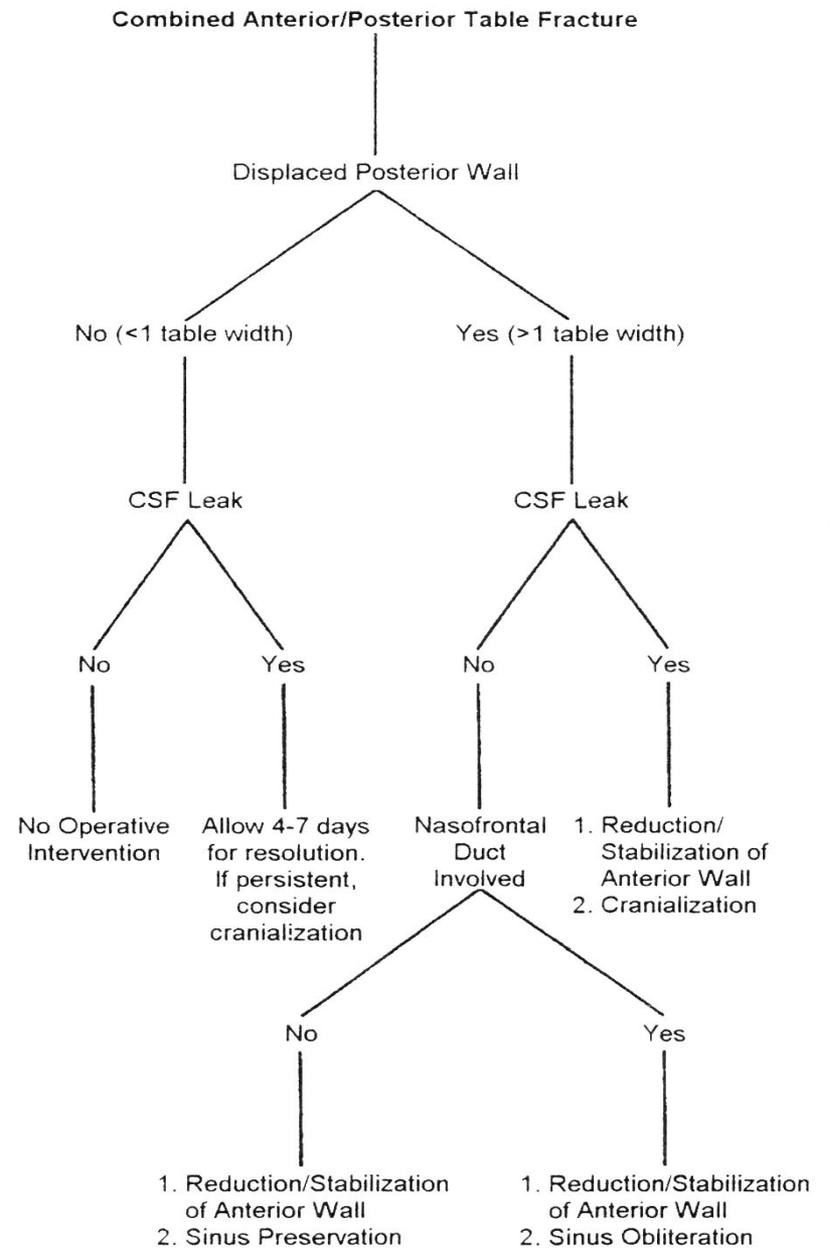
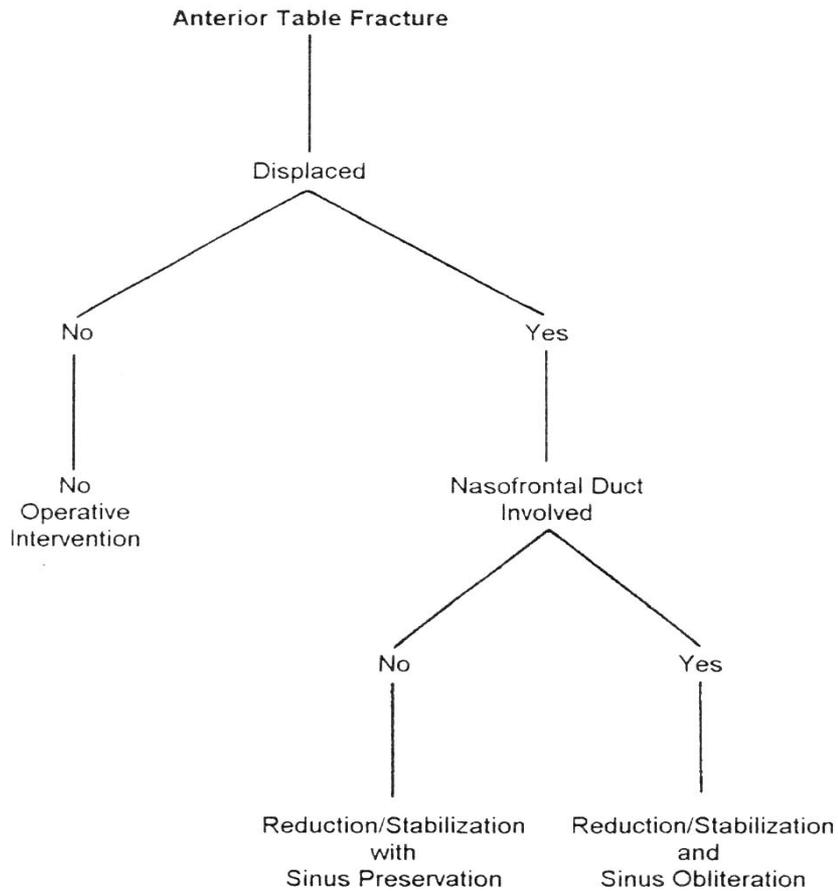
Diagnosis

- ▶ **Signs And Symptoms**
 - Forehead Laceration
 - CSF Rhinorrhea
 - Supraorbital Nerve Anesthesia
 - Depressed Frontal Region
 - Subconjunctival Ecchymosis

Frontal Sinus

Diagnosis

- ▶ **X-Ray**
 - Air Fluid Levels
- ▶ **CT Scan**
 - Axial and Coronal Images



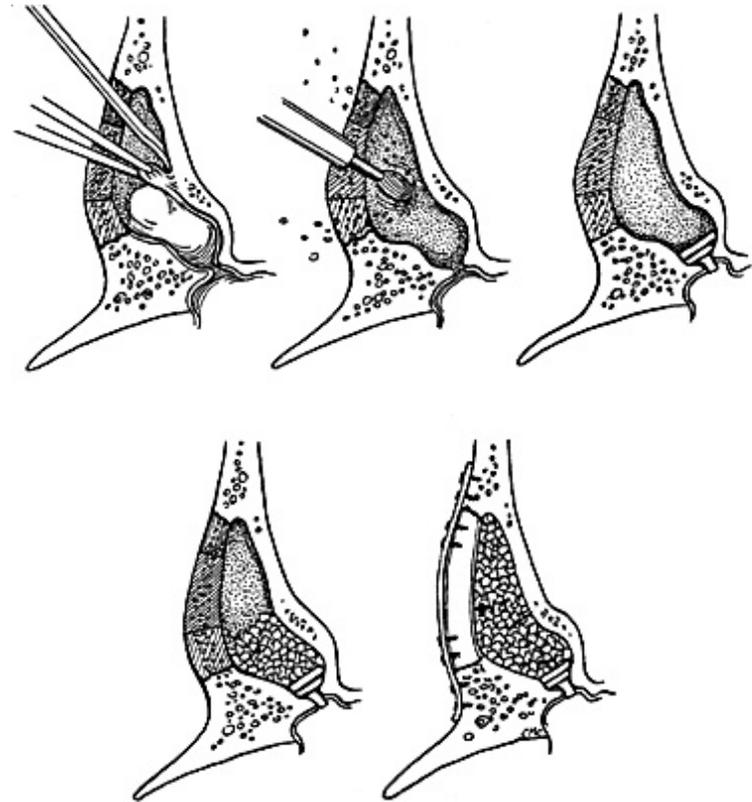
Frontal Sinus Treatment

- ▶ **Operative Indications**
 - Anterior Table Displacement With Contour Change
 - Nasofrontal Duct Involvement
 - Displaced Posterior Table

Frontal Sinus Treatment

▶ Nasofrontal Duct Injury

- Remove Mucosa
- Burr Inner Cortex
- Occlusion Of Duct
- Sinus Obliteration



Frontal Sinus Treatment

- ▶ **Posterior Table**

- **Cranialization**

- 1 Bicoronal Approach

- 2 Preserve Pericranial Flap

- 3 Dural Repair

- 4 Remove Sinus Mucosa

- 5 Obliterate Nasofrontal Duct

- 6 Remove Intersinus Septum And Posterior Wall

- 7 Pericranial Flap To Floor Of Sinus

Frontal Sinus

Complications

- ▶ Early (within 6 months)
 - Frontal Sinusitis
 - Meningitis
- ▶ Late
 - Mucocele
 - Mucopyocele
 - Brain Abscess
 - Osteomyelitis

Frontal Sinus Complications

- ▶ Incidence Of Late Complications
 - Freihofer
 - 71 Fractures
 - 2 Patients – Meningitis
 - 1 Patient – Mucopyocele With Osteomyelitis Of Frontal Bone

