Pediatric Fractures of the Shoulder and Humerus

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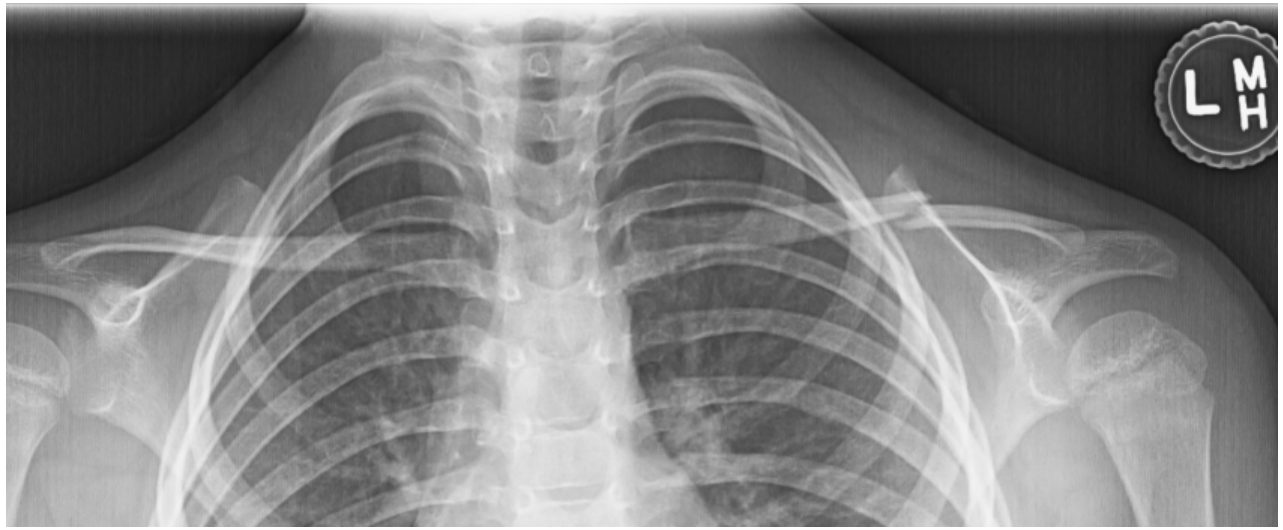
Pediatric Clavicle Fractures

- Objectives-
  - Epidemiology of Pediatric Clavicle Fractures
  - Key physical exam findings
  - Treatment recommendations

Pediatric Clavicle Fractures

- Clavicle fractures represent 5-15% of all pediatric fractures
  - Midshaft is the most common location (80%)
  - 15% lateral, 5% medial

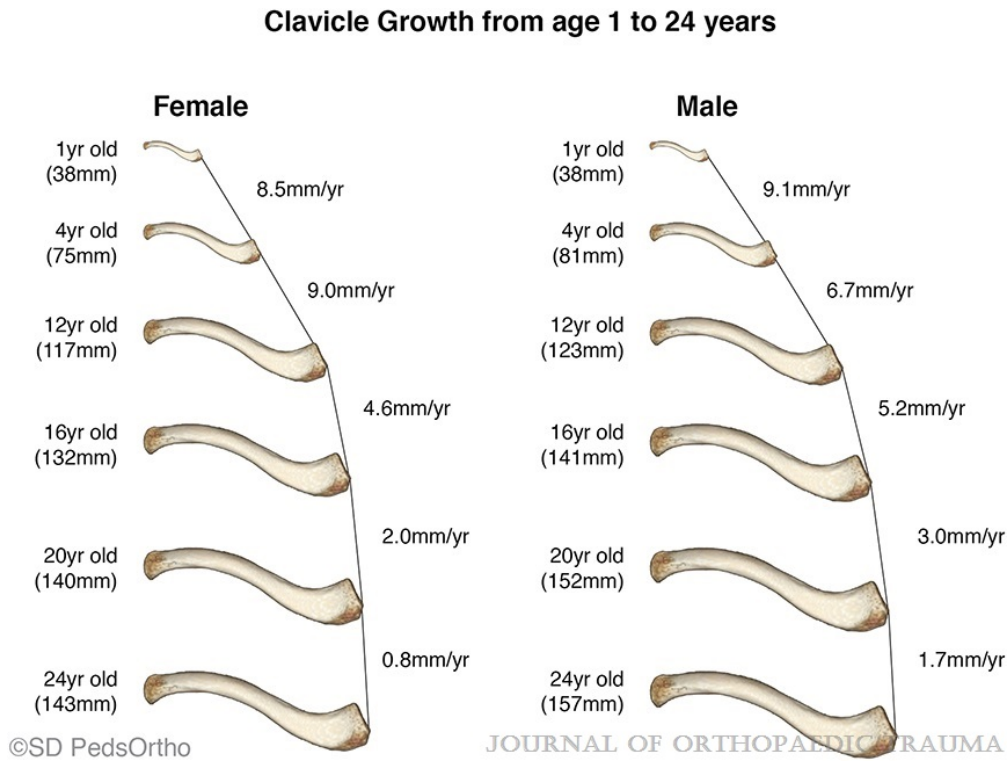


Anatomy

- Clavicular diaphysis is the first bone to ossify in utero
- Medial epiphysis is one of last centers to fuse

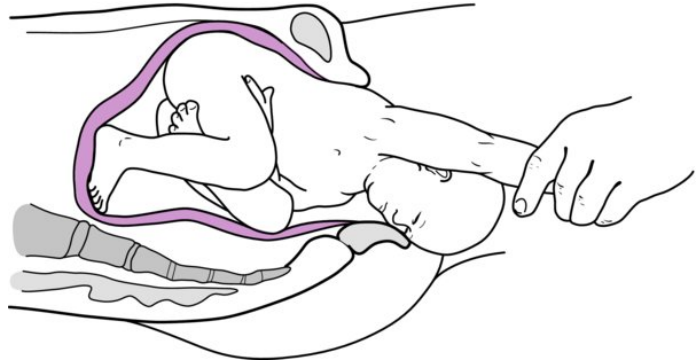
- Highest rates of growth occur by 12 years of age
  - Growth can continue into early 20s
  - Significant remodeling potential

- Thick periosteum leads to decreased nonunion rates



Mechanism of Injury

- Common in all stages of childhood
- Mechanism varies depending on age
  - Neonatal→ difficult delivery
    - Large gestational age
      - Shoulder dystocia
    - Right clavicle more common than left
    - Likely related to lateral shoulder compression during delivery
      - 0.5% of normal deliveries, 1.6% of breech deliveries
  - Toddlers → Fall from height
    - Must consider child abuse



Mechanism Cont'd

- School age
  - Fall with lateral compression of shoulder during sports
    - most common
  - Direct blow
- Adolescents
  - Athletic injuries
    - High impact sports such as football
  - High energy injuries
    - MVC
    - ATV
    - Motorcycle
  - Stress fracture secondary to repetitive activities
    - Rapid increase in athletic training program

