Chapter 52 – Humerus and Elbow

Episode Overview:

1) Describe an approach to the pediatric elbow

2) Classify supracondylar fractures in children

3) List 3 complications of supracondylar fractures

4) Describe the management of supracondylar fractures

5) Describe the management of:

- **a. Humeral shaft fractures – displaced and non-displaced**

6) Describe 3 injuries common in Little-leaguer's elbow

7) Describe the management and classification of radial head fractures

8) Describe the expected neurovascular injuries and management of posterior elbow dislocations

9) List the indications for x-ray in radial head subluxation

10) Describe the management of olecranon bursitis

Rosen's in Perspective:

Need to know the anatomy well

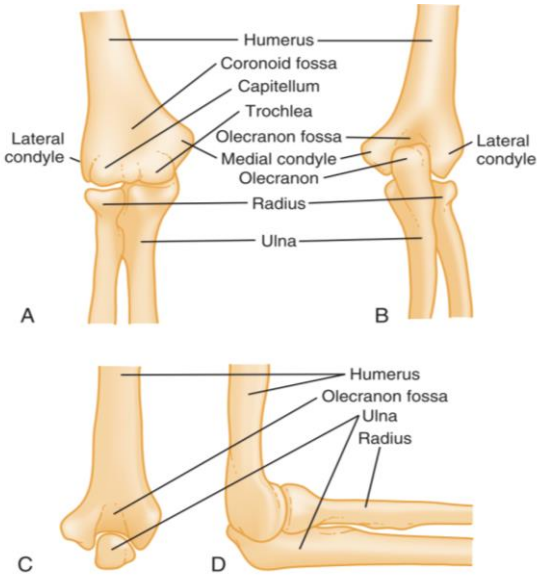

Figure 52-1. Bony anatomy of distal humerus and elbow region. **A,** Anterior view. **B,** Posterior view. **C,** Posterior view, 90 degrees flexion. **D,** Lateral view. Right elbow is shown. (Adapted from Connolly JF: DePalma's Management of Fractures and Dislocations. Philadelphia, WB Saunders, 1981.)

- The elbow allows for pronation, supination, flexion, extension
    - Three articulations:
        - Trochlea and the deep trochlear notch of the ulna
        - Capitellum and the radial head allowing elbow flexion
        - The radial head rotating on the capitellum and radial notch of the ulna

Bones

- Distal humerus tapers into:
    - Medial (wrist flexors) and lateral (wrist extensors) condyles, which sandwich the coronoid fossa in-between
        - Fractures through the distal humerus usually result in displacement because of these muscular attachments
    - The epicondyles sit above the articular condyles
- Volarly the capitellum articulates with the radial head
    - The trochlea articulates with the ulna
- Dorsally is the olecranon and the olecranon fossa
- Some people have a supracondylar process (that has the median nerve right around it)

Ligaments

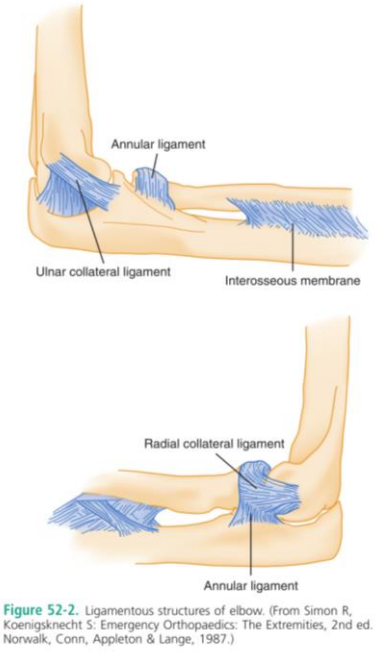

Figure 52-2. Ligamentous structures of elbow. (From Simon R, Koenigsknecht S: Emergency Orthopaedics: The Extremities, 2nd ed. Norwalk, Conn, Appleton & Lange, 1987.)