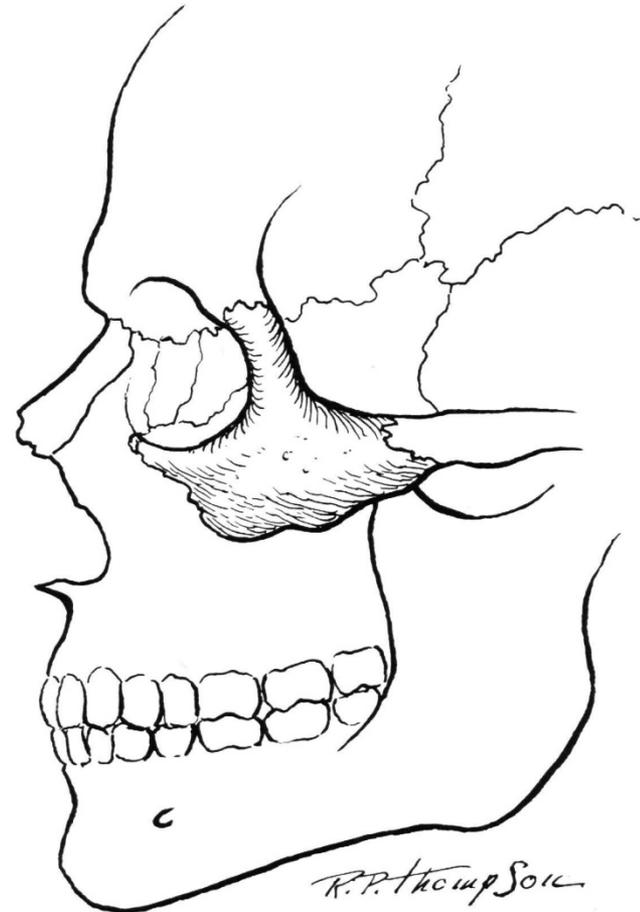
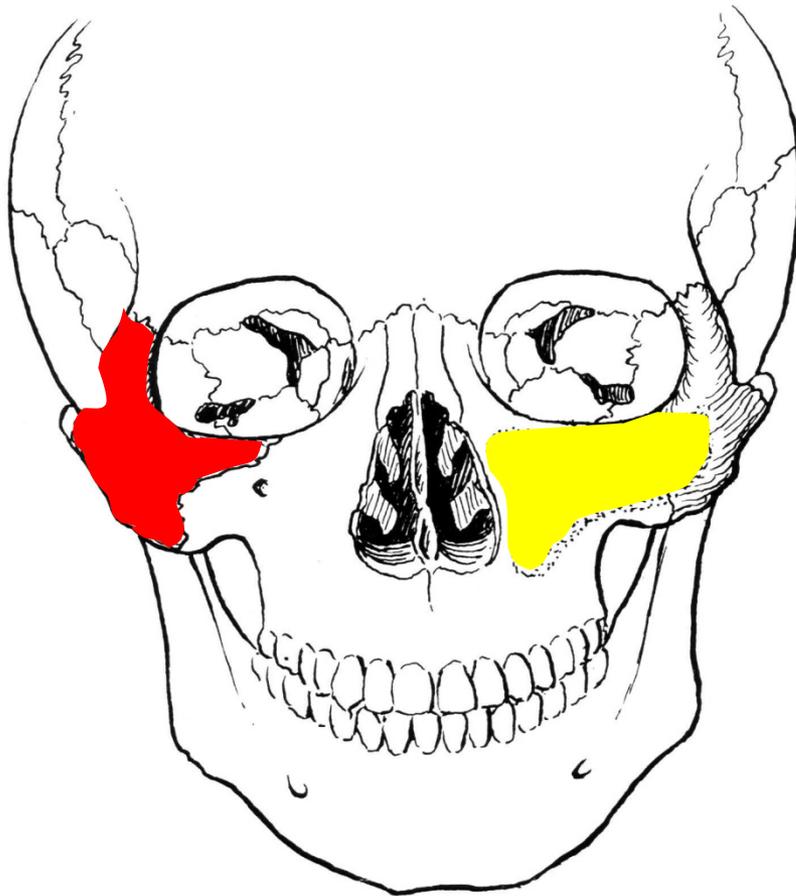
Zygomatic Fractures

Zygoma

Anatomy

- ▶ **Tetrapod Structure**
 - Frontal Bone
 - Temporal Bone
 - Maxilla
 - Greater Wing Of Sphenoid

Zygoma Anatomy



Zygoma

Anatomy

- ▶ Muscular Attachments
 - Masseter
 - Temporalis
 - Zygomaticus
 - Zygomatic Head of Quadratus Labii Superioris

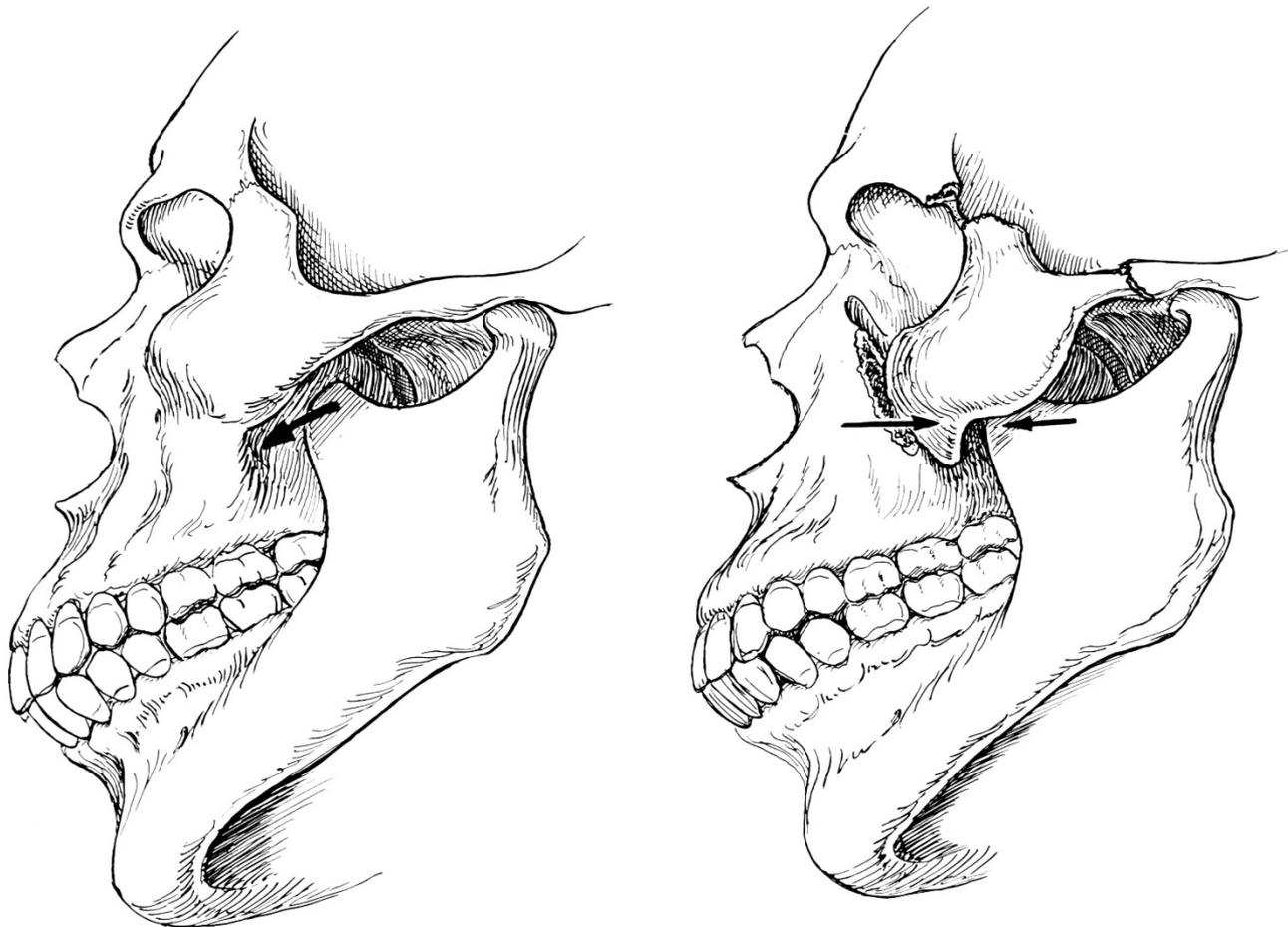
Zygoma

Physical Exam

- ▶ Circumorbital Swelling / Ecchymosis
- ▶ Subconjunctival Hemorrhage
- ▶ Abnormal Sensation V2 Distribution
- ▶ Diplopia or Globe Displacement
- ▶ Increased Facial Width
- ▶ Depressed Malar Prominence
- ▶ Palpable Step Deformities
- ▶ Unilateral Epistaxis
- ▶ Hematoma Upper Buccal Sulcus
- ▶ Trismus Due To Coronoid Process Impingement

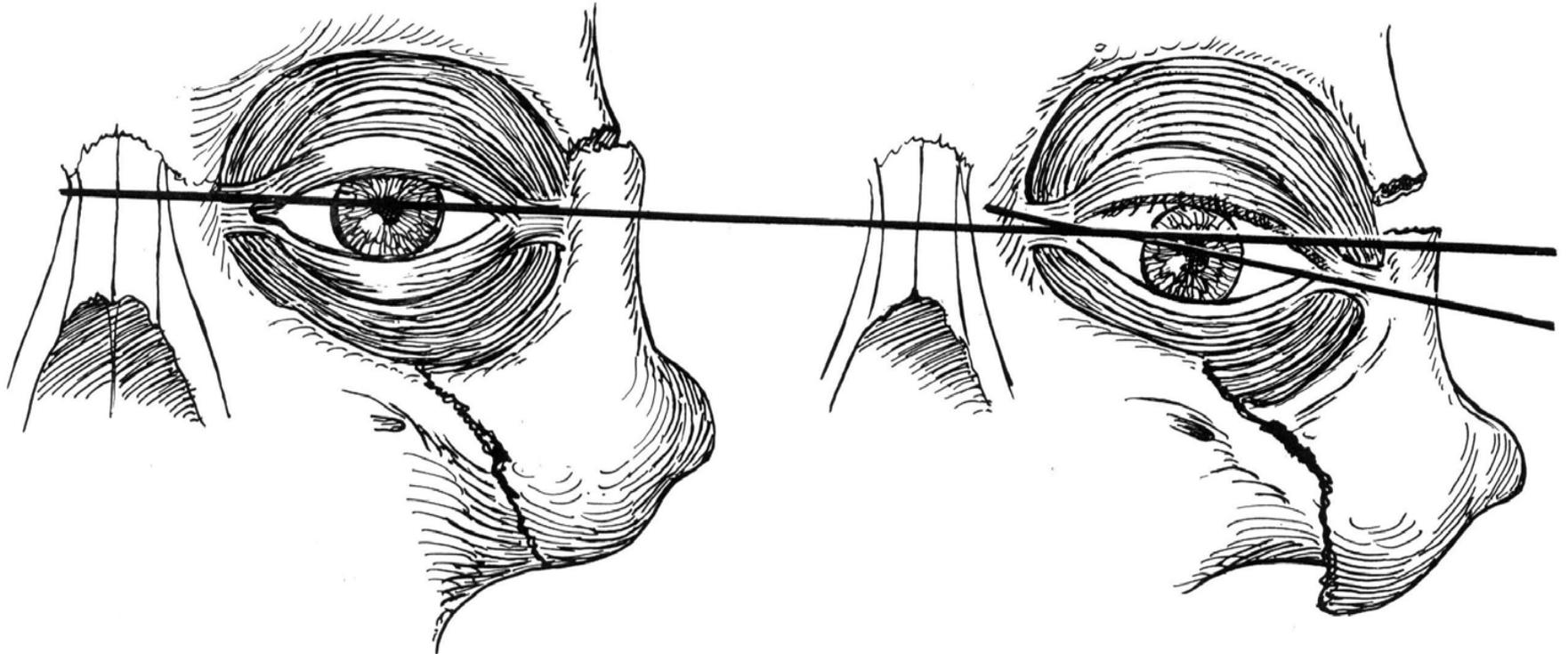
Zygoma

Physical Exam



Zygoma

Physical Exam



Zygoma

Radiology

- ▶ **X-Ray**
 - Water's View Most Useful
- ▶ **CT Scan**
 - Coronal Cuts For Orbital Anatomy

