Upper Extremity Trauma

Wesley Eilbert, MD, FACEP
(August Course & Webcast Course Lecturer)
Clinical Associate Professor, Department of Emergency Medicine, University of Illinois at Chicago, College of Medicine; Attending Physician, Mercy Hospital and Medical Center, Chicago

Marilyn Hallock, MD, MS
(October Course Lecturer)
Attending Physician, Department of Emergency Medicine, Rush University Medical Center; Clinical Instructor, Rush University, Chicago
UPPER EXTREMITY TRAUMA

I. NOMENCLATURE

A. Fracture descriptors

1. Transverse: perpendicular to the bone
2. Oblique: fracture line at an angle, usually 45° - 60°. No rotational component
3. Spiral: fracture curves in a spiral fashion around the bone
4. Comminuted: fracture with more than two fragments
5. Impacted: fracture ends are compressed together
6. Angulation: described in degrees of angulation of the distal fragment to the proximal
7. Apposition: the contact of the fracture surfaces

B. Joint injury descriptors

1. Dislocation: total disruption of the joint surfaces with loss of normal contact between bony ends
2. Direction of joint dislocation: named by the relationship of the distal articulating surface to that of the proximal
3. Subluxation: partial disruption of the joint with partial contact remaining between the two bony ends
4. Diastasis: disruption of the interosseous membrane between syndesmotic joints (e.g., radius and ulna, tibia and fibula)
II. EMERGENT COMPLICATIONS OF FRACTURES AND DISLOCATIONS

A. Hemorrhage

1. Primarily a concern with displaced pelvic fractures
2. Also significant with femoral shaft fractures

B. Open fractures/dislocations

1. Open fractures are classified based on the size of the overlying laceration, the amount of soft tissue damage, and the extent of contamination
2. Most will require debridement and irrigation in the OR. Some small, open fractures (i.e., the phalanges) may be treated in the ED.
3. Wound cultures are not necessary before antibiotics.
4. An I.V. first generation cephalosporin (cefazolin), with the addition of an aminoglycoside for more severe/contaminated cases is recommended.
5. Open dislocations also require irrigation (usually in the OR) and I.V. antibiotics.

C. Neurovascular deficits

1. The longer a deficit goes untreated, the longer it is likely to persist and the greater the possibility that it will be irreversible. Emergent reduction of the offending fracture or dislocation is indicated.

D. Irreducible dislocations

1. The longer a joint is dislocated, the more difficult it usually is to reduce and the more likely it is to be unstable after reduction.
2. With hip dislocations, the risk of avascular necrosis of the femoral head increases with the length of time of the dislocation.

E. Compartment syndromes

1. Occur when tissue pressures in a fascia-enclosed compartment rise to the point of compromising perfusion. Nerves and muscles are most susceptible to the resultant ischemia.
2. The clinical features of compartment syndromes can be remembered as the six Ps.
   a. Pain out of proportion to the injury is the earliest and most significant finding
   b. Pain with passive stretch of the involved muscle group
   c. Paresis (or weakness) of the involved muscle group
   d. Paresthesias in the distribution of the nerve in the involved compartment
   e. Pulses intact, unlike arterial injuries where pulses are absent
   f. Pressure (increased) in the involved compartment
3. Diagnosis is made by measuring the compartment pressure. Several commercial devices are available for this purpose.
a. Normal compartmental pressure is 0
b. Compartmental pressures <15 mmHg are generally safe. Pressures of 20-30 mmHg may cause damage if they persist for several hours. Pressures of 30-40 mmHg are considered grounds for fasciotomy.
c. Treatment is emergent fasciotomy of the involved muscle group.
d. Complications include rhabdomyolysis and hyperkalemia (especially with large muscle groups). If improperly treated, loss of nerve and muscle function resulting in ischemic contracture can occur.

III. FRACTURE IMMOBILIZATION

A. Basic principles

1. For injured joints, provide ample length above and below the joint to immobilize it.
2. For midshaft fractures, immobilize the joint above and the joint below the fracture.