- Laterally (radial)
    - Annular ligament & radial collateral ligament
- Medially (ulnar)
    - Ulnar collateral ligament
- Interosseous membrane of the radius – ulna

Soft tissues

- Two compartments in the upper arm:

- Anterior (everything else) and posterior (triceps and radial nerve)

Nerves and blood vessels:

- Brachial artery travels in the anterior compartment with the median nerve alongside it

The anatomy at the AC fossa:

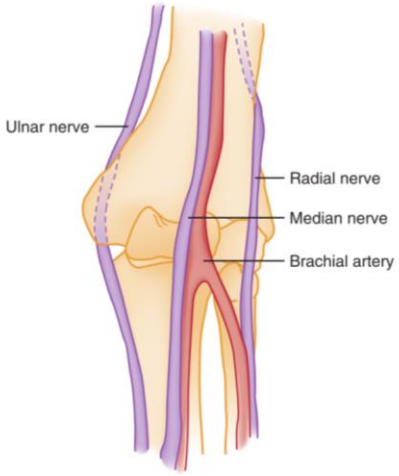

Figure 52-3. Neurovascular structures of elbow region. Volar surface of left elbow is shown.

The radial nerve:

- Spirals around the humerus posteriorly, and re-enters the anterior compartment laterally (LE) to power the wrist and finger extensors
- ***the radial nerve is VERY susceptible to injury with any midshaft humerus fracture***
- Because it is fixed in the intermuscular septum, the nerve can become trapped when reduction is attempted.

The ulnar nerve:

- Runs parallel to the median nerve until half-way down the humerus, and then it moves medially
- It passes BEHIND the medial epicondyle which puts it at risk of injury.

Elbow Bursae:

- Olecranon bursa (elbow skin gliding)
- Radiohumeral bursa (supination/pronation)
- Bicep tendon cushioning bursa - protects the radius during elbow flexion

Clinical features:

- History: standard stuff
- Physical:
  - Compare bilaterally
  - In kids:
    - Note the position it is held in:
      - Extension type supra-condylar #'s are held at the side with an S-shape

- Flexion type supra-condylar #'s held in flexion, with the other hand, at 90 degrees
- Radial head subluxation - elbow in slight flexion and pronation.

- Check for prominence of the olecranon (posterior dislocation) vs. loss of olecranon = anterior dislocation
- Some people use carrying angle measurements to assess for adequacy of reduction (measure bilaterally and tolerate < 12 degrees difference).
- Need to assess vascular status: use doppler if pulses aren't well palpated.
  - Pain is the only early dependable sign of compartment syndrome
  - Consider checking ankle brachial index.
- Ensure the limb is re-examined before and after manipulation.

See box 52-1 for a classification of fractures for the humerus (shaft vs distal) and radial head, and ulna

Box 52-1 Classification of Fractures

I. Humerus fracture
  A. Shaft of the humerus fractures
  B. Distal humerus fractures
    1. Supracondylar
      a. Extension
      b. Flexion
    2. Transcondylar
      a. Extension
      b. Flexion
    3. Intercondylar
      a. Nondisplaced
      b. Separated
      c. Separated and rotated
      d. Combination with articular surfaces
    4. Condylar
      a. Medial
      b. Lateral
    5. Articular surface
      a. Capitellum
      b. Trochlea
    6. Epicondylar
      a. Medial
      b. Lateral
II. Radial head fracture
  A. Nondisplaced
  B. Displaced
  C. Comminuted
III. Ulnar fracture
  A. Olecranon fracture
  B. Coronoid fracture

1) Describe an approach to the pediatric elbow

Physical examination can add some clues (see above), but is inaccurate.

Have a low threshold for obtaining radiographs, especially kids!

- Views:
  - AP, true lateral (90 degrees with thumb upward), oblique

The Approach:

1. Right patient, views, etc.
2. Gross deformity
3. Soft tissue assessment
   a. Fat pads

i. Watch out for the missed radial head fracture (look at the radial head and fat pads)
ii. Watch out for subtle changes in the elbow fat pads as they may the only sign of a fracture
    1. A small anterior elbow lucency (anterior fat pad) is normal
        a. A “sail sign” is abnormal
iii. Any posterior fat pad is abnormal - with 95% of people with this having an intra-articular injury.
    i. Adults = it means a radial head fracture
    ii. Children = it means a non-displaced supracondylar #
    iii. Fat pad signs may be *absent* in cases of severe capsule rupture.