Zygoma

Fracture Classification

▶ Knight

- 1 Undisplaced
- 2 Arch Fractures
- 3 Unrotated Body Fractures
- 4 Medially Rotated Body Fractures
- 5 Laterally Rotated Body Fractures
- 6 Complex Fractures – Additional Fractures Across Zygoma

Zygoma

Fracture Classification

▶ Manson

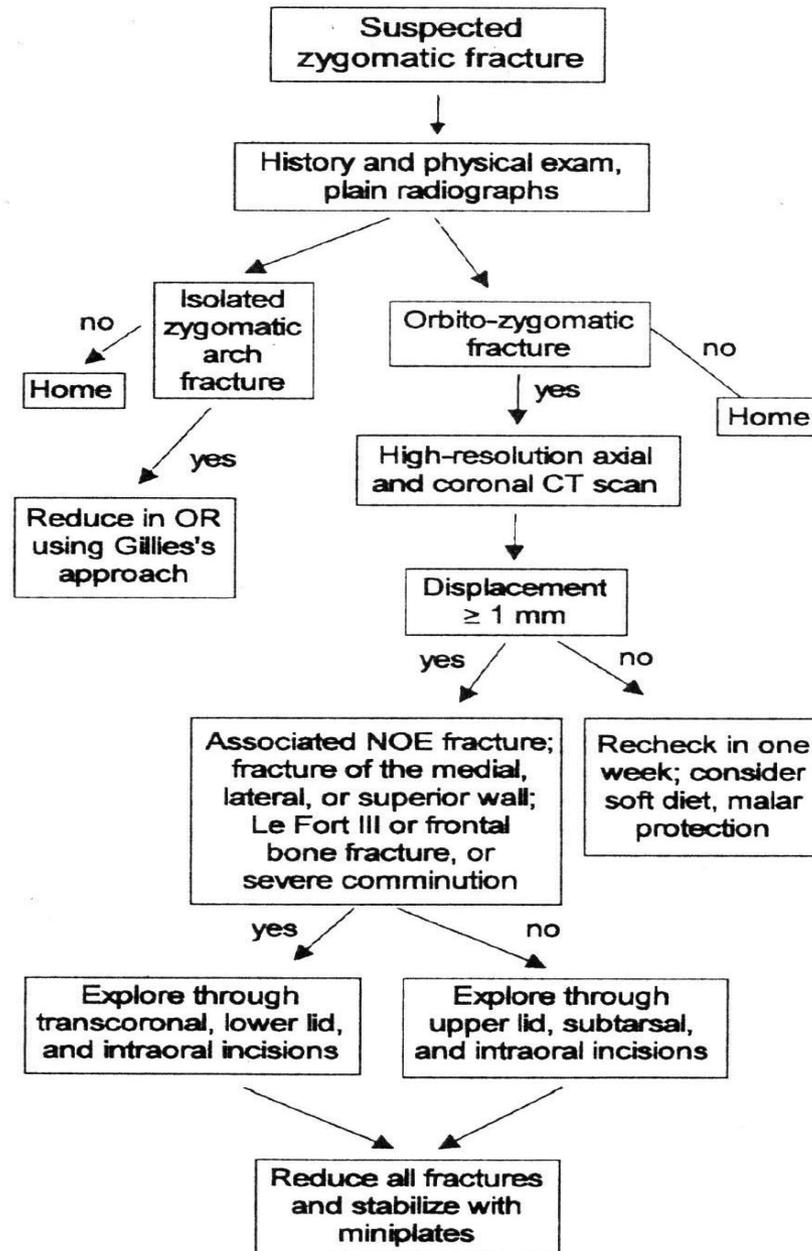
- Low Energy
 - minimal displacement
 - do not require operative reduction
- Middle Energy
- High Energy
 - often part of panfacial fractures

Zygoma

Management

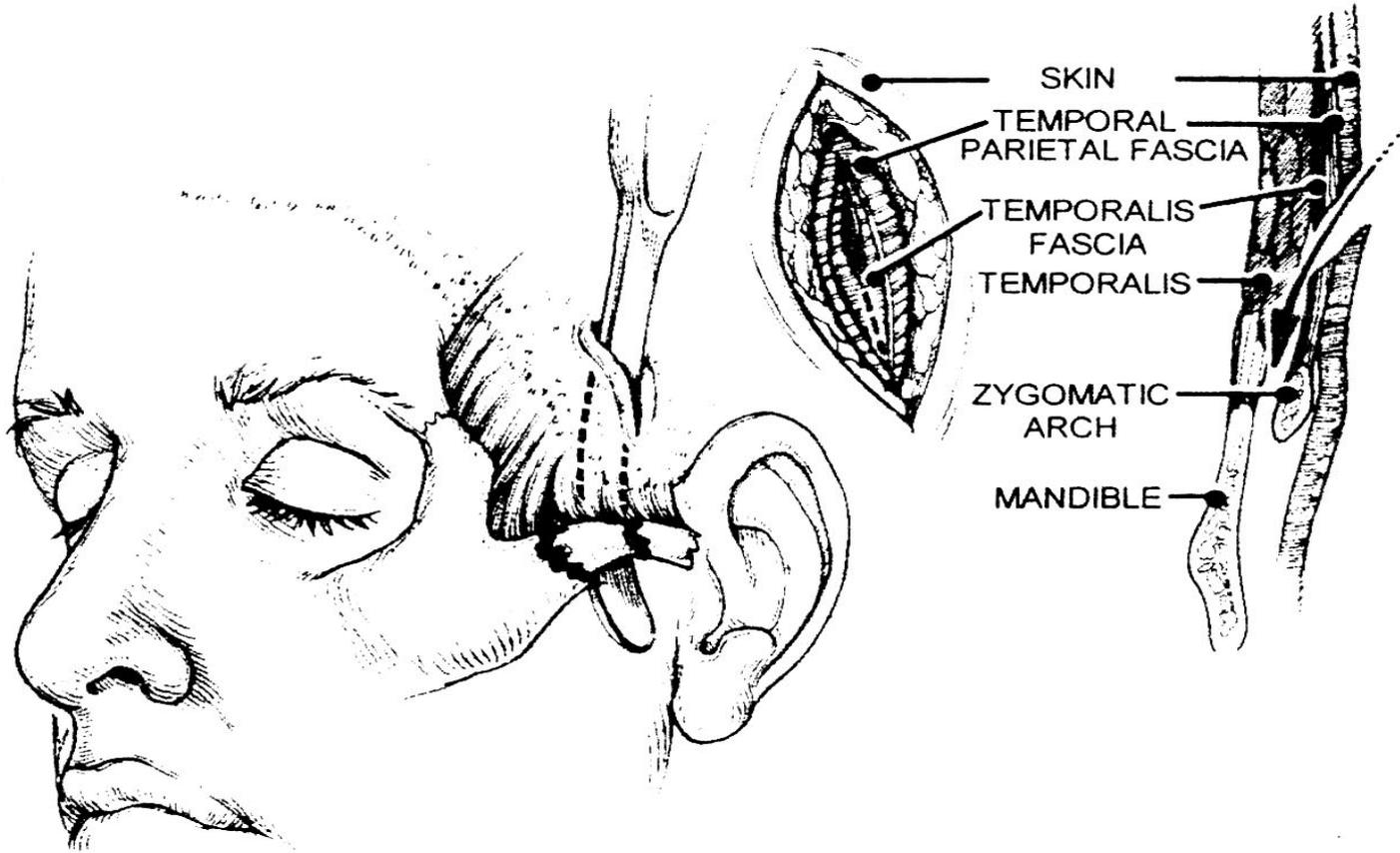
- ▶ **Undisplaced**
 - Nonoperative
- ▶ **Displaced**
 - Isolated Zygomatic Arch – Gilles Elevation
 - Orbitozygomatic Fractures – Open reduction and Stabilization