<table>
<thead>
<tr>
<th>TABLE 267-3 Immobilization Devices and Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immobilization Technique</td>
</tr>
<tr>
<td>Shoulder immobilizer</td>
</tr>
<tr>
<td>Sling</td>
</tr>
<tr>
<td>Long-arm gutter</td>
</tr>
<tr>
<td>Sugar-tong</td>
</tr>
<tr>
<td>Short-arm gutter</td>
</tr>
<tr>
<td>Thumb spica</td>
</tr>
<tr>
<td>Knee immobilizer</td>
</tr>
<tr>
<td>Posterior ankle mold (consider above-the-knee extension and/or adjacent use of ankle sugar-tong for unstable ankle injuries)</td>
</tr>
<tr>
<td>Ankle stirrup</td>
</tr>
</tbody>
</table>
IV. COMPLICATIONS OF FRACTURE IMMOBILIZATION

A. Casts

1. Tight cast
   a. Pain is the first and most reliable symptom
   b. Bivalve the cast and the cast padding. The bivalved cast can be replaced and held in place with an elastic bandage.
   c. A new cast should then be placed in 1 to 3 days

2. Cast sores
   a. Caused by indentation in the cast or a lack of padding
   b. Treat with cast removal and replacement with adequate padding

3. Cast cuts
   a. Occur at the cast ends
   b. Treat with bending the cast ends away from the skin with pliers.

4. Itching under the cast
   a. Treat with oral antipruritic agents or blowing hot air under the cast with a blow dryer.
   b. DO NOT try to scratch under the cast (e.g., with a coat hanger).

B. External fixation

1. Pin site infections
   a. Release the skin around the pin with a scalpel, obtain cultures, clean and irrigate and begin antibiotics (i.e., a first generation cephalosporin).

2. Pin loosening in the bone frequently occurs and warrants orthopedic consultation.

C. Internal fixation

1. Infection is always a potential early complication, and more common after treatment of an open fracture. Treatment involves antibiotics and possible removal of the hardware.

V. SEPTIC ARTHRITIS

A. More common in children under 3 years, the elderly, patients with HIV and chronic debilitating illnesses and those taking immunosuppressive medications, IV drug abusers and patients with prosthetic joints, and after arthrocentesis.

B. Bacterial pathogens reach joint spaces by hematogenous spread (most common), direct inoculation, and by direct spread from bony
or soft tissue infection.

C. Staph aureus is the most common pathogen across all age groups.

D. Neisseria gonorrhea is a common cause in young adults, and usually causes a polyarthritis.

E. Diagnosis

1. Patients usually complain of a painful joint, made acutely worse with movement. The joint is typically swollen and hot.
2. Fever, usually low grade, is present in the majority of cases.
3. Approximately 50% of patients have a serum WBC over 15,000. An elevated ESR, while nonspecific, is present 90% of the time, with mean values ranging from 68 to 82 mm/h.
4. Definite diagnosis is by arthrocentesis
   a. WBC is usually elevated - over 50,000 /mm3 in 50%-70% of patients. The percentage of PMNs is usually higher than 85%.
   b. Gram stain will show bacteria 50%-70% of the time.
   c. Synovial fluid glucose is typical less than 50.
   d. Synovial fluid culture will grow the responsible pathogen approximately two-thirds of the time. Blood cultures are positive in less than half of all cases.

F. Treatment

1. Hospitalization for incision and irrigation of the joint and IV antibiotics
2. Empiric antibiotics:
   a. Under 3 months: Nafcillin or oxacillin plus a 3rd generation Cephalosporin
   b. 3 months to 14 years: Vancomycin plus a 3rd generation Cephalosporin
   c. 15 years to 39 years: Ceftriaxone plus Vancomycin
   d. Over 40 years: Nafcillin or Vancomycin
3. Delay in diagnosis and treatment results in destruction of the articular cartilage.

VI. DISLOCATIONS

A. Sternoclavicular

1. Relatively rare
2. Anterior dislocation is more common than posterior
3. Posterior dislocations can be associated with life threatening injuries in the mediastinum
4. Pain with movement of the arm or lateral compression of the
shoulders.