Associated Injuries

- Associated injuries depend on age of patient
  - Neonates
    - Brachial plexus palsy
      - C5-C6 palsy
  - Toddlers
    - Injuries associated with non accidental trauma
  - Adolescents
    - Injuries associated with high energy mechanism
      - Rib, scapula fx, pneumothorax, brachial plexus injury

Signs and Symptoms

- Neonates
  - Decreased movement of effected extremity
  - Crying with passive movement of arm
  - Swelling, crepitus
  - Decreased Moro reflex

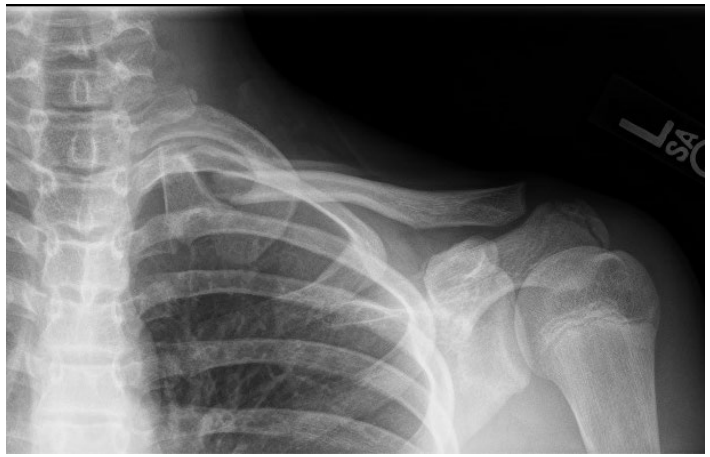
- Child/Adolescent
  - Deformity, swelling, ecchymosis
  - Skin tenting
  - Shoulder drooping/ shortening
  - Pain with range of motion

Imaging

- XR
  - AP
  - 45 degree cephalic tilt view
- CT
  - May be warranted in high energy mechanisms to further evaluate for additional injury
  - Allows evaluation of SC and AC joint injuries

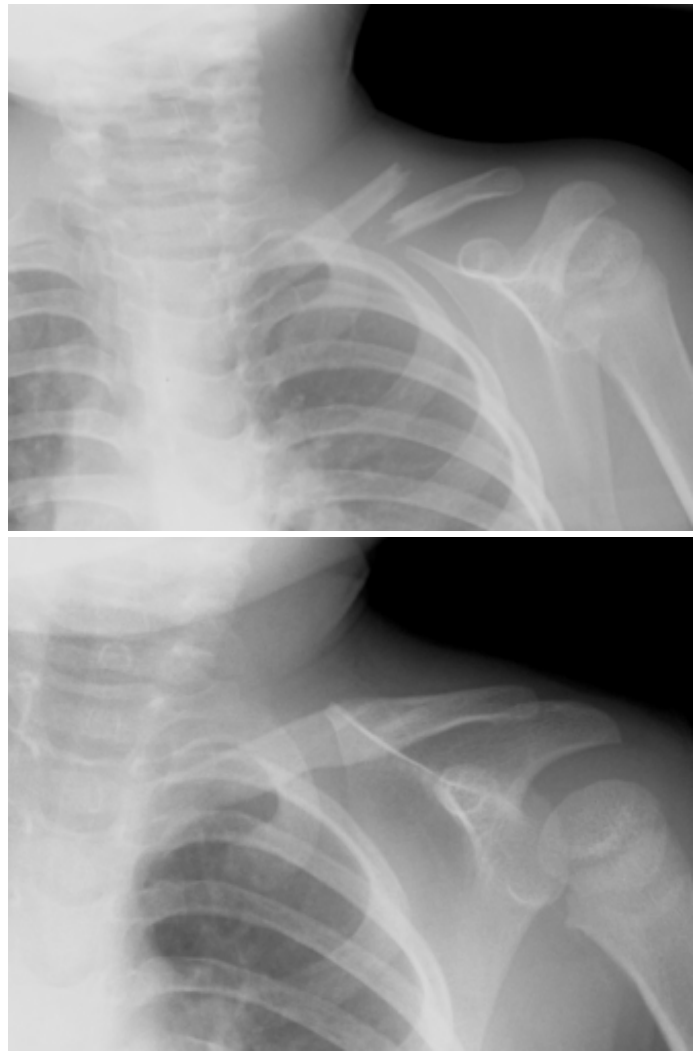
Classification

- Generally described in terms of location and morphology
  - Medial vs midshaft vs lateral
  - Displaced vs nondisplaced
  - Open vs closed
  - Simple vs comminuted



Treatment

- Non-operative
  - Nondisplaced fractures
  - <2cm displacement
  - 95-100% union rate
    - ***Almost all fractures unite and result in minimal to no residual disability***



Treatment

- Treatment
  - Sling immobilization for 2 weeks
    - Sling when out of home for an additional 2-4 weeks
  - No proven benefit to figure-8 brace

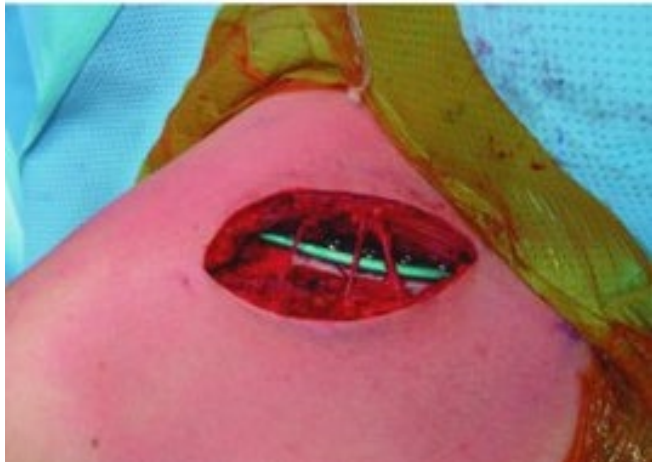
  - XR obtained at 4 week intervals until union occurs
  - Noncontact activities typically resume at 6 weeks
  - Contact activities resume at 3 months if healing is present
    - *Must discuss refracture risk with early return to sports*

Surgical Treatment

- Operative Indications
  - Absolute
    - Open fractures
    - Fractures with impending skin compromise
    - Fractures associated with neurovascular injury
  - Relative
    - Floating shoulder injuries
    - Polytrauma
    - “Severely displaced” ??

