Upper extremity injuries

Topics

- Clavicle
- Shoulder Dislocation
- Humerus
- Elbow
- Forearm
- Distal Radius

Clavicle Fractures

- Mechanism
  - Fall onto shoulder (87%)
  - Direct blow (7%)
  - Fall onto outstretched hand (6%)
- Trimodal distribution
  The clavicle is the last ossification center to complete (sternal end) at about 22-25 yo.
- Clinical Evaluation
  - Inspect and palpate for deformity/abnormal motion
  - Thorough distal neurovascular exam
  - Auscultate the chest for the possibility of lung injury or pneumothorax
- Radiographic Exam
  - AP chest radiographs.
  - Clavicular 45deg A/P oblique X-rays
  - Traction pictures may be used as well
- Allman Classification of Clavicle Fractures
  - Type I Middle Third (80%)
  - Type II Distal Third (15%)
    - Differentiate whether ligaments attached to lateral or medial fragment
  - Type III Medial Third (5%)
- Closed Treatment
  - Sling immobilization for usually 3-4 weeks with early ROM encouraged
- Operative intervention
  - Fractures with neurovascular injury
  - Fractures with severe associated chest injuries
  - Open fractures
  - Group II, type II fractures
  - Cosmetic reasons, uncontrolled deformity
  - Nonunion
- Associated Injuries
  - Brachial Plexus Injuries
    - Contusions most common, penetrating (rare)
  - Vascular Injury
  - Rib Fractures
  - Scapula Fractures
  - Pneumothorax

Shoulder Dislocations

- Epidemiology
  - Anterior: Most common
  - Posterior: Uncommon, 10%, Think Electrocutions & Seizures
  - Inferior (Luxatio Erecta): Rare, hyperabduction injury
- Clinical Evaluation
  - Examine axillary nerve (deltoid function, not sensation over lateral shoulder)

    - Examine M/C nerve (biceps function and anterolateral forearm sensation)
- Radiographic Evaluation
    - True AP shoulder
    - Axillary Lateral
    - Scapular Y
    - Stryker Notch View (Bony Bankart)
- Anterior Dislocation Recurrence Rate
    - Age 20: 80-92%
    - Age 30: 60%
    - > Age 40: 10-15%
- Look for Concomitant Injuries
    - Bony: Bankart, Hill-Sachs Lesion, Glenoid Fracture, Greater Tuberosity Fracture
    - Soft Tissue: Subscapularis Tear, RCT (older pts with dislocation)
    - Vascular: Axillary artery injury (older pts with atherosclerosis)
    - Nerve: Axillary nerve neuropraxia

<u>Classification</u>

- Anterior Dislocation
    - Traumatic
    - Atraumatic (Congenital Laxity)
    - Acquired (Repeated Microtrauma)
- Posterior Dislocation
    - Adduction/Flexion/IR at time of injury
    - Electrocution and Seizures cause overpull of subscapularis and latissimus dorsi
    - Look for «lightbulb sign» and «vacant glenoid» sign
    - Reduce with traction and gentle anterior translation
- Inferior Dislocations (Luxatio Erecta)
    - Hyperabduction injury
    - Arm presents in a flexed «asking a question» posture
    - High rate of nerve and vascular injury
    - Reduce with in-line traction and gentle adduction

<u>Treatment</u>

    - Nonoperative treatment
        - Closed reduction should be performed after adequate clinical evaluation and appropriate sedation
    - Reduction Techniques:
        - Traction/countertraction - Generally used with a sheet wrapped around the patient and one wrapped around the reducer.
        - Hippocratic technique - Effective for one person. One foot placed across the axillary folds and onto the chest wall then using gentle internal and external rotation with axial traction
        - Stimson technique - Patient placed prone with the affected extremity allowed to hang free. Gentle traction may be used
        - Milch Technique - Arm is abducted and externally rotated with thumb pressure applied to the humeral head
        - Scapular manipulation
- Postreduction
    - Post reduction films are a must to confirm the position of the humeral head
    - Pain control
    - Immobilization for 7-10 days then begin progressive ROM
- Operative Indications
    - Irreducible shoulder (soft tissue interposition)
    - Displaced greater tuberosity fractures
    - Glenoid rim fractures bigger than 5 mm