5. Plain X-rays may be difficult to interpret; CT is the study of choice

6. Treat with closed reduction
   a. Posterior dislocations should ideally be reduced in the OR

B. Acromioclavicular

1. Most occur in young males
2. Usually caused by a direct blow to the point of the shoulder while the arm is adducted
3. Non displaced sprains and those with minimal displacement (<5mm) can be treated with a sling
4. Displaced injuries may require surgical repair, often for cosmetic reasons

![Image of mechanisms producing anterior and posterior dislocations of the sternoclavicular joint](Image)

![Image of reduction of dislocated sternoclavicular joints](Image)

C. Shoulder (the most commonly dislocated major joint)

1. Anterior dislocations (95% of all shoulder locations)
   a. The most common mechanism is a posterior-to-anterior force applied to an abducted, extended arm.
   b. Axillary nerve injury may occur (5%-54%) with resultant anesthesia over the lateral aspect of the shoulder and deltoid
weakness. Rotator cuff tears occur in 10%-15%.
c. 11% to 50% will have a Hill-Sachs deformity of the humeral head, 5% have a fracture of the anterior glenoid rim, and 10%-15% have an avulsion fracture of the greater tuberosity.
d. After reduction, immobilize with a sling and swathe.
e. Recurrence is very common (79%-100%).

2. Posterior dislocations (2% of all shoulder dislocations)
a. Classically caused by seizures or electrocution. Also, a fall on an outstretched, adducted arm
b. 50% are missed on initial evaluation.
c. Arm is held adducted and internally rotated.
d. Findings on AP X-rays can be subtle. Transscapular (“Y view”) and axillary views confirm the diagnosis.
e. Fractures of the glenoid rim, greater and lesser tuberosity and humeral may occur. Neurovascular injury is rare.

3. Luxatio Erecta (rare)
a. Arm is locked over head.
b. Almost always associated with tears of the rotator cuff
c. Injury to the axillary artery and brachial plexus may occur.

D. Elbow

1. Posterior dislocations (most common)
2. Cause by a fall on an outstretched hand
3. Injuries of the brachial artery occur in up to 8% of cases
4. Median nerve injury may also occur
5. Most can be reduced in the ED, then discharged with a posterior splint and sling
6. Medial and lateral dislocations occur by the same mechanism as posterior dislocations and have similar complications and treatment
7. Anterior dislocations (rare)
   a. Frequently open
   b. Have a high incidence of vascular injury.

VII. FRACTURES

A. Clavicle

1. The most commonly fractured bone during childhood.
2. 80% occur in the middle 1/3 of the bone.
3. Caused by a direct force applied to the lateral aspect of the shoulder
4. Most can be treated with a sling.
   a. Associated neurovascular injury is rare.
   b. Fractures of the distal clavicle with displacement may require operative intervention

B. Scapula

1. Relatively rare.
2. Usually due to MVAs or falls.
3. 80% have associated injury to the lung, chest wall or shoulder girdle.
4. Most are treated with a sling.
5. Surgical intervention may be necessary with displaced fractures of the glenoid, acromion or coracoid.
C. Humerus

1. Proximal humerus
   a. Typically occur in elderly, osteoporotic women.
   b. Often due to a fall on an outstretched arm and hand
   c. Most (85%) are minimally displaced.
   d. Fracture lines tend to occur across old epiphyseal lines (i.e., the anatomic neck, the greater and lesser tuberosities and the surgical neck)
   e. Injury to the brachial plexus (most commonly the axillary nerve) and axillary artery can occur, especially with displaced fractures of the surgical neck.
   f. Minimally displaced fractures (85%) can be treated with sling and swathe.
   g. Significantly displaced (>1cm) or angulated (>45º) fractures, as well as fractures involving multiple parts of the proximal humerus may require surgical repair.
   h. Adhesive capsulitis (“frozen shoulder”) is the most common complication. Avascular necrosis of the humeral head may occur with displaced fractures of the anatomic neck.
2. **Humeral shaft**
   a. Typical occur in young, active men and elderly, osteoporotic women.
   b. Often due to a direct blow or a fall on an outstretched hand with a torsional force.
   c. The most common site of fracture is the middle third.
   d. Concomitant injury to the axillary artery or vein, or the radial, ulnar or median nerves (most often the radial nerve) may occur.
   e. The vast majority are treated nonoperatively.
   f. Most can be treated in the ED with a sling and swathe. Other options include a “sugar-tong” splint or a hanging cast for grossly displaced fractures.
D. Elbow

1. Since many elbow fractures may be subtle, close inspection of the lateral elbow film for abnormal fat pads (signifying intraarticular hemorrhage) is very important. The presence of any posterior fat pad or an abnormally large anterior fat pad (i.e., the “sail sign”) usually indicates the presence of intraarticular skeletal injury.