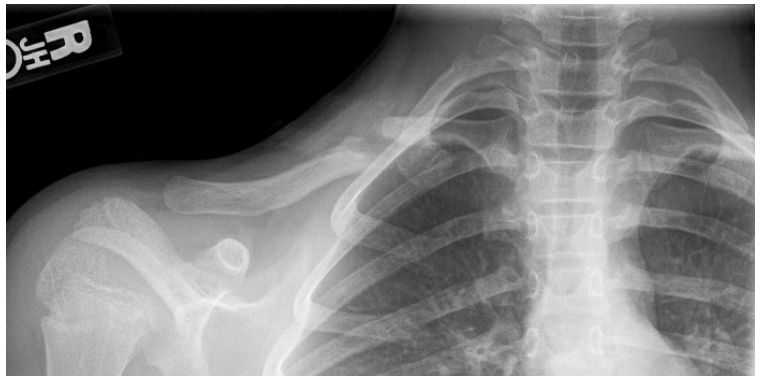
Surgical Treatment

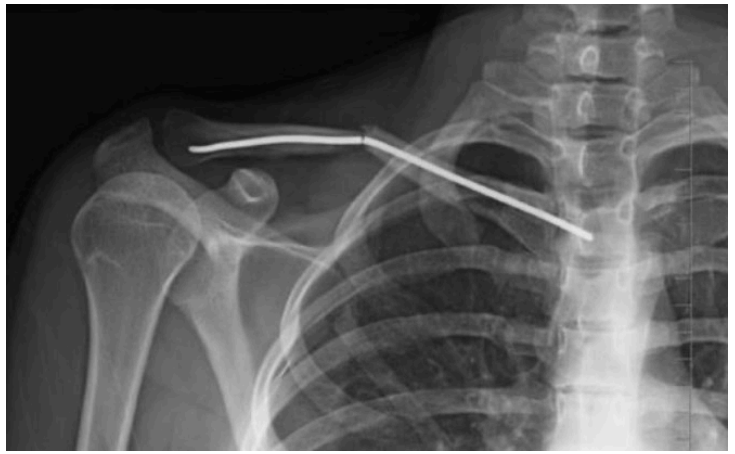
- Technique
  - Approach superiorly over clavicle along Langer lines or inferiorly for improved cosmesis
    - Avoid cutaneous supraclavicular nerves traversing the clavicle
  - ORIF
    - Anatomic plates
    - Superior vs anterior placement
  - Intramedullary fixation
    - Titanium nails
    - Perc vs mini-open



Complications

- Non-operative treatment
  - Nonunion
  - Malunion
  - Bony prominence
- Operative Treatment
  - Hardware prominence / pain
  - Re-fracture
  - Infection



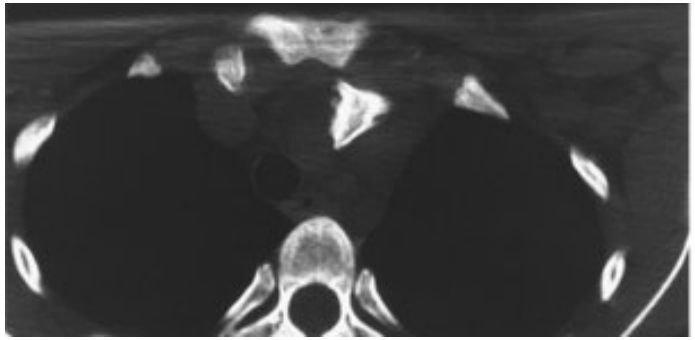


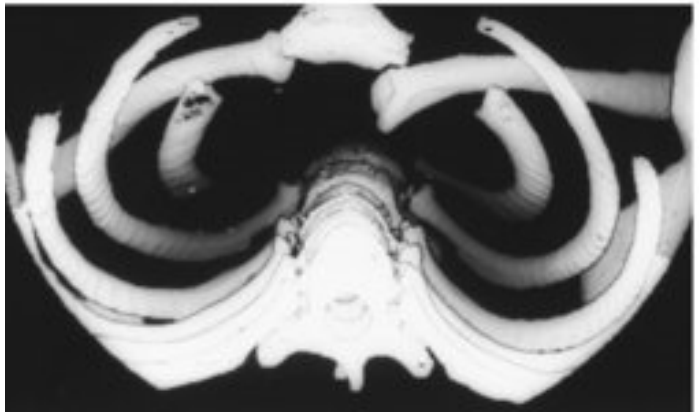
Physeal Considerations

- Clavicle is the first bone to ossify
- Medial epiphysis fuses at 22-25 years of age
  - Last physis to close
- Lateral physis closes at 19 years
- Injuries to medial or lateral clavicle usually represent physeal separations
  - True sternoclavicular or acromioclavicular joint dislocations are less common
- Growth disturbance very rare

Medial Clavicular Injuries

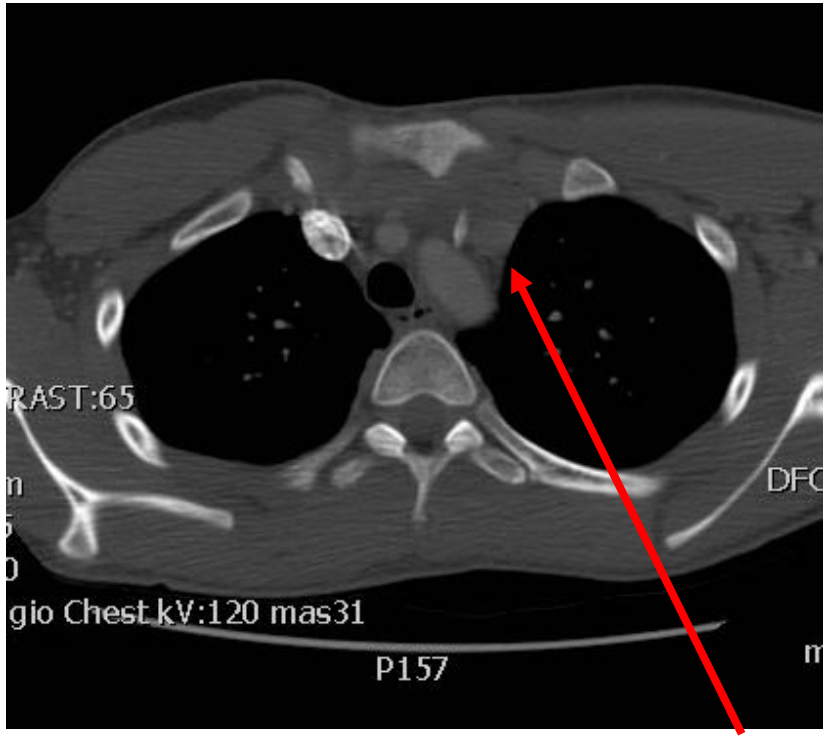
- Lateral metaphyseal fragment displaces anteriorly or posteriorly
  - Periosteal sleeve left intact
- Strong costoclavicular and sternoclavicular ligaments usually remain attached to periosteal sleeve
- Medial epiphysis remains well located at sternoclavicular joint
  - Sternoclavicular dislocations are less common