- Elective repair for younger patients

Proximal Humerus Fractures

- Epidemiology
  - Most common fracture of the humerus
  - Higher incidence in the elderly, thought to be related to osteoporosis
  - Females 2:1 greater incidence than males
- Mechanism of Injury
  - Most commonly a fall onto an outstretched arm from standing height
  - Younger patient typically presents after high energy trauma such as MVA
- Clinical Evaluation
  - Patients typically present with arm held close to chest by contralateral hand. Pain and crepitus detected on palpation
  - Careful NV exam is essential, particularly with regards to the axillary nerve. Test sensation over the deltoid. Deltoid atony does not necessarily confirm an axillary nerve injury
- Neer Classification
  - Four parts
    - Greater and lesser tuberosities,
    - Humeral shaft
    - Humeral head
  - A part is displaced if >1 cm displacement or >45 degrees of angulation is seen
- Treatment
  - Minimally displaced fractures - Sling immobilization, early motion
  - Two-part fractures -
    - Anatomic neck fractures likely require ORIF. High incidence of osteonecrosis
    - Surgical neck fractures that are minimally displaced can be treated conservatively. Displacement usually requires ORIF
  - Three-part fractures
    - Due to disruption of opposing muscle forces, these are unstable so closed treatment is difficult. Displacement requires ORIF.
  - Four-part fractures
    - In general, for displacement or unstable injuries ORIF in the young and hemiarthroplasty in the elderly and those with severe comminution. High rate of AVN (13-34%)

Humeral Shaft Fractures

- Mechanism of Injury
  - Direct trauma is the most common especially MVA
  - Indirect trauma such as fall on an outstretched hand
  - Fracture pattern depends on stress applied
    - Compressive - proximal or distal humerus
    - Bending - transverse fracture of the shaft
    - Torsional - spiral fracture of the shaft
    - Torsion and bending - oblique fracture usually associated with a butterfly fragment
- Clinical evaluation
  - Thorough history and physical
  - Patients typically present with pain, swelling, and deformity of the upper arm
  - Careful NV exam important as the radial nerve is in close proximity to the humerus and can be injured
- Radiographic evaluation

    - AP and lateral views of the humerus
    - Traction radiographs may be indicated for hard to classify secondary to severe displacement or a lot of comminution
- Conservative Treatment
    - Goal of treatment is to establish union with acceptable alignment
    - >90% of humeral shaft fractures heal with nonsurgical management
        - 20 degrees of anterior angulation, 30 degrees of varus angulation and up to 3 cm of shortening are acceptable
        - Most treatment begins with application of a coaptation spint or a hanging arm cast followed by placement of a fracture brace
- Operative Treatment
        - Indications for operative treatment include inadequate reduction, nonunion, associated injuries, open fractures, segmental fractures, associated vascular or nerve injuries
        - Most commonly treated with plates and screws but also IM nails
- Holstein-Lewis Fractures
    - Distal 1/3 fractures
    - May entrap or lacerate radial nerve as the fracture passes through the intermuscular septum

Elbow Dislocations

- Epidemiology
    - Accounts for 11-28% of injuries to the elbow
    - Posterior dislocations most common
    - Highest incidence in the young 10-20 years and usually sports injuries
- Mechanism of injury
    - Most commonly due to fall on outstretched hand or elbow resulting in force to unlock the olecranon from the trochlea
    - Posterior dislocation following hyperextension, valgus stress, arm abduction, and forearm supination
    - Anterior dislocation ensuing from direct force to the posterior forearm with elbow flexed
- Clinical Evaluation
    - Patients typically present guarding the injured extremity
    - Usually has gross deformity and swelling
    - Careful NV exam in important and should be done prior to radiographs or manipulation
    - Repeat after reduction
- Radiographic Evaluation
    - AP and lateral elbow films should be obtained both pre and post reduction
    - Careful examination for associated fractures
- Treatment
    - Posterior Dislocation
        - Closed reduction under sedation
        - Reduction should be performed with the elbow flexed while providing distal traction
        - Post reduction management includes a posterior splint with the elbow at 90 degrees
        - Open reduciton for severe soft tissue injuries or bony entrapment
    - Anterior Dislocation
        - Closed reduction under sedation
        - Distal traction to the flexed forearm followed by dorsally direct pressure on the volar forearm with anterior pressure on the humerus

- Associated injuries
    - Radial head fx (5-11%)
    - Treatment
        - Type I - Conservative
        - Type II/III - Attempt ORIF vs. radial head replacement
        - No role for solely excision of radial head in 2006.
    - Coronoid process fractures (5-10%)
    - Medial or lateral epicondylar fx (12-34%)
- Instability Scale
    - Type I
        - Posterolateral rotary instability, lateral ulnar collateral ligament disrupted
    - Type II
        - Perched condyles, varus instability, ant and post capsule disrupted
    - Type III
        - A: posterior dislocation with valgus instability, medial collateral ligament disruption
        - B: posterior dislocation, grossly unstable, lateral, medial, anterior, and posterior disruption