4. Alignment
    a. Anterior humeral line
        i. On the lateral radiograph draw a line along the anterior surface of the humerus through the elbow joint
        ii. This line should intersect the **middle ⅓ of the capitellum**

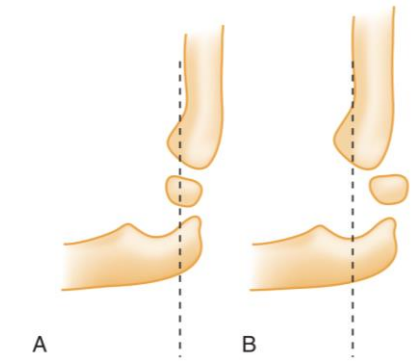

Figure 52-8. **A,** A line drawn down the anterior surface of the humerus on a lateral film should transect the middle of the capitellum. **B,** With an extension supracondylar fracture, the line passes more anteriorly. (From Simon R, Koenigsknecht S: Emergency Orthopaedics: The Extremities, 2nd ed. Norwalk, Conn, Appleton & Lange, 1987.)

        iii. An extension type supracondylar fracture will have this line transecting the anterior ⅓ or in front of it. = fracture

    b. Radio-capitellar line

c. Baumann's angle

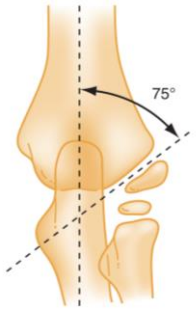

Figure 52-9. Baumann's angle as measured on anteroposterior film. (From Worlock P: Supracondylar fractures of the humerus. J Bone Joint Surg [Br] 68:755, 1986.)

i. Use the AP film to draw an angle through the mid shaft of the humerus AND the growth plate of the capitellum
ii. This angle should be 75 degrees in both elbows
iii. This can be used to assess the accuracy of a reduction

d. Centres of ossification:

Table 52-1 Ossification Centers of the Elbow: CRITOE

OSSIFICATION CENTERS	AGE OF APPEARANCE
Capitellum	1-2
Radial head	4-5
Internal (medial) epicondyle	4-5
Trochlea	8-10
Olecranon	8-9
External (lateral) epicondyle	10-11

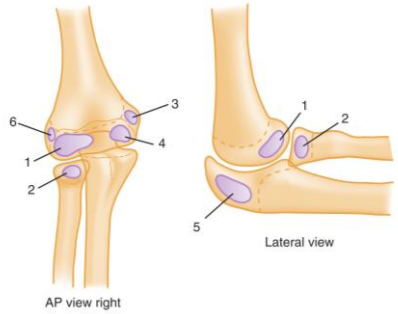

Figure 52-10. Secondary growth centers of the elbow. *(1)* Capitellum; *(2)* radial head; *(3)* medial epicondyle; *(4)* trochlea; *(5)* olecranon; *(6)* lateral epicondyle. (From Townsend DJ, Bassett GS: Common elbow fractures in children. Am Fam Physician 53:2031, 1996.)

CRITOE

1. Trochlea is medial
2. May be helpful to get films of the other side
3. 1-3-5-7-9-11 - for the AGE of appearance

2) Classify Supracondylar fractures in children

"A fracture of the distal humerus, proximal to the epicondyles"
Occurs in the 5-10 yr olds, rarely occurs > 15 yrs, this is ⅓ of ALL pediatric limb #s

- Why? The collateral ligaments (and joint capsule) in children's elbows are greater than the bone.

Classified using Gartland Classification:

Box 52-2 Gartland Classification for Supracondylar Fractures in Children

Type I—Minimal or no displacement
Type II—Displacement of the fracture, but with the posterior cortex intact
Type III—Displaced, no cortical contact
Type IIIA—No rotation of the fracture
Type IIIB—Rotation present

These can be further divided into:

- **Flexion SC#s**
- **Extension SC#s**: most common (98%)
    - FOOSH monkey bars - lever forces of the forearm on the moment of the elbow→ snap. Posterior and proximal fragment gets pulled proximally
        - The forces can cause the apex to go anteriorly and endanger the brachial nerve and median artery
    - Kid arrives in hyperextension, with a S-shaped configuration or an isolated elbow effusion as the only clinical sign
    - Examination often facilitated by analgesia!
    - NEED an x-ray
        - Lateral view is the money shot, with 25% being the greenstick variety with an intact posterior cortex (Gartland II)
        - AP view is good for the displaced fractures
    - The x-rays are used to classify them based on the Gartland system.