Medial Clavicular Injuries

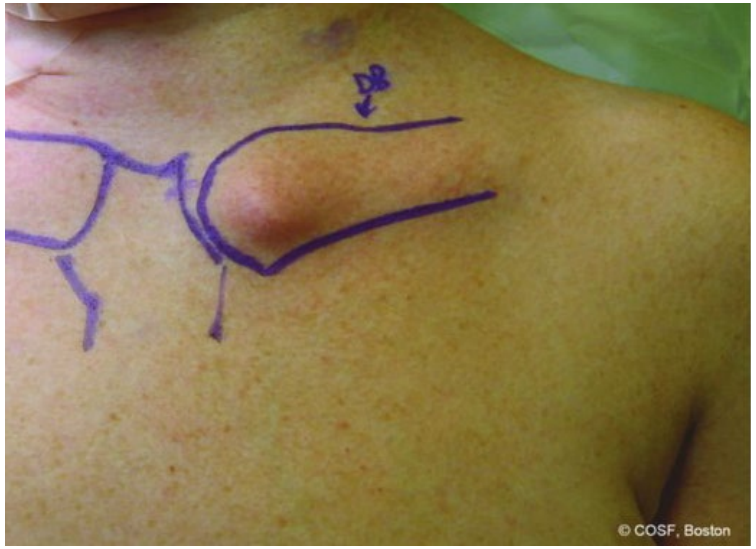
- Pseudo-sternoclavicular dislocation
  - Anterior displacement
    - Metaphyseal fragment lies in subcutaneous position
  - Posterior displacement
    - Puts innominate artery/vein, trachea, and esophagus at risk
    - Patients can present with dysphagia, hoarseness, pneumothorax, respiratory distress, brachial plexus injury, and vascular compromise
  - Critical to perform thorough neurovascular exam of extremity and assess respiratory status



Notice: Medial tip of clavicle adjacent to aortic arch!

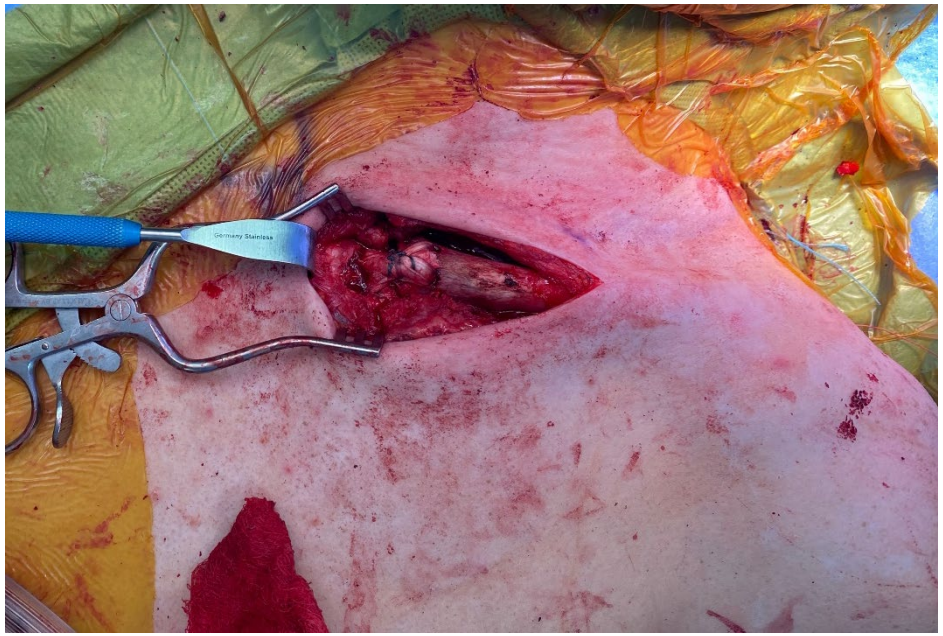
Treatment

- Non-operative
  - Anterior fractures or dislocations
  - Can be considered for asymptomatic posterior dislocations
  - Significant remodeling potential, some deformity acceptable
    - Physeal fractures remodel
    - Dislocations DO NOT REMODEL
  - Treat symptomatically in sling or figure-of-eight brace
  - Recurrent instability is uncommon



Treatment

- Operative
  - Closed reduction can be considered for displaced injuries
  - Emergent reduction in OR indicated for posterior displacement with dyspnea or dysphagia
    - Consider having general or thoracic surgery on standby
  - Closed reduction with traction and manual manipulation
  - Open reduction utilized for posterior dislocations
    - Heavy sutures are used to stabilize the reduction

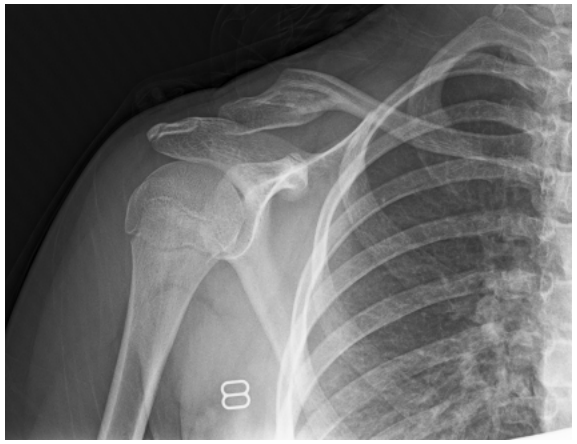


Reduction Techniques

- Anterior Displacement
  - Supine with bolster between scapula
  - Longitudinal traction on bilateral upper extremities
  - Gentle posterior pressure on displaced metaphyseal fragment
- Posterior Displacement
  - Same positioning and traction as anterior reduction
  - Grasp medial clavicle with towel clip and pull anterior while applying posterior force on shoulder
  - *If closed reduction fails, proceed to open reduction through incision superior to clavicle*

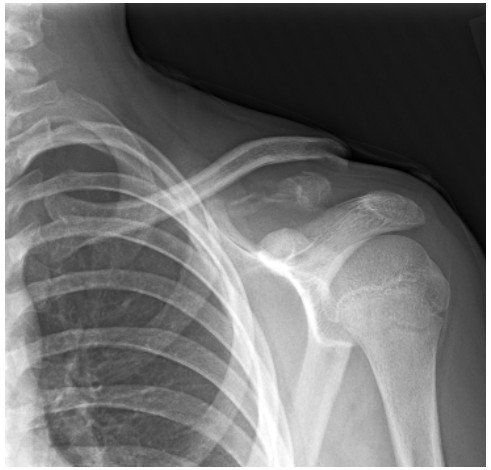
Lateral (Distal) Clavicle Injuries

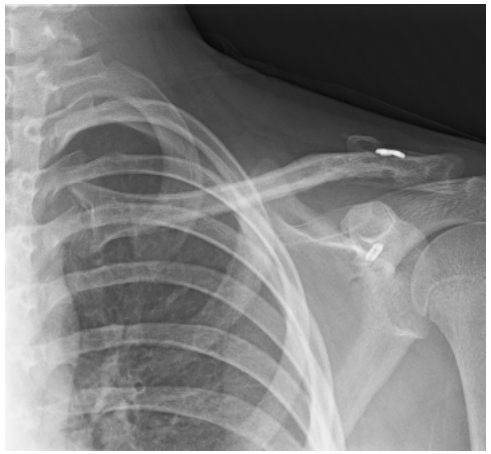
- Coracoclavicular ligaments (conoid and trapezoid) usually remain attached to periosteal sleeve and the lateral epiphyseal fragment
- When medial metaphyseal fragment is significantly displaced, intact periosteal sleeve may form new metaphysis resulting in duplicate lateral clavicle