Zygoma Management



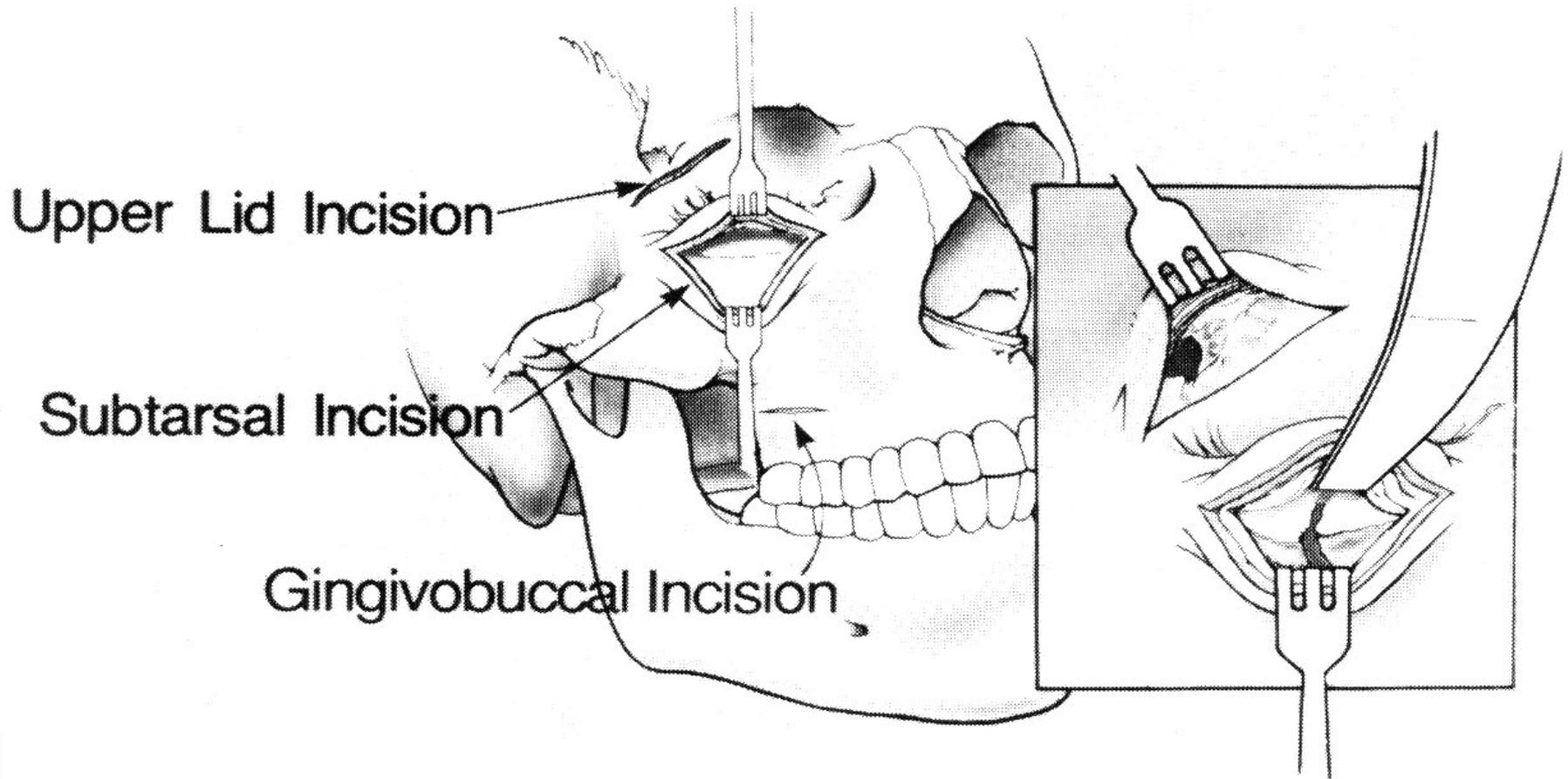
Zygoma

Gilles Elevation



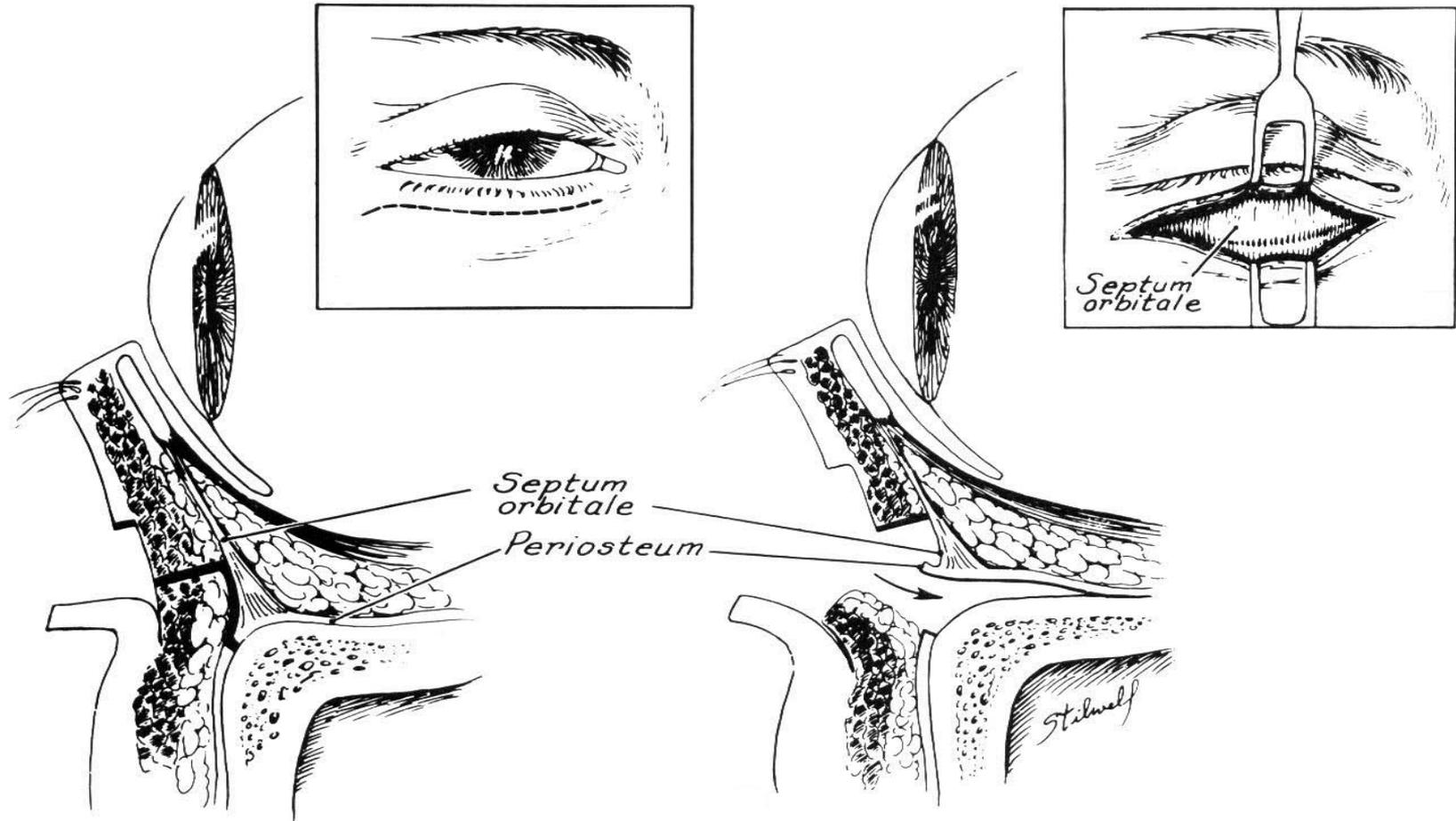
Zygoma

Operative Exposure



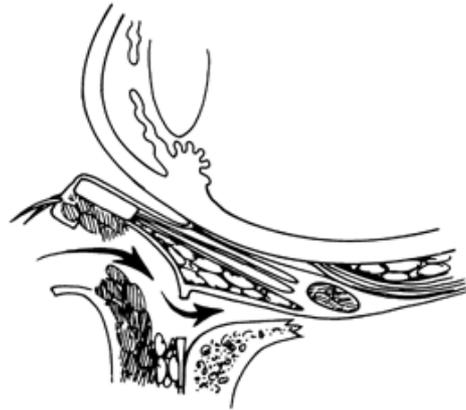
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Operative Exposure

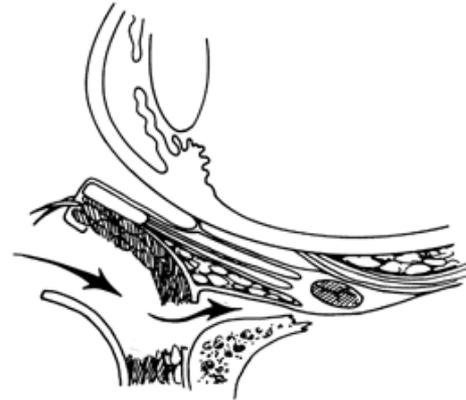


Zygoma

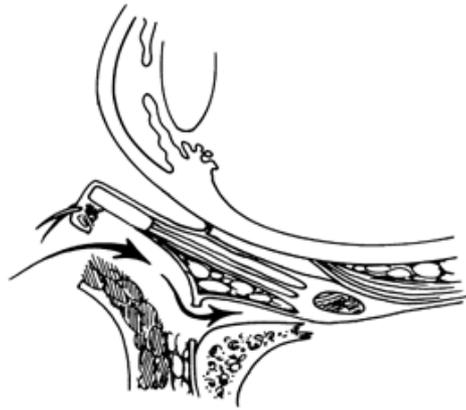
Operative Exposure



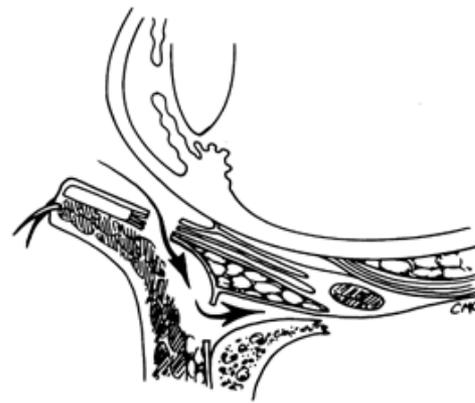
A



B



C



D

Zygoma

Complications – Early

- ▶ Bleeding
- ▶ Infection
- ▶ Exacerbation of Sinus Disease
- ▶ Malfunction of Extraocular Muscles
- ▶ Blindness