3) List 3 complications of supracondylar fractures

Complications:

1. Brachial artery injury
    a. Usually a temporary loss of the radial pulse due to swelling
        i. Avoid flexion the reduced fracture more than 90 degrees, keep the arm elevated, gentile reduction
2. Compartment syndrome
    a. Leading to volkmann's ischemic contracture from prolonged forearm ischemia - is rare <0.5%
3. Loss of the normal carrying angle
    a. Most common because valgus/varus deformities have little chance of remodeling
    b. Leads to cubitus varus "gunstock" deformity - with cosmetic problems long term
    c. Baumann's angle can be used to assess the adequacy of reduction
4. Injury to nerves
    a. Interosseous nerve is most commonly injured
        i. Radial, median, ulnar nerve (most commonly injured with a flexion#) may also be injured

   b. Most injuries are neuropraxic - which motor function returns in 7-12 weeks, and sensory function in 6 months
5. Stiffness
   a. Due to prolonged rehab, surgery and casting

4) Describe the management of supracondylar fractures

Kids:

- Extension:
  - Type I - non displaced -
    - Immobilized for comfort and protection. These are stable.
    - Cast at 90 degrees, thumb up. Protected active ROM at 3 weeks.
    - **even without radiographic findings, a child with localized tenderness consistent with a SC# should be splinted with 48 hr f/u
  - Type II - minimally displaced
    - Reduction
    - Cast at 90-120 degrees* with follow up
      - Flexion thought to hold the fracture in place, with the risk of worsening vascular obstruction which peaks at 48 hrs
    - Some may need percutaneous pinning
  - Type III - totally displaced:
    - High risk for neurovasc. Damage and swelling
    - All need ortho consultation, and reduction
      - Almost all need operative pinning to maintain the reduction
    - Regular neurovascular checks pre, during and post reduction.
    - When to attempt reduction in the ED?
      - When a displaced SC # is associated with neurovascular compromise:
      - Steps: [fig 52-19]
        - Counter

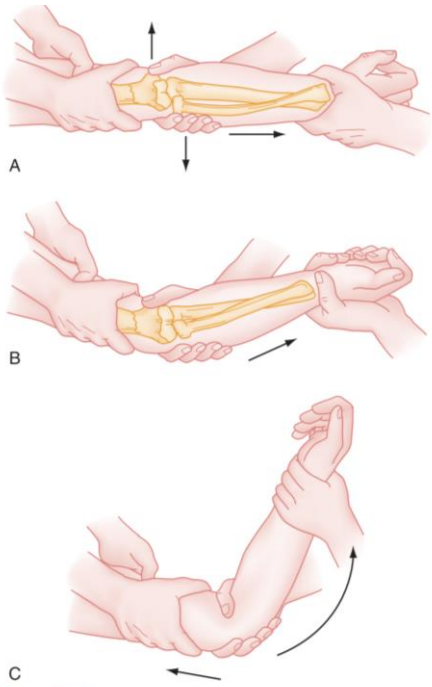

Figure 52-19. Steps in reduction of displaced supracondylar fracture (see text).

Adults:

- Adults have the reverse problem compared to kids: they usually suffer a posterior elbow dislocation
- Any limb threatening injury needs immediate reduction, splinting and OR
- Open # need antibiotics

5) Describe the management of humeral shaft fractures – displaced and non-displaced

Usually broken by: MVCs, direct falls, powerful twisting motions

- Fig 52-11 describes the movement of the humerus based on the various different muscular attachments:
    - # Proximal to Pec. Major and Deltoid insertion = proximal humeral head twists by the action of the rotator cuff muscle, and pec.mj. Pulls the distal fragment medially
    - # in between pec. Major insertion and deltoid insertion = proximal fragment (broken edge) gets pulled to the chest
    - # is distal to the deltoid insertion, the fragment gets pulled so the apex is lateral.