Treatment

- Non-operative
  - All type I and II injuries, type III in pts < 15y can be managed with sling
- Operative
  - Open reduction indicated for types IV, V, VI injuries
  - Fixation with suture repair of periosteal sleeve
  - Coracoclavicular fixation can be used
    - Avoid percutaneous pin fixation in clavicle due to risk of migration



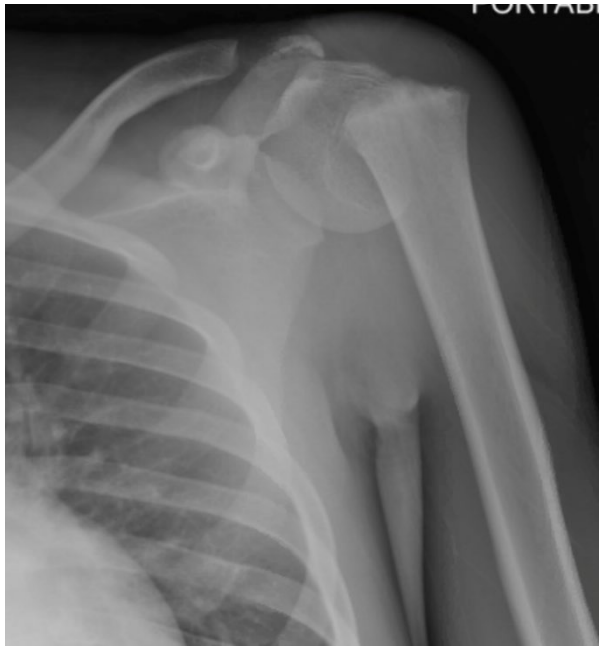


Pediatric Proximal Humerus Fractures

- Objectives- At the Conclusion of this presentation, the viewer should be familiar with
  - Epidemiology of pediatric proximal humerus fractures
  - Proximal humerus development
  - Common mechanism of injury
  - Classification of proximal humerus fractures
  - Treatment guidelines including acceptable radiographic alignment
  - Types of surgical management
  - complications

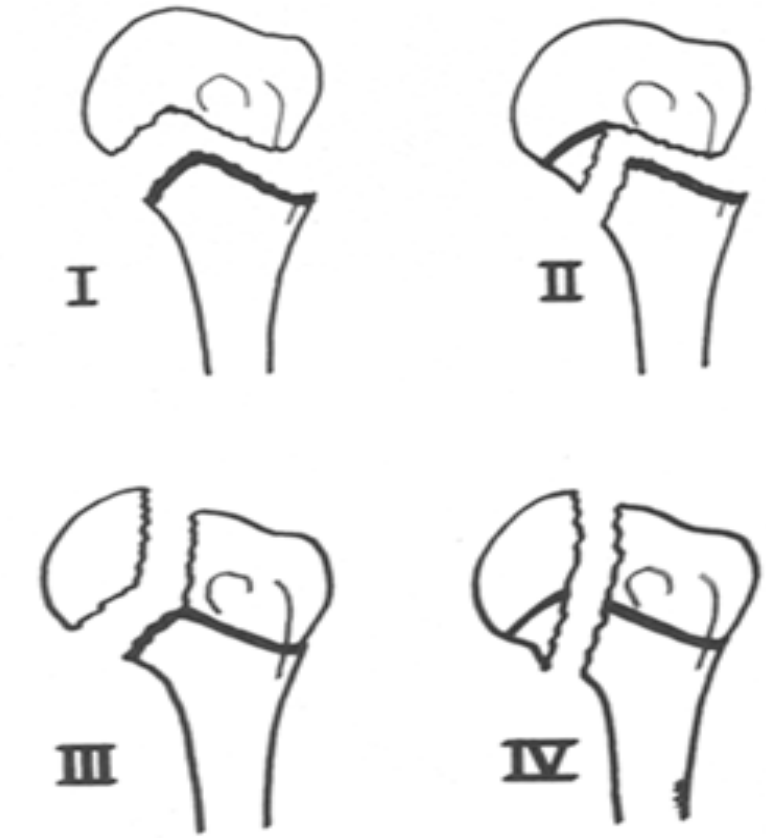
Proximal Humerus Fractures

- 3% of all physeal injuries
- More common in adolescents
- Most commonly Salter-Harris I or II injuries
- 80% of humeral growth comes from proximal physis
- Can be associated with glenohumeral dislocation



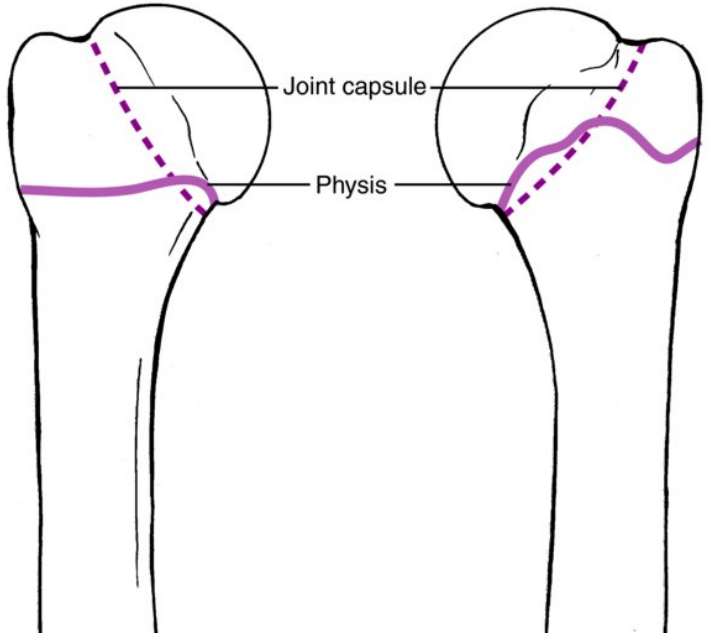
Proximal Humerus Fractures

- Birth injuries → SH 1
- 0-5 yo → SH 1
- 5-11 yo → metaphyseal
- 11 to maturity → Salter II
- Others rare (III, IV)



Proximal Humerus Development

- Primary officiation center appears at 4-6m
- Secondary ossification centers:
  - Greater tuberosity- appears at 3y
  - Lesser tuberosity– appears at 5y
- Coalesce into single ossification center at 7y
- Physis concaves medially following the anatomic neck and extends distally to the inferior border of greater tuberosity
- Physis closure in later adolescence
  - As early as 14y is some girls and as late at 22y in some males