2. Several important neurovascular structures lie in close proximity to the elbow joint (i.e. the brachial artery and the median, radial and ulnar nerves). Evaluation of their function is important after any elbow injury.

3. Intercondylar T or Y fractures (see picture on page 14)
   a. Caused by direct trauma to the elbow that drives the olecranon against the humeral articular surface, splitting the distal end.
   b. Usually associated with severe soft tissue injury, and notoriously difficult to treat.
   c. Most require ORIF to reestablish articular surface congruity.
   d. Patients with severe edema or displaced fractures should be admitted.
4. Epicondyle fractures
   a. Lateral epicondyle fractures are extremely rare
   b. Medial epicondyle fractures in adults are usually caused by a direct blow
   c. Use of forearm flexors causes pain
   d. Concomitant ulnar nerve injury can occur
   e. Minimally displaced fractures can be treated with a posterior mold; displaced fractures may require operative repair; intraarticular fragments are an indication for surgery

5. Trochlea fractures usually occur in the setting of posterior elbow dislocations. Displaced fractures should be treated with internal fixation.

6. Capitellum fractures also occur primarily with posterior elbow dislocations and frequently are associated with a radial head fracture. As with the trochlea, displaced fractures should be treated with internal fixation.

7. Radial head fractures are the most common fracture of the elbow.
   a. Usually from a fall on an outstretched hand
   b. Often associated with other elbow injuries, like capitellum fractures and elbow dislocations
   c. May be difficult to see on standard X-rays. May only be seen as an abnormal radiocapitellar line or an abnormal fat pad.

![Distal humerus](image)

**FIG. 270-8.** The radiocapitellar line. On lateral views a line drawn through the center of the radius transects the radial head and middle third of the capitellum. This relationship is lost even in subtle fractures.
8. Olecranon fractures are most commonly the result of a direct blow. They can also occur by a fall on an outstretched hand with the elbow in flexion and the triceps contracting.

   a. A significant percentage of these are open fractures.
   b. Triceps function, as tested by elbow extension, is usually impaired.
   c. Associated ulnar nerve injury is common.
   d. Best seen on lateral view elbow X-rays.
   e. ED management involves immobilization with the elbow in flexion.
   f. Displaced fractures usually require ORIF.

E. Forearm

1. The radius and ulna are joined together along their entire length by a tough interosseous membrane. Because of this close relationship, injury to one bone usually has a direct effect on the other (i.e., a displaced or angulated fracture of one bone causes a dislocation at the proximal or distal radioulnar joint).
   a. Nerve injuries are uncommon with most closed fractures.
   b. Due to collateral circulation, vascular compromise is unlikely if either the ulnar or radial artery remains intact.
   c. Forearm fractures are at relatively high risk for compartment syndrome.
   d. Most displaced forearm fractures will require operative reduction and internal or external fixation.
2. Ulnar shaft fractures ("Nightstick fractures")
   a. Due to a direct blow
   b. Non displaced fractures can be treated with a long arm posterior splint. Displaced fractures require ORIF.
      i. X-rays of displaced fractures should be scrutinized for any evidence of fracture or dislocation of the radius

3. Monteggia fracture – dislocation
   a. Fracture of the ulnar shaft with a radial head dislocation. The majority of the time, it’s a fracture of the proximal third of the ulna with an anterior dislocation of the radial head.
   b. Typically due to a forced pronation of the forearm during a fall on an outstretched hand.
   c. The radial head dislocation may be subtle and noted only as a disruption of the radiocapitellar line
   d. Treatment is with ORIF.
4. Galeazzi fracture  
   a. Fracture of the distal third of the radial shaft with a dislocation of the distal radioulnar joint.  
   b. Usually due to a fall on an outstretched hand with the forearm pronated  
   c. The ulna is displaced dorsally on the lateral view X-ray. The majority will also have an ulnar styloid fracture.  
      i. Treatment is with ORIF.