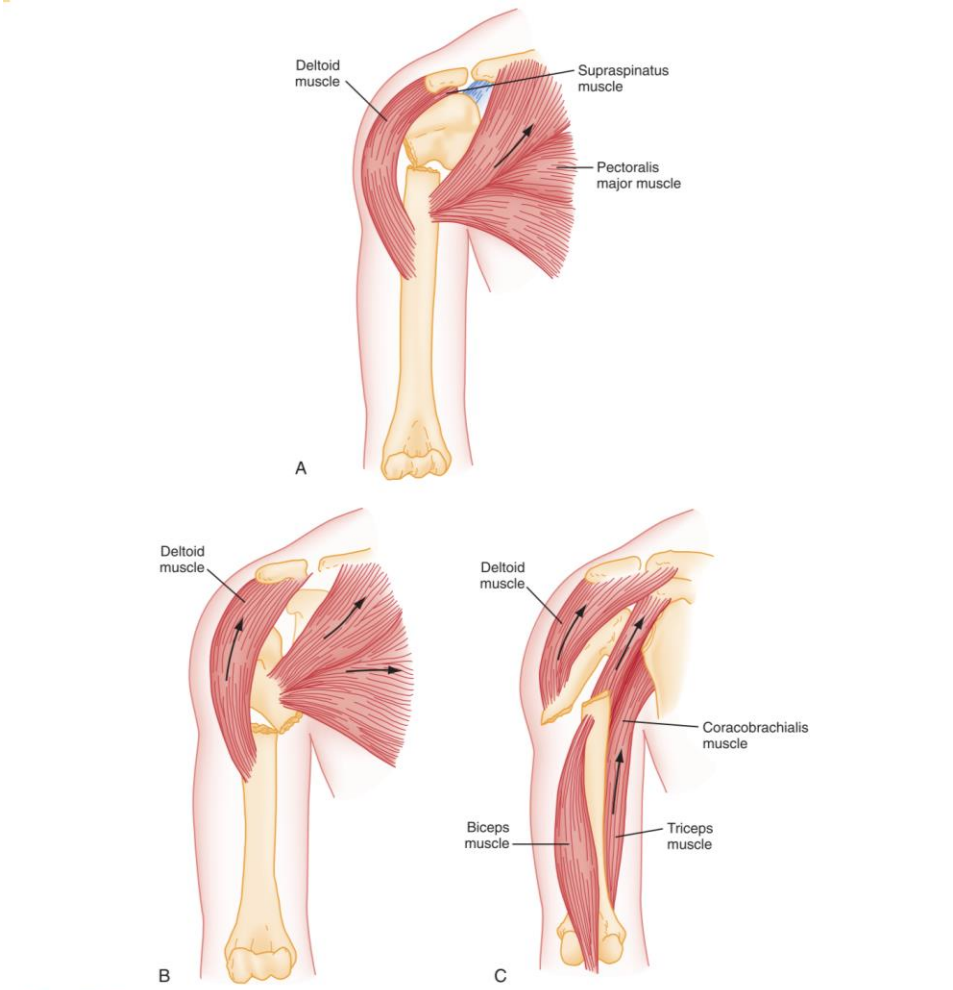

Figure 52-11. Influence of muscles on displacement of humeral shaft fractures based on fracture location. **A,** Fracture is proximal to the attachment of the pectoralis major muscle. **B,** Fracture is between insertion of the pectoralis major and deltoid muscles. **C,** Fracture is distal to the deltoid insertion.

Management principles:

- Closed #s are treated with a great degree of success non-operatively. The BEST chance at fracture healing is with gravity and muscle balance (fractures are richly surrounded by vascularized muscle).

  Displaced/comminuted
  - Use the “hanging cast technique”
    - See complex description on page 602 and Fig 52-14
    - Requires the person to remain upright 24/7

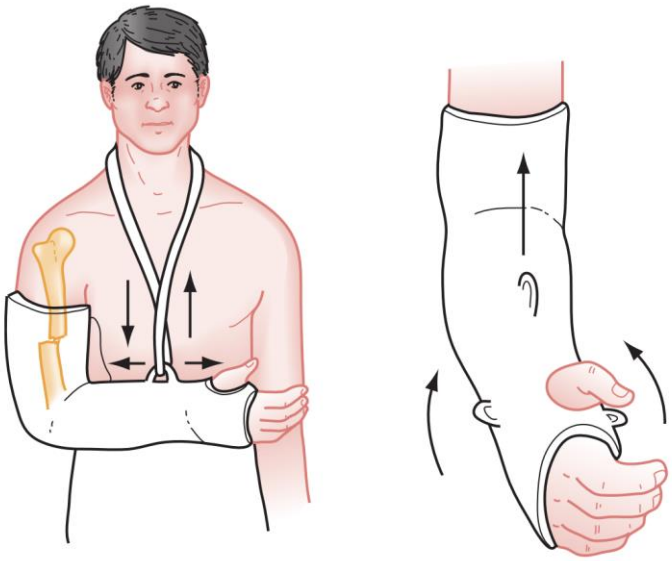

Figure 52-14. Hanging cast technique.