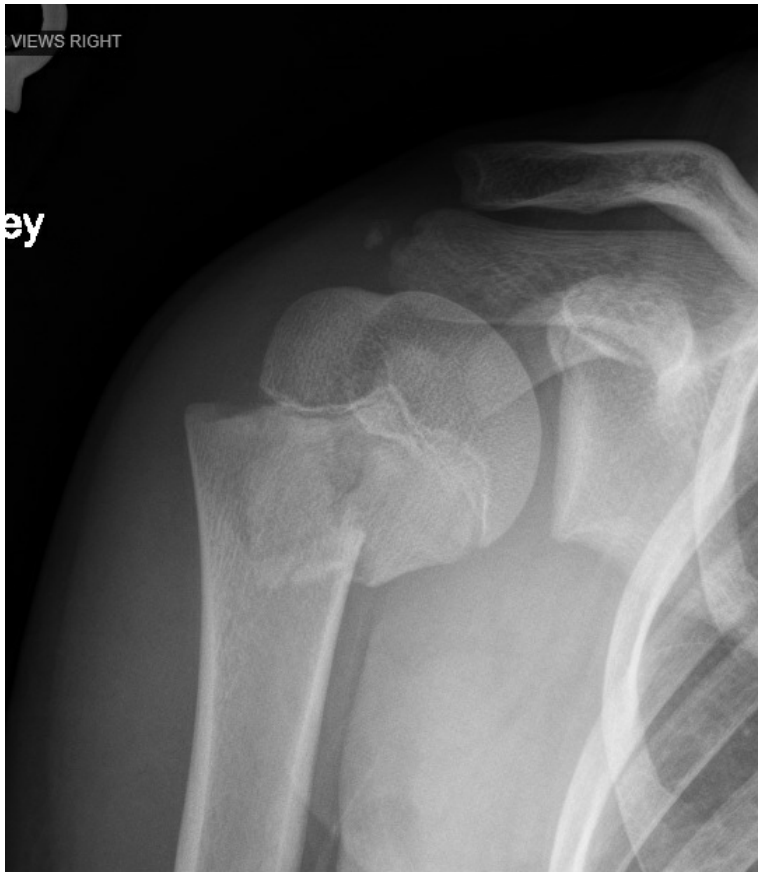


Mechanism of Injury

- Birth trauma
  - Hyperextension and rotation
- Child abuse
- Direct blow
- Indirect forced extension during a fall
- Pathological fractures through tumor or cyst
  - Unicameral bone cyst (shown)
  - Aneurysmal bone cyst

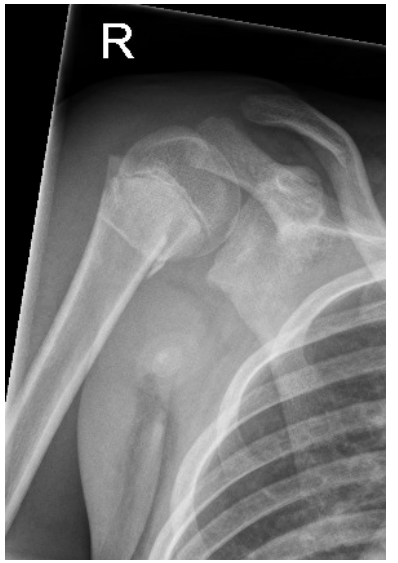
Classification

- Neer-Horwitz
  - Grade 1- less than 5mm displacement
  - Grade 2- between 5mm and 1/3 humeral shaft diameter
  - Grade 3- between 1/3 and 2/3 humeral shaft diameter
  - Grade 4- greater than 2/3 humeral shaft diameter



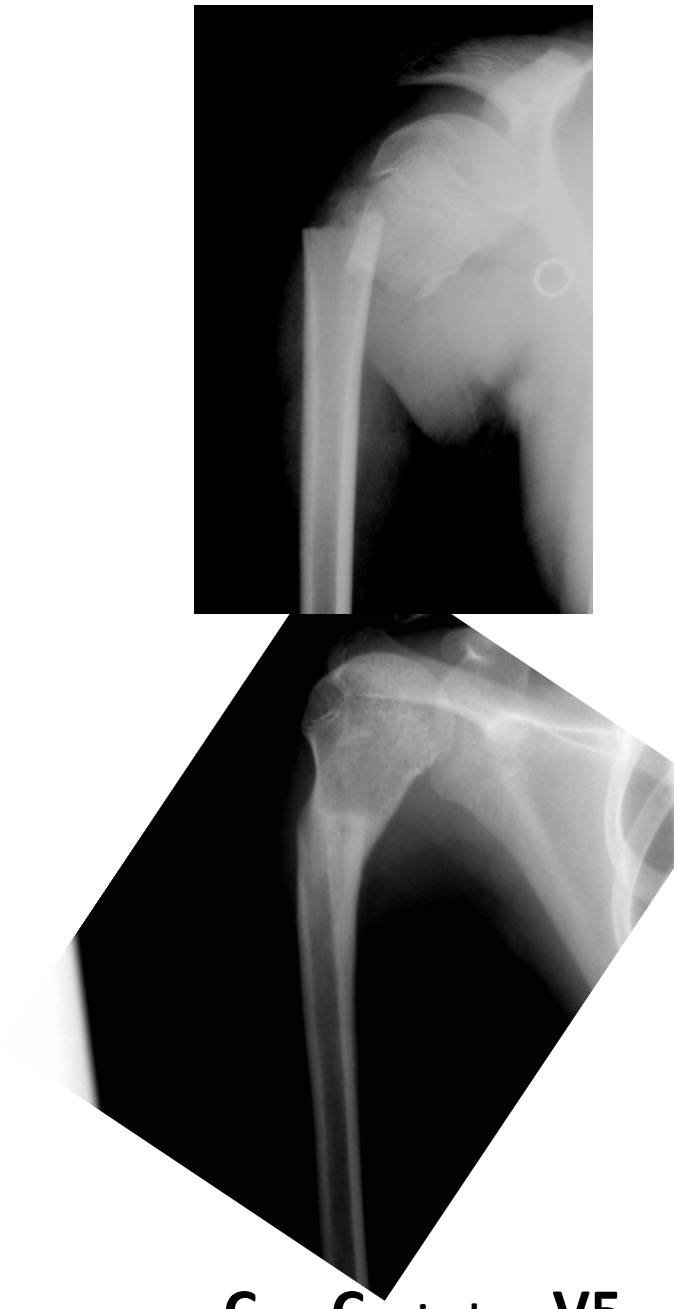
Proximal Humerus Fracture

- Proximal fragment flexed, abducted and externally rotated
  - Rotator cuff muscles
- Distal fragment displaced anteromedially, shortened, and adducted
  - Pectoralis major, latissimus dorsi, teres major
- *Must look at Scapular-Y view for anterior displacement*



Treatment

- Most can be treated non-operatively
  - Most children under 10y have sufficient growth remaining to remodel severely displaced fractures
- Consider surgical management in adolescent patients >13y with over 30 deg angulation or more than 50% displacement
- Surgical treatment
  - Open fractures
  - Polytrauma
  - Vascular injuries