Forearm Fractures

- Epidemiology
    - Highest ratio of open to closed than any other fracture except the tibia
    - More common in males than females, most likely secondary mva, contact sports, altercations, and falls
- Mechanism of Injury
    - Commonly associated with mva, direct trauma missile projectiles, and falls
- Clinical Evaluation
    - Patients typically present with gross deformity of the forearm and with pain, swelling, and loss of function at the hand
    - Careful exam is essential, with specific assessment of radial, ulnar, and median nerves and radial and ulnar pulses
    - Tense compartments, unremitting pain, and pain with passive motion should raise suspicion for compartment syndrome
- Radiographic Evaluation
    - AP and lateral radiographs of the forearm
    - Don’t forget to examine and x-ray the elbow and wrist
- Ulna Fractures
    - These include nightstick and Monteggia fractures
    - Monteggia denotes a fracture of the proximal ulna with an associated radial head dislocation
        - Monteggia fractures classification - Bado
        - Type I - Anterior Dislocation of the radial head with fracture of ulna at any level - produced by forced pronation
        - Type II - Posterior/posterolateral dislocation of the radial head- produced by axial loading with the forearm flexed
        - Type III - Lateral/anterolateral dislocation of the radial head with fracture of the ulnar metaphysis- forced abduction of the elbow
        - Type IV- anterior dislocation of the radial head with fracture of radius and ulna at the same level- forced pronation with radial shaft failure
- Radial Diaphysis Fractures
    - Fractures of the proximal two-thirds can be considered truly isolated
    - Galeazzi or Piedmont fractures refer to fracture of the radius with disruption of the distal radial ulnar joint

    - A reverse Galeazzi denotes a fracture of the distal ulna with disruption of radioulnar joint
- Mechanism
    - Usually caused by direct or indirect trauma, such as fall onto outstretched hand
    - Galeazzi fractures may result from direct trauma to the wrist, typically on the dorsolateral aspect, or fall onto outstretched hand with pronation
    - Reverse Galeazzi results from fall with hand in supination

Distal Radius Fractures

- Epidemiology
    - Most common fractures of the upper extremity
    - Common in younger and older patients. Usually a result of direct trauma such as fall on out stretched hand
    - Increasing incidence due to aging population
- Mechanism of Injury
    - Most commonly a fall on an outstretched extremity with the wrist in dorsiflexion
    - High energy injuries may result in significantly displaced, highly unstable fractures
- Clinical Evaluation
    - Patients typically present with gross deformity of the wrist with variable displacement of the hand in relation to the wrist. Typically swollen with painful ROM
    - Ipsilateral shoulder and elbow must be examined
    - NV exam including specifically median nerve for acute carpal tunnel compression syndrome
- Radiographic Evaluation
  3 view of the wrist including AP, Lat, and Oblique
- Eponyms
    - Colles Fracture
        - Combination of intra and extra articular fractures of the distal radius with dorsal angulation (apex volar), dorsal displacement, radial shift, and radial shortenting
        - Most common distal radius fracture caused by fall on outstretched hand
    - Smith Fracture (Reverse Colles)
        - Fracture with volar angulation (apex dorsal) from a fall on a flexed wrist
    - Barton Fracture
        - Fracture with dorsal or volar rim displaced with the hand and carpus
    - Radial Styloid Fracture (Chauffeur Fracture)
        - Avulsion fracture with extrinsic ligaments attached to the fragment
        - Mechanism of injury is compression of the scaphoid against the styloid
- Treatment
    - Displaced fractures require and attempt at reduction.
        - Hematoma block-10ccs of lidocaine or a mix of lidocaine and marcaine in the fracture site
        - Hang the wrist in fingertraps with a traction weight
        - Reproduce the fracture mechanism and reduce the fracture
        - Place in sugar tong splint
    - Operative Management
        - For the treatment of intraarticular, unstable, malreduced fractures.
        - As always, open fractures must go to the OR.