Zygoma

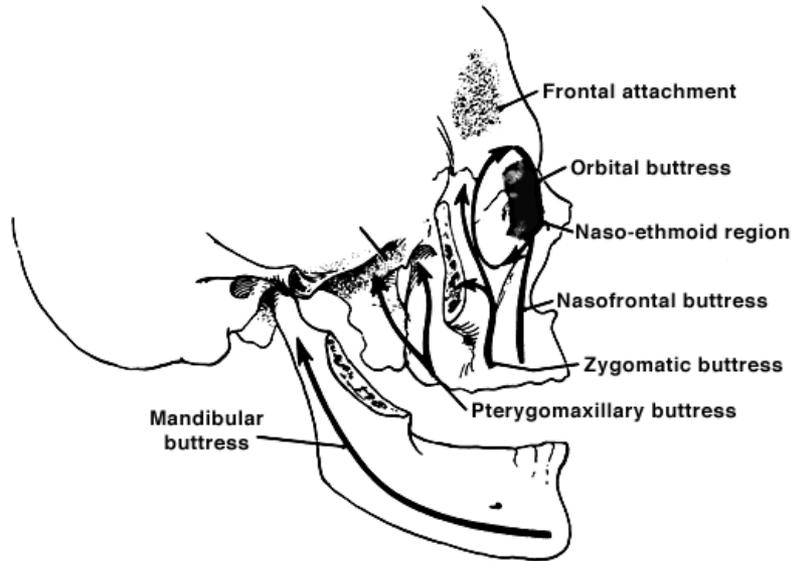
Complications – Late

- ▶ Nonunion / Malunion
- ▶ Diplopia (10% initial, 5% permanent)
- ▶ Persistent V2 Anesthesia (24%)
- ▶ Orbital Dystopia
- ▶ Chronic Maxillary Sinusitis (4–7%)
- ▶ Scarring
- ▶ Ectropion
- ▶ Problems With Mandible Motion
- ▶ Enophthalmos (3%)
- ▶ Soft Tissue Descent With Loss of Malar Prominence

Maxillary Fractures

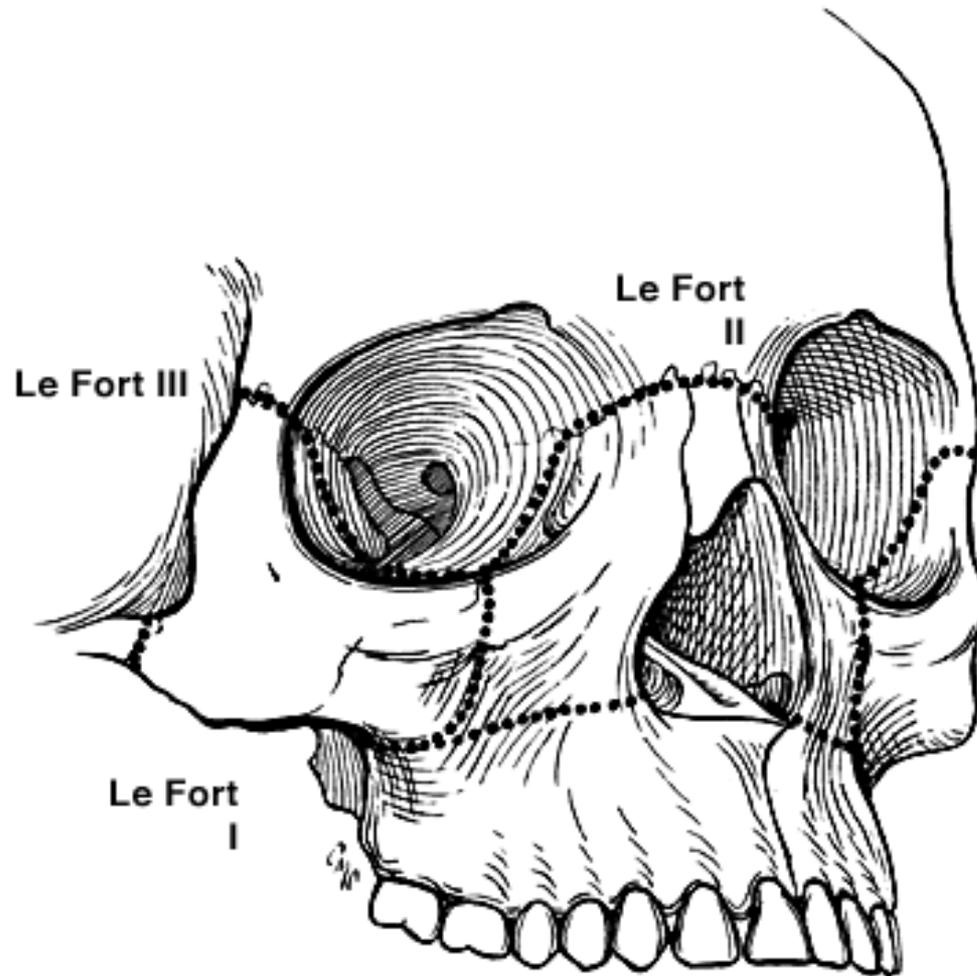
Maxillary Fractures

Facial Buttresses



Maxillary Fractures

LeFort Fractures



Maxillary Fractures

LeFort Fractures

▶ LeFort I

- Transverse Fracture That Separates Maxillary Alveolus From Midface Skeleton
- Runs Above Roots of Maxillary Teeth, Across Lower Pyriform Aperature, and Severs Pterygoid Process

Maxillary Fractures

LeFort Fractures

▶ Lefort II

- “Pyramidal” Fracture of Maxilla
- Separates Nasomaxillary Segment from Zygomatic and Upper Lateral Midface
- Fracture Line May Go Above or Beneath Medial Canthal Ligament Insertion
- Lacrimal System May Be Involved

Maxillary Fractures

LeFort Fractures

▶ LeFort III

- Craniofacial Dysjunction
- Zygomaticofrontal Junction, Traverses Lateral, Inferior, and Medial Orbit, Separates Frontal Process of Maxilla From Frontal Bones

Maxillary Fractures

Examination and Diagnosis

- ▶ Epistaxis
- ▶ Ecchymosis (periorbital, conjunctival, and scleral)
- ▶ Malocclusion With Anterior Open Bite
- ▶ Buccal Mucosa Hematoma
- ▶ Tear in Intraoral Soft Tissues
- ▶ Elongated, Retruded Appearance
 - “Donkey-Like” Facies
- ▶ CSF Leak in 25–50% of LeFort II and III

Maxillary Fractures

Radiology

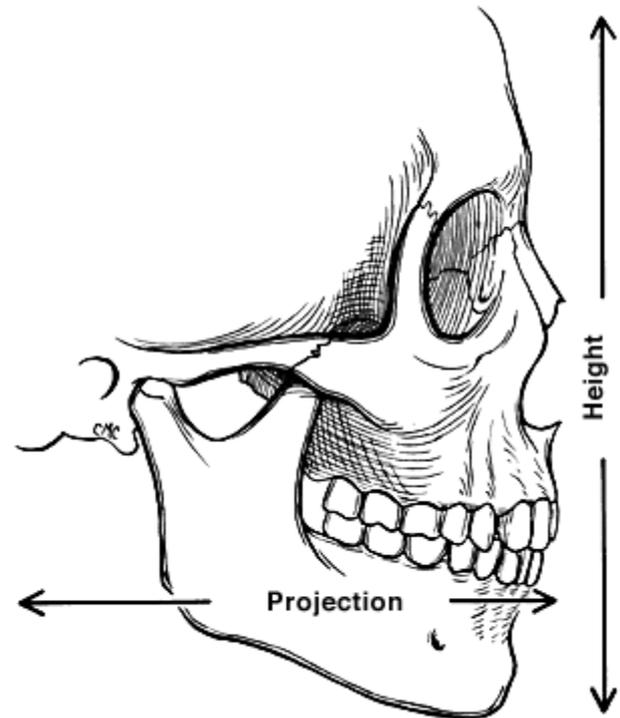
- ▶ X-Rays
 - Bilateral Maxillary Sinus Opacification
 - Pterygoid Plate Fracture On Lateral Projection
 - Fracture Through ZF and Nasofrontal Suture

Maxillary Fractures

Management

► Goals

- re-establish midfacial height and projection
- establish occlusal relationship
- maintain integrity of nose and orbits



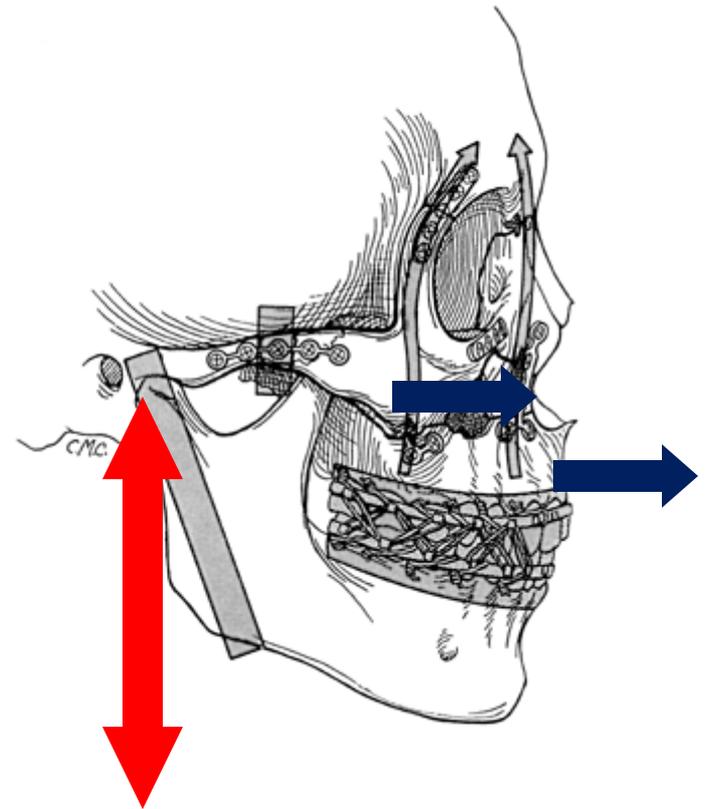
Maxillary Fractures

Management

- ▶ **Intermaxillary Fixation**
- ▶ **Open Reduction**
 - LeFort I
 - Bilateral Buccal Sulcus Incisions
 - LeFort II and III
 - Coronal and Lower Eyelid Incisions

Maxillary Fractures Management

- ▶ **Rigid Internal Fixation**
 - Frontal Bone as a Guide
 - Mandibular Ramus Dictates Facial Height
 - Stabilize Vertical Buttresses
 - Bone Grafts If Necessary



Maxillary Fractures

Complications

- ▶ **Early**
 - Extensive Hemorrhage
 - Airway Obstruction
 - Infection
 - CSF Leak
 - Blindness

Maxillary Fractures

Complications

▶ Late

- Palpable Hardware
- Non-Union / Malunion
- Plate Exposure
- Lacrimal System Obstruction
- V2 Anesthesia
- Devitalized Teeth
- Extra-Occular Muscle Imbalance