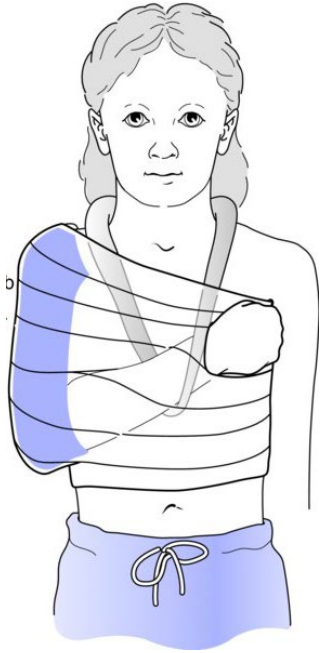
Acceptable Alignment

- <5y- 70 deg angulation, 100% displacement
- 5-11y- 40 - 70 deg angulation, 50-100% displacement
- >12y- <40 deg angulation, <50% displacement
- Reduction maneuver
  - Longitudinal traction
  - Abduction to 90 deg
  - External rotation

- ***Entrapped periosteum or bicep tendon can block reduction***

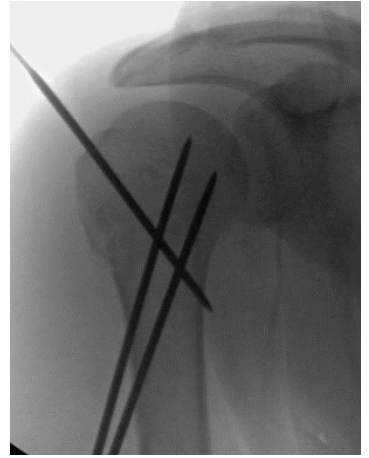
Shoulder Immobilization

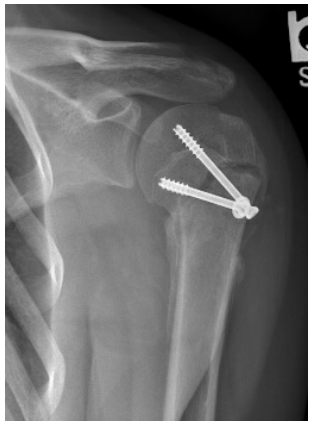
- Sling and swathe
- Hanging arm cast
- Cuff and Collar
- Start gentle pendulum at 2 weeks
- Can begin overhead activities 4-6 weeks



Types of Surgical Management

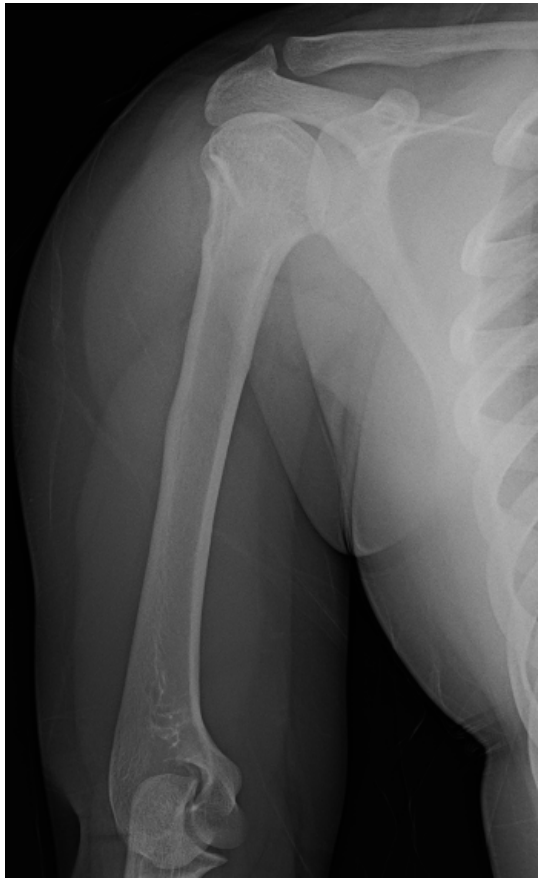
- Percutaneous Pinning
- Flexible nailing
- Cannulated crews
- Plate fixation
- No consensus on superior fixation strategy
  - Recommend fixation determined on case-by-case basis
    - Based on age, sex, displacement, and potential to remodel fracture





Complications

- Pain, weakness, loss of ROM
- Physeal arrest
  - Shortening of the humerus
    - 11% in Salter Harris I or II
    - 33% in Salter Harris III or IV
- Varus malalignment
- Neurovascular injury

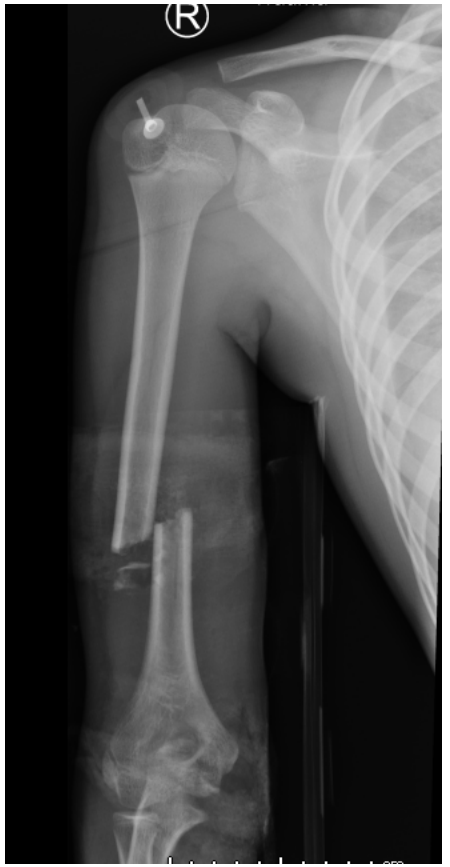


Pediatric Humeral Shaft Fractures

- Objectives- At the Conclusion of this presentation, the viewer should be familiar with
  - Epidemiology of pediatric humeral shaft fractures
  - Mechanism of Injury
  - Surgical and nonsurgical treatment options
  - Incidence of birth fractures
  - Complications

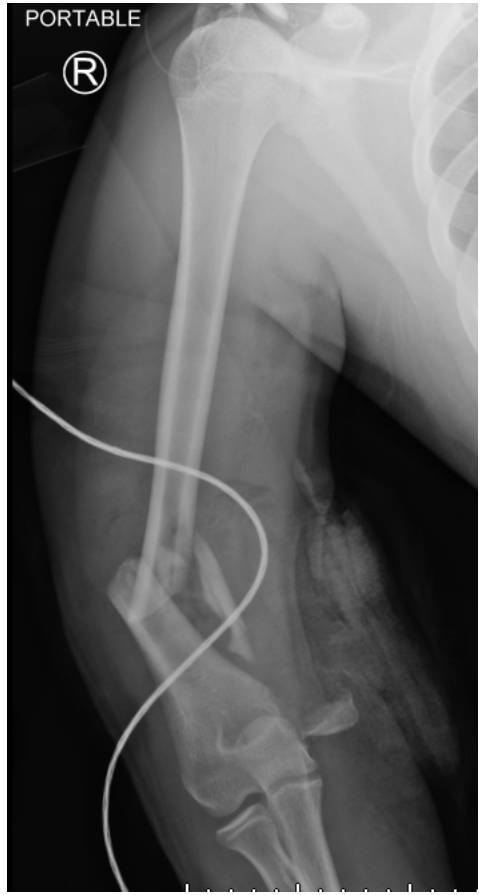
Humeral Shaft Fractures

- Second most common birth fracture
- **MUST consider NAT in those <3y**
- Pathologic fractures can occur through benign bone tumor or cyst
- Fractures can be associated with radial nerve palsy
  - 5% of pediatric humeral shaft fractures
    - High rates of spontaneous recovery