- Other options:
    - ORIF for:
        - Open #s, comminution, immobility, poor compliance, multi-trauma, pathologic bone, etc.

Non-displaced

- Sugar-tong splint (aka. Coaptation splint) then sling and swathe - fig 52-13
    - Pad the extremity, hold arm at 90 deg, run a plaster swathe from deltoid to elbow then back up into the arm pit,
    - Wrap the sugar tong with a bandage
    - Support the arm in 90 deg of flexion
    - Splint for 10-14 days, then functional brace

All need follow up with ortho.

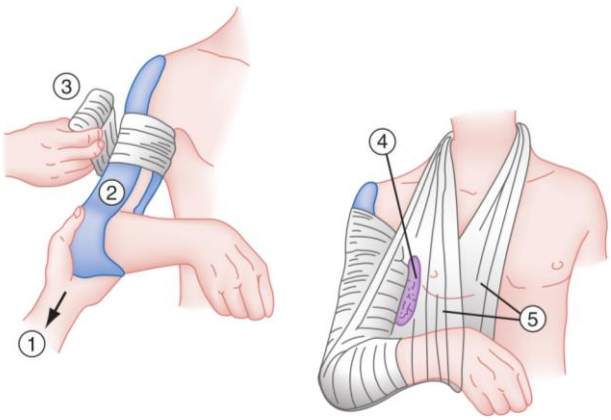

Figure 52-13. Sugar-tong splint for humeral shaft fractures. Gentle traction is applied *(1)* as the splint is placed *(2)* from over the deltoid laterally, under the elbow, and up into the axilla. An elastic wrap holds the splint in place *(3)*. The axilla must be padded *(4)*, and a sling is used *(5)*. (Adapted from Connolly JF: DePalma's Management of Fractures and Dislocations. Philadelphia, WB Saunders, 1981.)

Pearls:

- Elbow is at huge risk for stiffness if immobilized - so don't sling every injury!
- Watch for a radial nerve injury - this is the most common nerve injury associated with humeral shaft fracture
    - Most of these are thought to self-resolving neuropraxia and managed non-operatively with watchful waiting for months
    - *If the nerve palsy occurs post-reduction/manipulation, it is likely nerve entrapment and needs exploration operatively!*
- The humerus is a common site for metastatic bone cancers or benign cysts

6) Describe 3 injuries common in Little-leaguer's elbow

- An adolescent thrower traumatises his/her immature elbow epiphyses by repetitive throwing

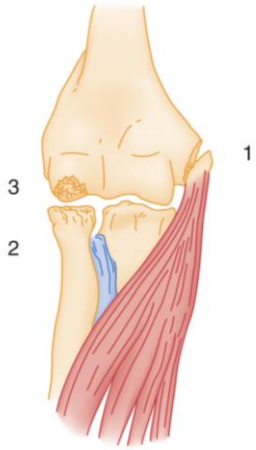

Figure 52-27. Little Leaguer's elbow. Avulsion fracture of medial epicondyle *(1)*. Compression fractures of the radial head *(2)* and capitellum *(3)*. (From Connolly JF: DePalma's Management of Fractures and Dislocations. Philadelphia, WB Saunders, 1981.)