Maxillary Fractures

Complications

- ▶ **Late**
 - Diplopia
 - Enophthalmos
 - Orbital Dystopia
 - Change In Facial Appearance
 - Facial height and width
 - Nasal Obstruction
 - Malocclusion

Maxillary Fractures

Palatal Fractures

- ▶ 8% of LeFort fractures
- ▶ Younger vs. Older
 - <30 years
 - midline fracture
 - >30 years
 - sagittal fractures adjacent to midline or alveolus

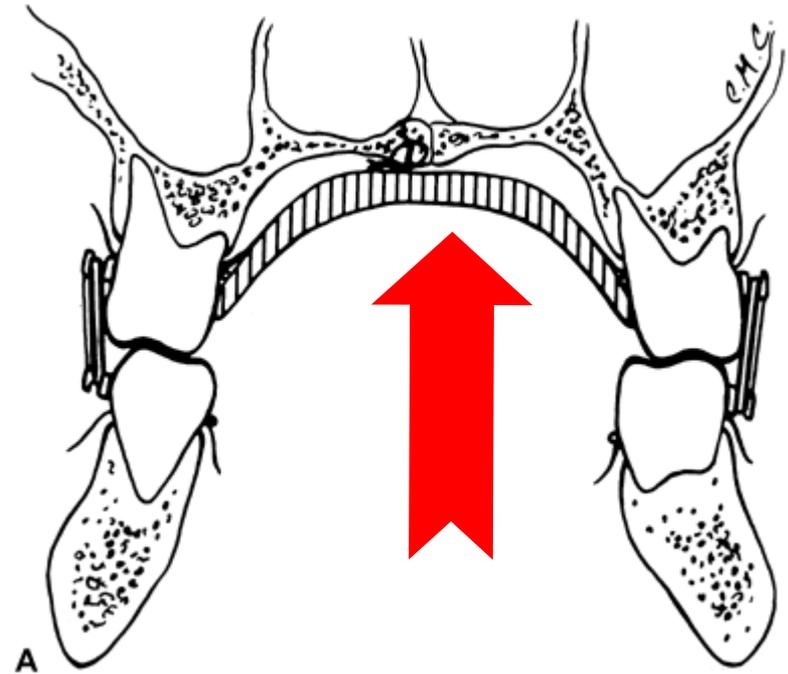
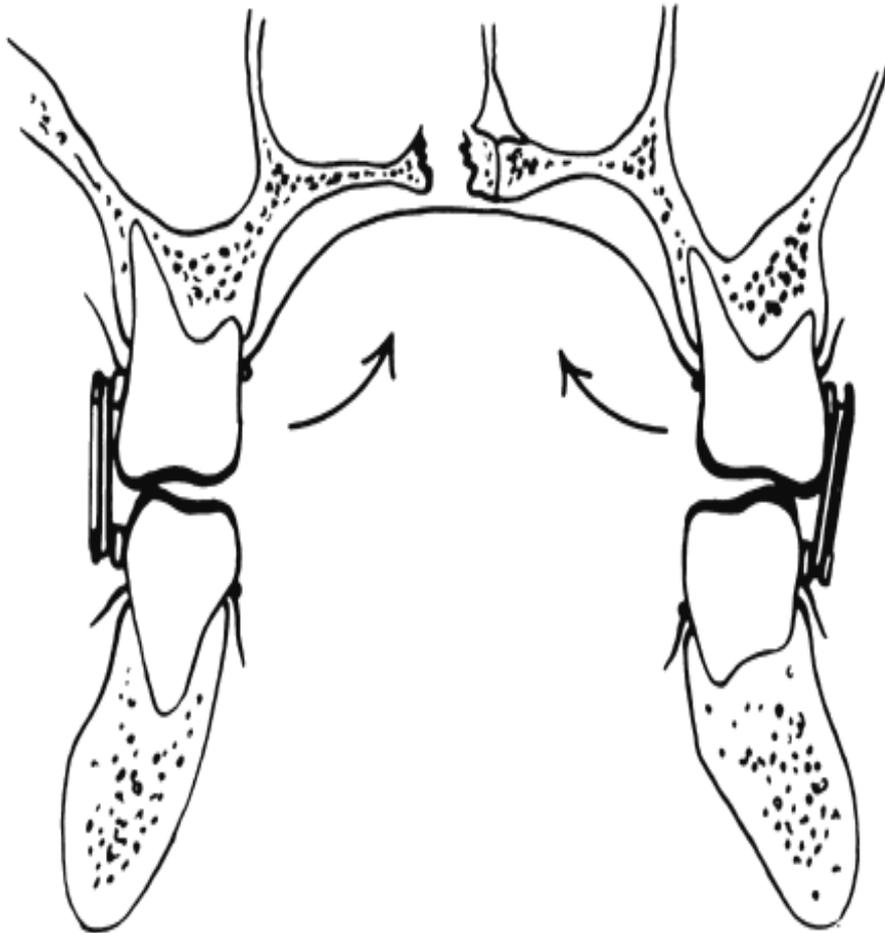
Maxillary Fractures

Palatal Fractures

- ▶ Stabilize before IMF
- ▶ Open reduction of palatal roof
- ▶ Pyriform aperture plate to unite maxillary segments
- ▶ Dental splints to prevent occlusion

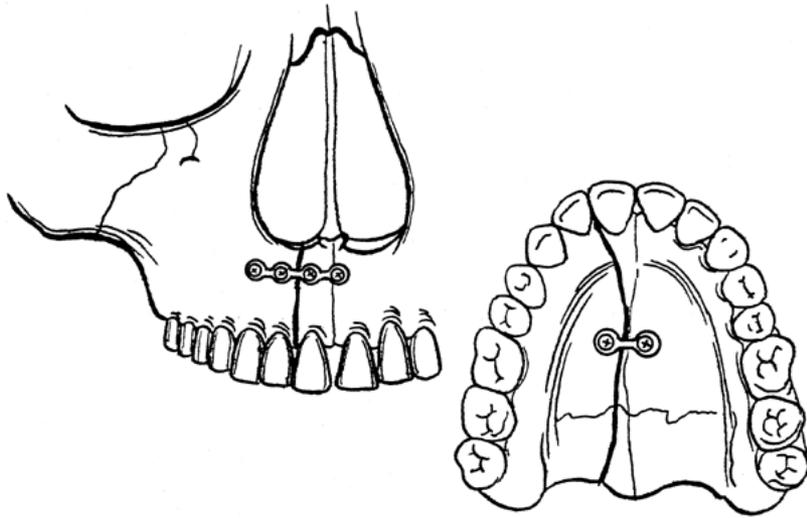
Maxillary Fractures

Palatal Fractures



Maxillary Fractures

Palatal Fractures



Orbital Fractures

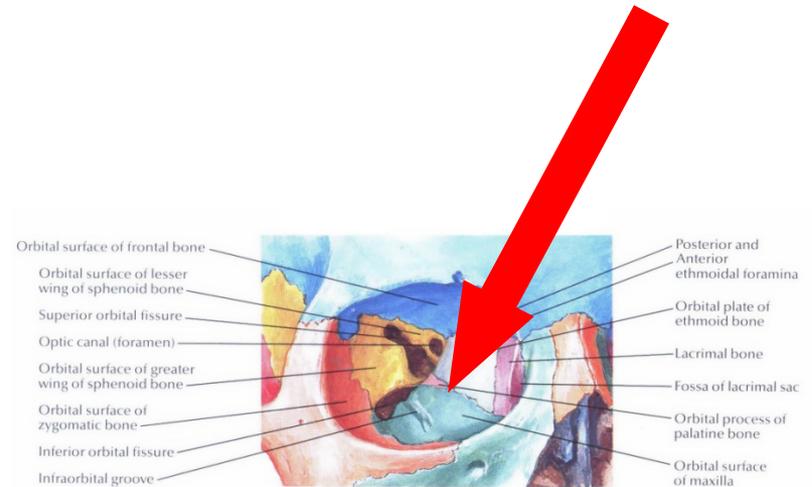


Orbital Fractures

Anatomy

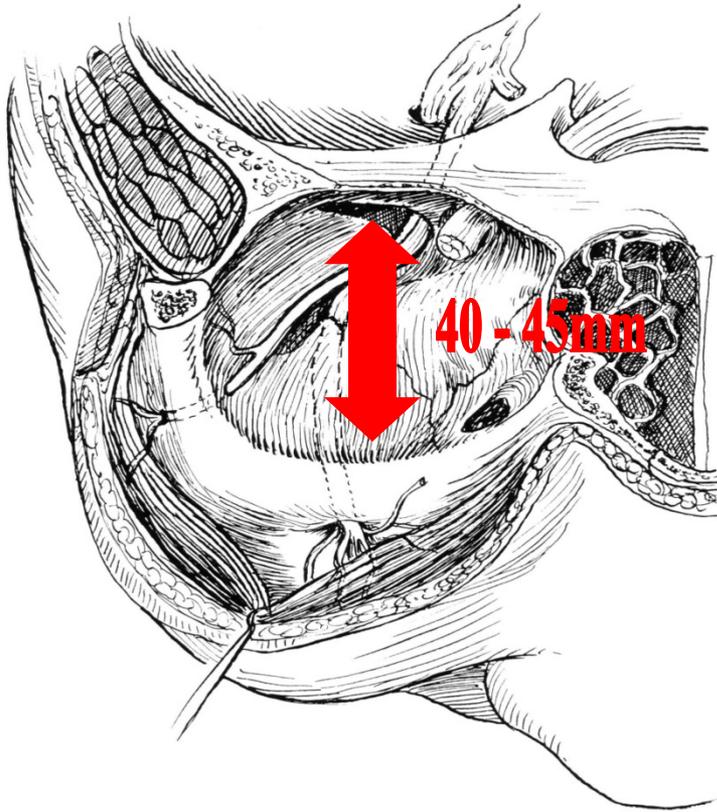
► Seven Bones

- Frontal
- Maxilla
- Zygoma
- Ethmoid
- Lacrimal Bone
- Greater and Lesser Wings of Sphenoid
- Palatine