VIII. SOFT TISSUE INJURIES

A. Rotator cuff tears

1. May be acute (10%) or chronic (90%).  
2. Acute tears are typically traumatic, usually due to forced abduction with significant resistance (i.e., catching a falling
heavy object) or an anterior shoulder dislocation.
3. Chronic tears are almost always due to repeated compression of the rotator cuff in the subacromial space caused by repetitive overhead use of the arm.
4. Physical exam is the key to diagnosis
5. Disuse atrophy may be present with chronic tears.
6. Weakness and pain are present with active abduction and external rotation of the upper arm.
7. The drop arm test is positive if the patient is unable to hold or lower a fully extended arm at 90 degrees shoulder abduction without dropping it.
8. Treatment in the ED includes support with a sling, ice and NSAIDs.
9. Complete tears (usually a MRI diagnosis) typically require surgical repair.

B. Bicep tendon rupture

1. The vast majority occur in the proximal portion of the long head
2. Typically occurs in middle-aged patients with a history of chronic bicipital tenosynovitis
3. Usually described as a pop or snap during contraction against resistance
4. Presents with pain over the anterior shoulder and a “Popeye” appearance of the arm due to distal retraction of the muscle. Active flexion is still possible due to the coracobrachialis and the short head.
5. Treat with ice, sling and analgesics
6. Surgical repair is usually indicated for young active patients.
C. Tennis elbow (epicondylitis)

1. Most involve the lateral epicondyle; thought involvement of the medial epicondyle can occur.
2. Seen in patients whose occupations require repetitive rotary motion at the elbow, such as pipe fitters and carpenters.
3. Caused by tears in the aponeurosis of the involved tendons or microavulsion fractures of the epicondyle.
4. The main symptom is a dull ache of the involved epicondyle, aggravated by grasping or twisting motions.
5. Treat by splinting with the elbow flexed, heat and NSAIDs.
UPPER EXTREMITY TRAUMA

PEARLS

1. Most open fractures require debridement and irrigation in the O.R.

2. The longer a joint remains dislocated, the more difficult it will be to reduce and the more likely it is to be unstable after reduction.

3. Pain out of proportion to the injury is the earliest and most significant finding with compartment syndromes.

4. Midshaft fractures of a bone should have the joint above and the joint below the fracture included in the immobilization.

5. Staph aureus is the most common pathogen in septic arthritis across all age groups. N. gonorrhea is a common cause in young adults.

6. Axillary nerve injury and rotator cuff tears may occur with anterior shoulder dislocations.

7. Transscapular (“Y view”) and axillary views of the shoulder are necessary to confirm the diagnosis of posterior shoulder dislocation.

8. Posterior dislocations of the elbow are the most common type, and may have an associated brachial artery or median nerve injury.

9. Clavicle fractures, the most common fracture of childhood, can usually be treated with a sling alone.

10. A high percentage (80%) of scapular fractures have an associated injury to the lung, chest wall or shoulder girdle.

11. Proximal humerus fractures typically occur in elderly women and can usually be treated with a sling and a swathe.

12. The radial nerve is the one most commonly injured with humeral shaft fractures.

13. The presence of any posterior fat pad or an abnormally large anterior fat pad on a lateral elbow X-ray indicates the presence of a fracture (radial head fracture in adult, supracondylar fracture in children).

14. Radial head fractures, while the most common fracture of the elbow, may be very difficult to detect on standard X-rays. Look for posterior fat pad or anterior fat pad “sail sign"
15. Olecranon fractures usually present with impairment of triceps function and are frequently complicated by ulnar nerve injury.

16. Due to the interosseus membrane, a fracture of one of the paired forearm bones usually results in dislocation of a common joint. These fracture-dislocations are unstable and require ORIF.

17. The majority of rotator cuff tears are chronic and typically present with weakness and pain on active abduction.

18. Bicep tendon ruptures usually occur during contraction against resistance and present with a “Popeye” appearance (due to distal retraction of the muscle) of the upper arm.

19. Tennis elbow (epicondylitis) occurs in patients whose occupations require repetitive rotary motions of the elbow, and present with pain and tenderness of the involved epicondyle.
REFERENCES


8/10