Mechanism of Injury

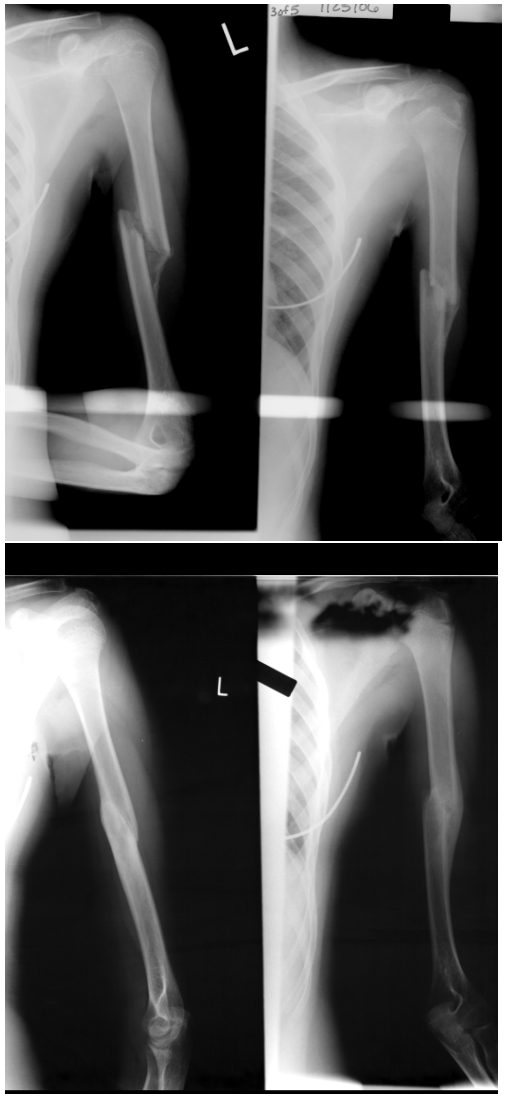
- Birth trauma
- Direct high energy forces
  - More likely to be open or proximal humeral shaft
  - Transverse, comminuted, segmental patterns
- Indirect forces
  - Oblique or spiral fractures
- Low-energy mechanisms should raise possibility of pathologic fx



Treatment

- Most common treatment option
  - Birth-related fractures
  - Stress fractures
  - Benign pathological fractures
  - Closed diaphyseal fractures with acceptable alignment

- Acceptable Alignment
  - 1 to 2 cm of shortening
  - ≤ 20 deg of varus or valgus angulation
  - ≤ 20 deg of anterior-posterior angulation
  - ≤ 15 deg of malrotation

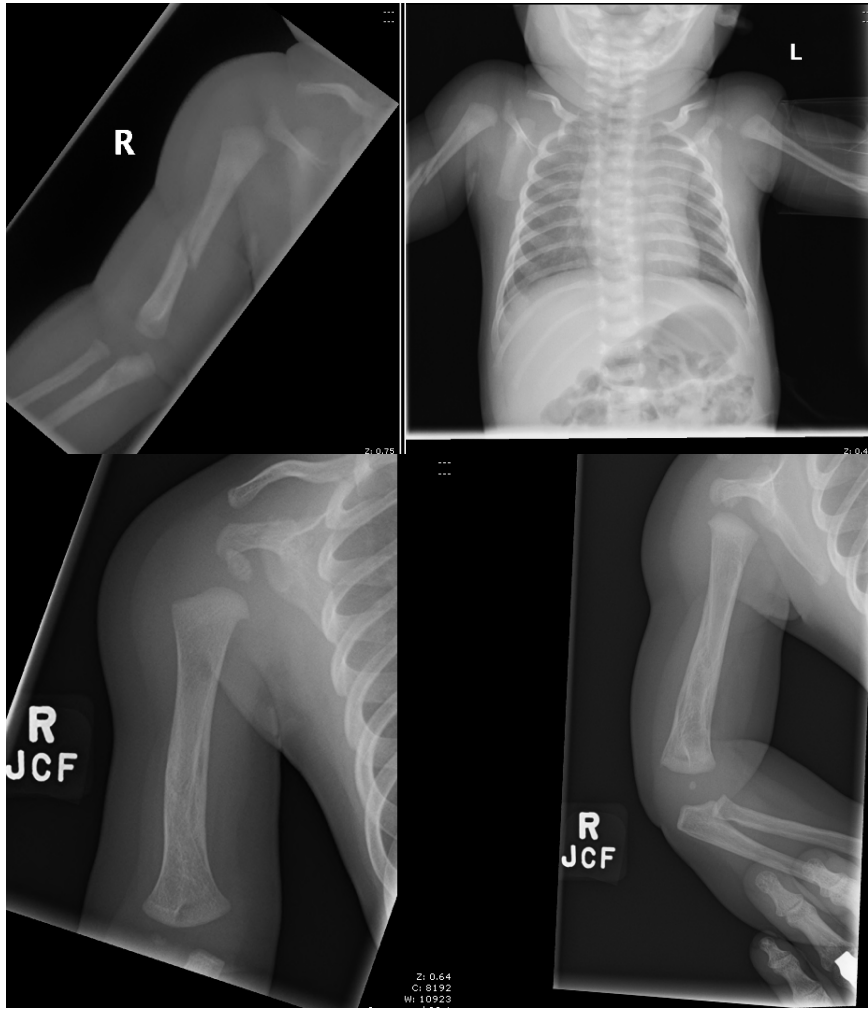


Treatment

- Surgical management
  - Open fractures
  - Polytrauma
    - Earlier mobilization
  - Vascular injury
- Options
  - External fixation
  - ORIF
  - ESIN
    - Retrograde
    - Antegrade

Birth Fractures

- Presents with deformity and/or pain
- May demonstrate pseudoparalysis
  - Observe neurological function
- Reduction is not needed
- Simple immobilization
  - Pin the sleeve to the shirt
  - Bandaging arm to thorax
    - Modified Velpeau bandage
  - Sling and swath
- 1-3 weeks of immobilization



Shoulder Immobilization

- Cuff and Collar
- Sling and swathe
- Coaptation splint
- Fracture bracing
- Hanging arm cast
- Velpaeu Bandage

Complications

- Malunion
  - Can occur, but rarely cause functional problem
- Nonunion
  - Uncommon
- Radial nerve palsy
  - Most commonly neuropraxia
  - Typically resolves with observation
  - Apply wrist splint to maintain wrist motion in extension
  - EMG and radial nerve exploration at 3-4 months if activity is not present

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