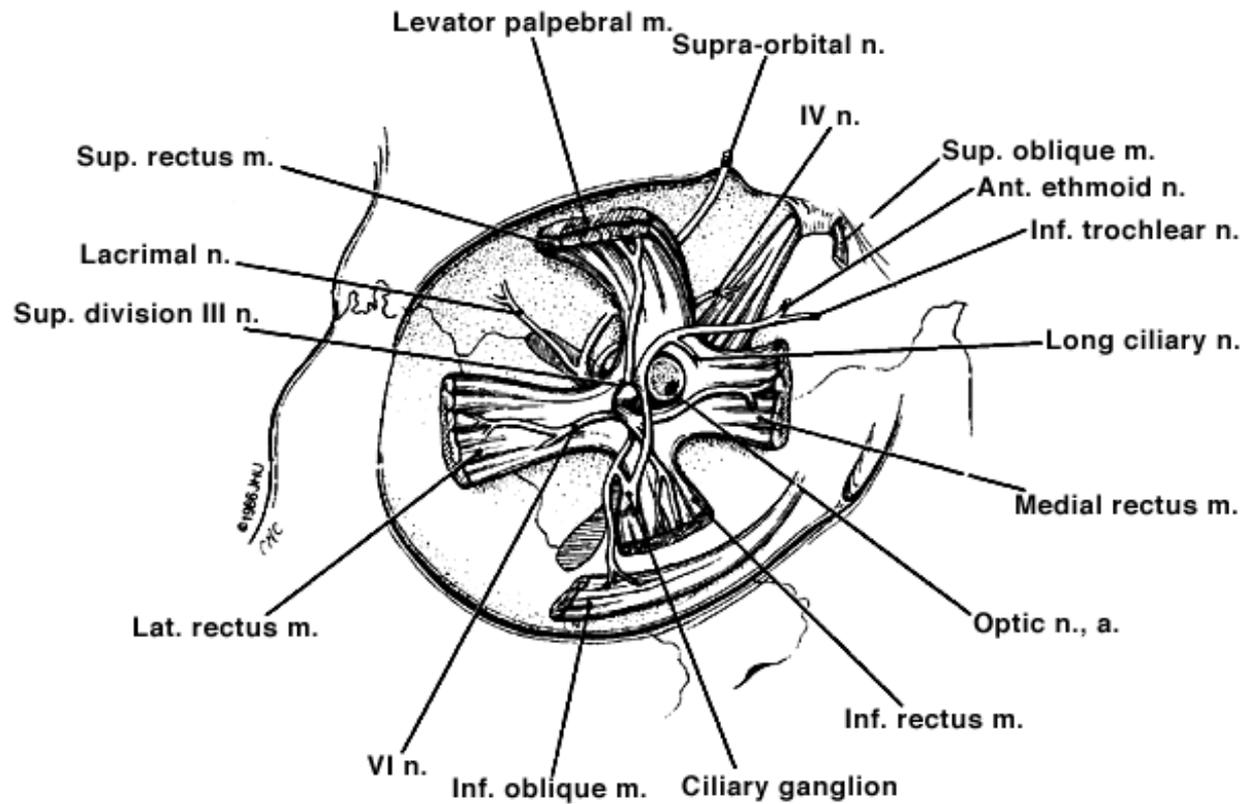
Orbital Fractures

Anatomy



Orbital Fractures

Anatomy



Orbital Fractures

Anatomy

▶ **Inferior Wall**

- Vulnerable
- Thin Maxillary Roof
- Infraorbital Canal
- Curvature of Floor

▶ **Medial Wall**

- Thin Lacrimal Bone And Lamina Paprycea of Ethmoid
- Medial Canthal Ligament and Lacrimal Sac

Orbital Fractures

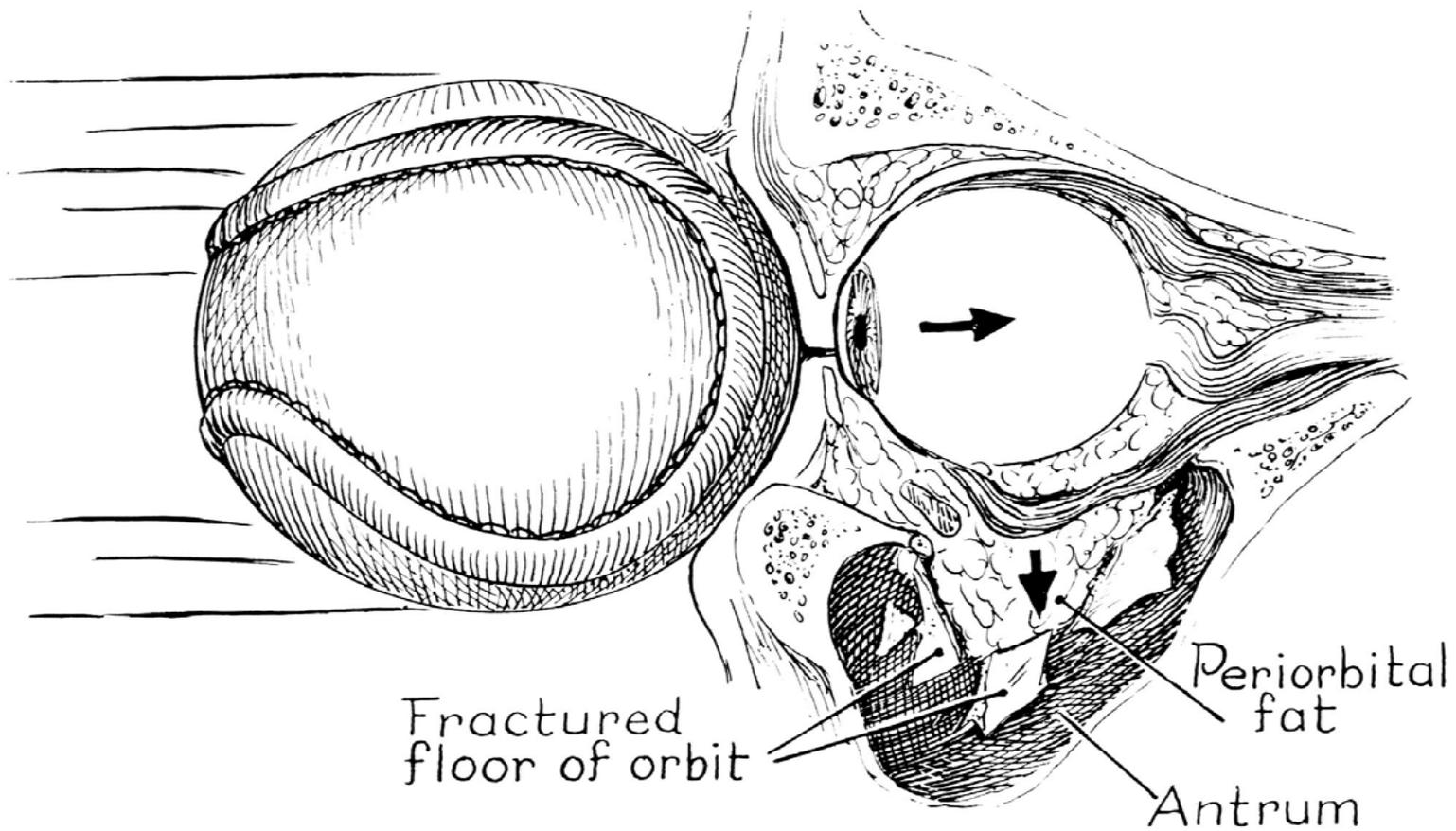
Blowout Fractures

Pure Blowout – only orbital floor or medial wall injured

Impure Blowout – associated orbital rim fractures

Orbital Fractures

Blowout Fractures



Orbital Fractures

Physical Exam

- ▶ Diplopia
- ▶ Enophthalmos
- ▶ Inferior Displacement Palpebral Fissure
- ▶ Anesthesia of Infraorbital Nerve
- ▶ Orbital Emphysema

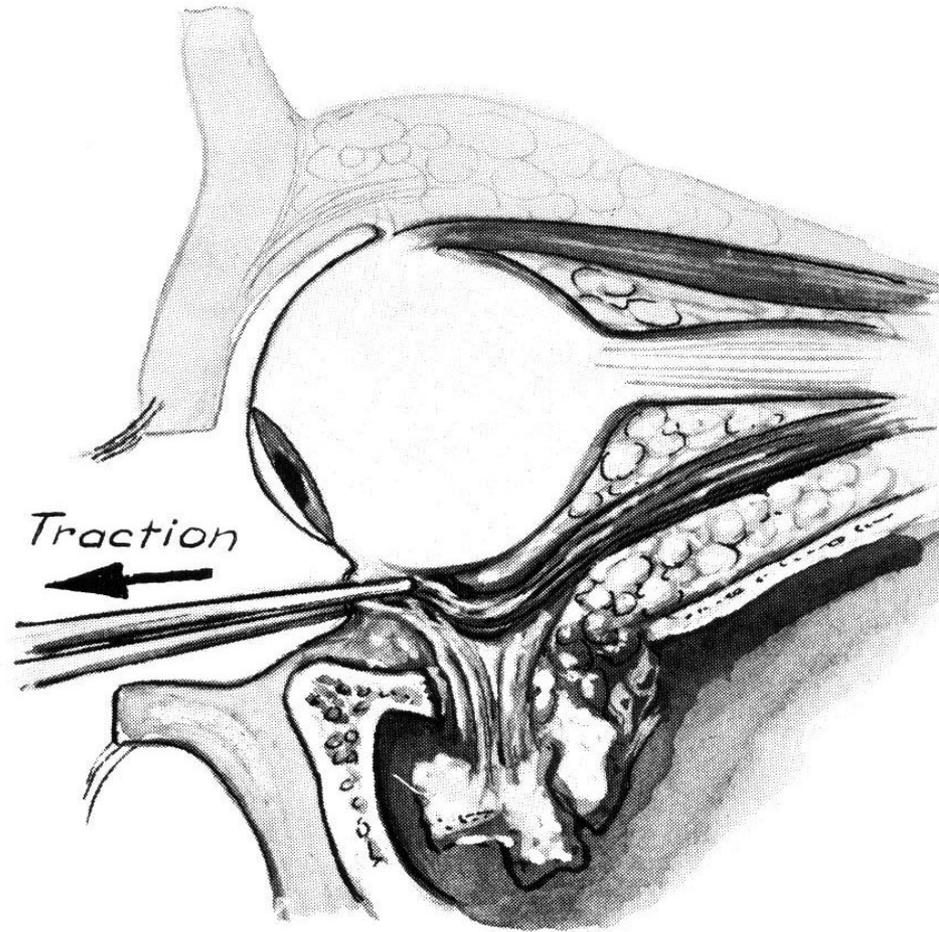
Orbital Fractures

Physical Exam

- ▶ **Diplopia**
 - Commonly on Upward Gaze
 - Primary (Central Gaze) or Secondary (Peripheral)
 - Mechanical (incarceration of infraorbital tissue) or Nonmechanical (paresis)
 - Forced Duction Test