- Usually affects:
    - ***Medial epicondyle avulsion*** # (wrist flexors)
    - ***Compression # of the subchondral bone of radial head***
    - ***and/or the capitellum (lateral condyle)***
- In any adolescent throwing athletes with medial or lateral elbow pain without acute injury, this diagnosis should be suspected
- They should rest until pain is gone, and then usually need to closely monitor the number of pitches per game

7) Describe the management and classification of radial head fractures

- Occur in a FOOSH mechanism, because the capitellum is stronger than the radial head/neck

- Need to suspect articular capitellar injury and radial collateral ligament injury
- Tender over the head, with painful passive ROM

- Dx:
  - Undisplaced #s are super difficult to see. Treat based on symptoms and presence of fat pad signs
- ***Classification types:***

I. **Undisplaced**
II. **Marginal fracture**, < 30% of the articular surface, with > 2mm displacement, including angulation and displacement
III. **Comminuted** of the ENTIRE radial head
IV. **Any of the above WITH an elbow dislocation**

- Management:
  - Type I:
    - Treat symptomatically with sling support, and ROM in 24-48 hrs
      - The joint can be aspirated and injected with anesthetic for symptom control and to improve ROM
    - Most recover in 2-3 months. But all have risk of chronic pain and decreased ROM
  - Type II: similar treatment to above
    - Aspiration and injection may further help identify loose/obstructing fragments causing mechanical obstruction
  - Type III and IV fractures: in consult with orthopedics, these may need radial head excision. These have higher risks of long term disability

8) Describe the expected neurovascular injuries and management of posterior elbow dislocations

- Second most commonly dislocated large joint next to the shoulder
  - Defined as a loss of normal relationship of the humerus and olecranon, described based on the position of the ulna in relation to the humerus

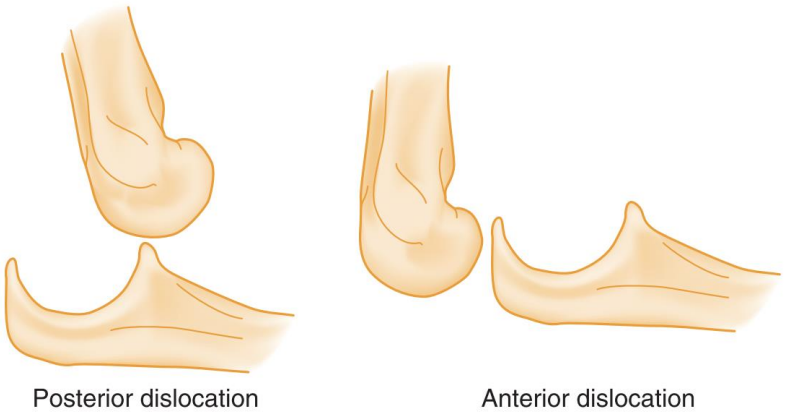

Figure 52-30. Elbow dislocation, posterior and anterior. (Adapted from Simon R, Koenigsknecht S: Emergency Orthopaedics: The Extremities, 2nd ed. Norwalk, Conn, Appleton & Lange, 1987.)

- **Posterior**

        - **Anterior**
        - **Medially**
        - **Laterally**
        - **Divergent dislocation**
    - **If there** is an associated fracture it is a “complex elbow dislocation”

- <u>Posterior elbow dislocations:</u>
    - FOOSH injury - hyperextension with a valgus force levers the ulna from the trochlea
        - The distal humerus gets lodged on the coronoid process
    - Arm held in 45 degrees of flexion
    - Assess for **brachial artery and median nerve injury**
        - From initial injury, reduction, or swelling
    - Radiographs are important pre-reduction to investigate for possible fractures
    - Reduction:
        - Facilitated by procedural sedation, intra-articular anesthesia or regional block
        - Assistant provides counter traction
        - Elbow at 30 degrees of flexion and arm in supination with distal traction
        - If not successful, apply downward pressure on the proximal forearm and use the fingers to pull the olecranon forward
    - When reduced and stable, splint elbow in at least 90 degrees of flexion
    - Thorough post-reduction exam and radiographs
    - Follow-up and begin ROM at 3-5 days post
    - **loss of median nerve or brachial artery function need immediate ortho/vascular consultation**
- Median and lateral dislocations are managed like a posterior dislocation
- Anterior dislocations are rare
    - Usually an associated triceps rupture, vascular injury and open fracture
    - May be reduced with backward pressure on the forearm

9) List the indications for x-ray in radial head subluxation

- Aka, nursemaid’s elbow, usually affects girls > boys, and the left arm most commonly
    - Usually ages 1-4, but can occur 6 months - 15 yrs
- The annular ligament is pulled, and fibers slip between the capitellum and the radial head → the child is unable to supinate hand
- Hx usually is of a pulling of the arm while in pronation
    - Arm is usually held in the ED with passive pronation and slight flexion
- Swelling, ecchymosis, deformity are absent
- Reduction:
    - 1) the supination flexion method
    - 2) the hyperpronation method

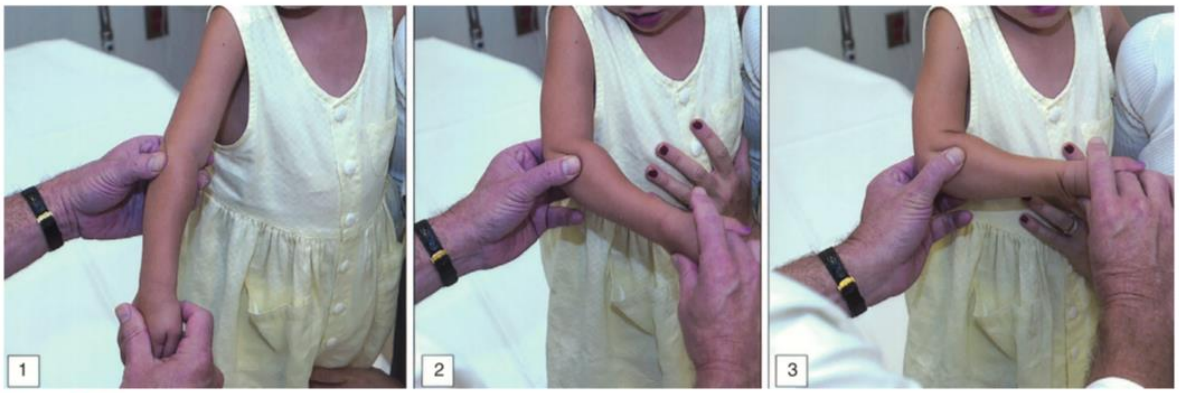

Figure 52-32. Subluxation of the radial head. Method of reduction: *(1)* Apply pressure to radial head, *(2)* supinate the forearm, and *(3)* flex elbow, in one continuous motion.

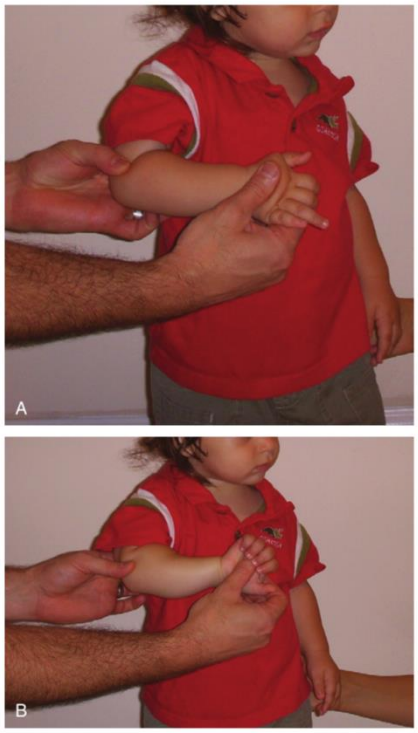

Figure 52-33. Hyperpronation method of radial head subluxation reduction: **A,** Support elbow with pressure to radial head, then hyperpronate the arm distally **(B)**.

- A palpable “click” is reassuring, but may not be felt
- 90% of kids regain function in their arm in 30 minutes
- Recurrence rate - 20%

Reasons to image:

1. Ecchymosis, swelling, deformity
2. Tenderness to wrist, forearm, humerus, clavicle on palpation
3. **No return of function in 24 hrs**

10) Describe the management of olecranon bursitis

- The most commonly affected bursa in the elbow region

- Usually caused by repetitive minor trauma (leaning on the elbow)
    - May also be from gout, or septic bursitis (swollen, hot, erythematous, tender)
- Pain, tenderness, swelling over the olecranon, markedly limited flexion
- Considerable overlap exists between septic and traumatic bursitis
- Aspiration of the bursa may help with diagnosis:
    - Crystals, cell counts, gram stain, culture
        - Traumatic WBC = 1000
        - Septic WBC = > 10 000 wbc/mm3
- Treatment:
    - Aspiration can be diagnostic and therapeutic
        - If purulent it should be drained as much as possible
        - Antibiotics for MRSA
    - If non-purulent:
        - Compression