Orbital Fractures

Forced Duction Test



Orbital Fractures

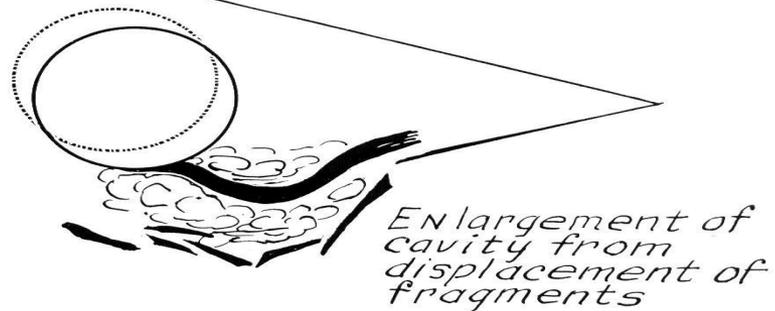
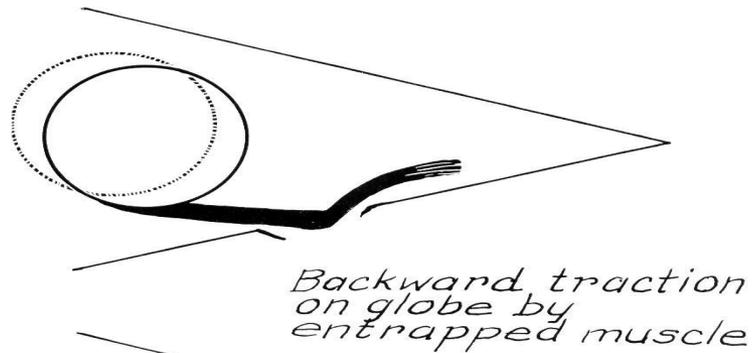
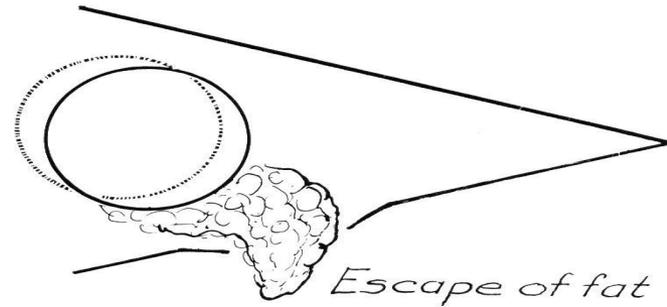
Physical Exam

▶ **Enophthalmos**

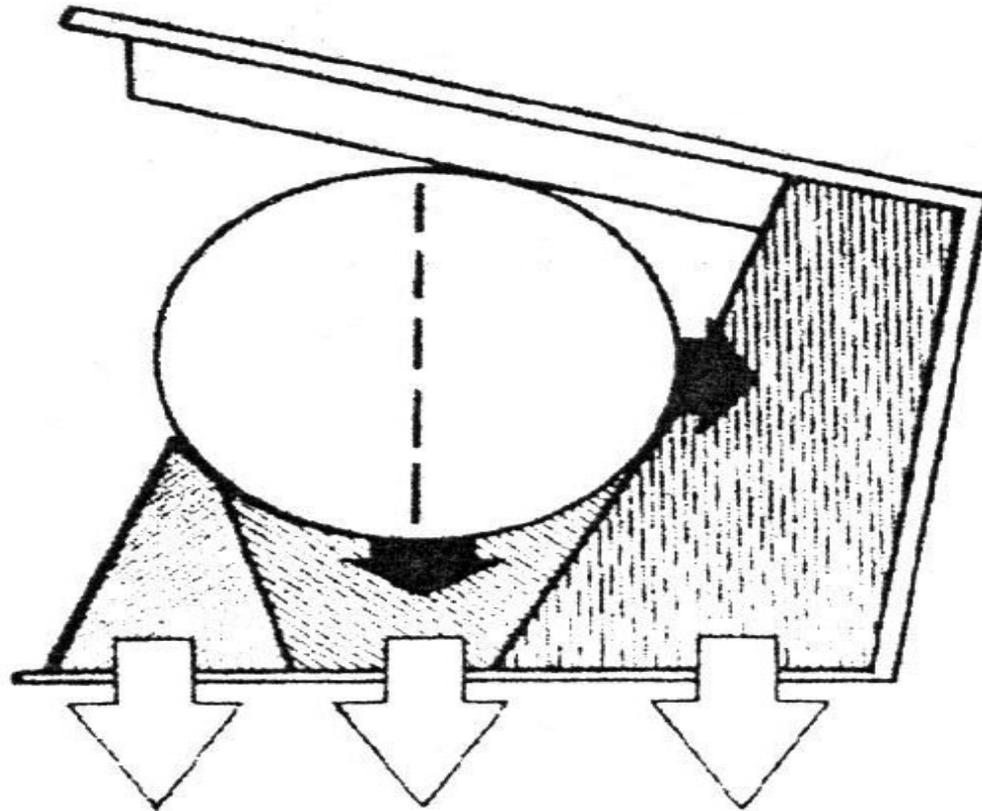
- Inferior and Posterior Displacement of Globe and Intraorbital Soft Tissue
- **Etiology**
 - Enlargement of the Bony Orbital Cavity
 - Escape of Orbital Fat or Fat Necrosis
 - Muscle Entrapment in Fracture Line
 - Soft Tissue Scarring and Contracture

Orbital Fractures

Enophthalmos



Orbital Fractures



No Effect Inferior Posterior

Orbital Fractures

Physical Exam

- ▶ No Diplopia + No Enophthalmos
?Significant Fracture
- ▶ Diplopia + No Enophthalmos
Incarceration Only
- ▶ No Diplopia + Enophthalmos
Volume Discrepancy Only
- ▶ Diplopia + Enophthalmos
Incarceration + Volume Discrepancy

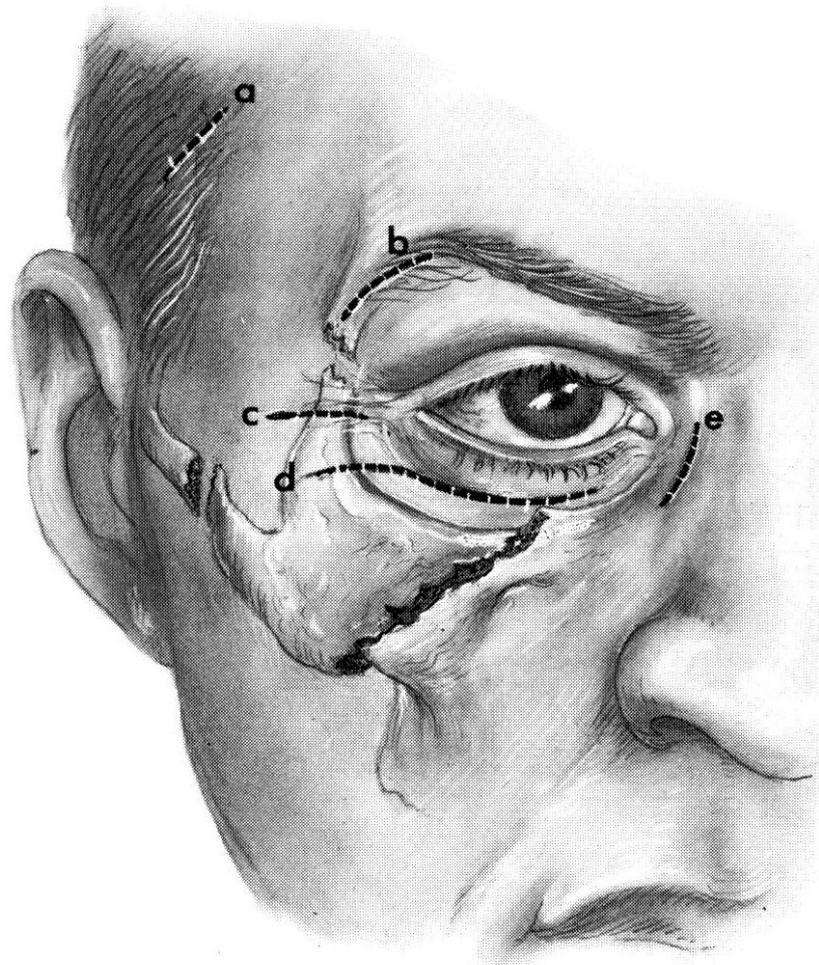
Orbital Fractures

Indications For Exploration

- ▶ Symptomatic Diplopia With Positive Forced Duction Test
- ▶ Xray evidence of Extraocular Muscle Entrapment
- ▶ Early Enophthalmos ($>3\text{mm}$)
- ▶ Large Orbital Floor Defect
- ▶ Abnormally Low Vertical Globe Level
- ▶ Associated Orbital Rim or Other Craniofacial Fractures

Orbital Fractures

Incisions



Orbital Fractures

Management

- ▶ **Grafts**
 - Autologous Bone
 - Cartilage
 - Fascia lata
- ▶ **Alloplastic Implants**
 - Teflon
 - Silastic
 - Titanium

Orbital Fractures

Complications

- ▶ Infection
- ▶ Implant problems
- ▶ Persistent Diplopia (2–50%)
- ▶ Persistent Enophthalmos (15–22%)
- ▶ Ectropion (1%)
- ▶ Blindness

Orbital Fractures

Complications

- ▶ **Superior Orbital Fissure Syndrome**
 - extension of fracture into SOF
 - ophthalmoplegia with injury to III, IV or VI
 - anesthesia in V1 plus loss of corneal reflex
 - ptosis and proptosis
 - parasympathetic block
 - fixed, dilated pupil

Orbital Fractures

Complications

- ▶ **Orbital Apex Syndrome**
 - same as superior orbital fissure syndrome
 - plus blindness