Upper Extremity Injuries in the Pediatric Population

Overview

- Birth traumas
  - Clavicular Fracture
  - Klumpke's Palsy
  - Erb's Palsy
- Fractures
  - Not related to abuse
  - Torus, Greenstick, and Supracondylar types
  - Salter-Harris Classification
- Sprains and Strains
- Nursemaid's Elbow

Clavicular Fracture

- Most common bone fractured during delivery
- Complete fracture symptoms include:
  - Decreased or absent movement
  - Gross deformity of the clavicle
  - Tenderness on palpation
  - Localized crepitus
  - Absence of Moro's reflex
- Greenstick (partial) fractures have no symptoms initially and the diagnosis is made at 7 to 10 days postpartum because of callus formation

Klumpke's Palsy

- Involves the lower arm
- Affects the C7, C8, and T1 nerve roots
- Hand is paralyzed and has an absent grasp reflex
- Causes a "claw hand" deformity
- Rare to have an isolated Klumpke's palsy
- Often accompanied by Horner's syndrome
  - P = Ptosis
  - A = Anhidrosis
  - M = Miosis

Erb's Palsy aka Erb-Duchenne

- Involves the upper arm
- Most common type of palsy during birth
- Involves C5 and C6 nerve roots
- Arm is adducted and internally rotated, but the grasp reflex is intact

Treatment for Palsy

- Symptoms resolve by two years in most cases
- Treatment involves early immobilization with passive movement in order to prevent contractures, followed by physical therapy with active range of motion exercises
- In severe cases, surgery may be required to replace nerves that are refractory to healing

Torus Fracture

- AKA buckle fracture
- Impact injury in which the bone cortex is buckled but not disrupted
- Acute angulation of the cortex is noted, as opposed to the usual curved surface
- Stable
- Often best visualized on lateral view
- Soft tissue changes may be the only indication of fracture (ie pronator fat pad)

Greenstick Fracture
Angulation beyond the limits of plastic deformation
Incomplete fracture in which the cortex is disrupted only on one side
Represents bone failure (fracture) on the tension side and a plastic (or bend) deformity on the compression side
Like breaking a green stick, hence the name

Supracondylar Fracture
- Distal humerus just above the epicondyles
- Most common fracture in children
- Associated with ligamentous laxity
- Extension or Flexion
    - Extension (80% of cases) – distal fragment is displaced posteriorly
    - Flexion (20%) – distal fragment is displaced anteriorly
- Degree of separation
    - Type I – undisplaced or minimally displaced
    - Type II – partially displaced
    - Type III – fully displaced
- H/o falling on an outstretched hand followed by pain, swelling, and inability to move the affected elbow
- Neurovascular complications can result in compartment syndrome
    - Involves entrapment, spasm, and/or compression of the brachial artery
    - Compression of the median nerve also involved
    - Lack of pulse/circulation results in lack of reperfusion of tissues and possible necrosis
    - If left untreated, brachial artery injury can lead to Volkmann's contracture
        - Permanent flexion contracture of the hand at the wrist, resulting in a claw-like deformity of the hand and fingers
        - Secondary to necrosis of the flexor muscles of the forearm

Salter-Harris Fracture Classification of Growth Plate Injuries
- Type I: through the physis (growth plate only)
- Type II: through the metaphysis and physis
    - Common in distal radius
- Type III: through the epiphysis and physis
- Type IV: through the epiphysis, physis, and metaphysis
    - Most common site is lateral condyle of humerus
    - Can produce joint deformity and chronic disability
- Type V: crush injury of the physis
    - May appear as narrowing of the growth plate lucency but often not visible radiographically
    - May lead to premature fusion
    - Mechanism is axial compression

Sprains and Strains
- Sprain – injury to ligament
- Strain – injury to muscle-tendon unit
- Severity of signs and symptoms:
    - Grade I – pain, tenderness, no loss of motion
    - Grade II – pain, tenderness, ecchymosis, decreased ROM

    - Grade III – ligament is completely disrupted; pain, tenderness, edema, ecchymosis, joint instability, complete loss of ROM
- Management:
    - Goal of treatment is to decrease local edema and improve ROM
    - RICE therapy – rest, ice, compression, elevation
    - Protection may include joint immobilization and elastic (ie Ace) bandages
    - Splinting the affected joint protects against injury and relieves swelling and pain
    - Mobility exercises as pain and swelling subsides
    - NSAIDs as needed for analgesia

Nursemaid's Elbow

- Subluxation of the radial head
- Slippage of the head of the radius under the annular ligament
- Most common cause is axial traction
- H/o arm being pulled followed by sudden refusal to use the arm, in particular to supinate, and holding of the arm in a flexed, pronated position
- Diagnosis can often be made by history alone without the need for imaging studies
- To repair, the elbow is placed in full supination and slowly moved from full flexion to full extension
    - A click at the level of the radial head signifies reduction
    - Relief of pain is usually significant and occurs within minutes

Role of OMT

- Main objective of OMT is to encourage the body's natural ability to heal itself
- Restoring structure improves function
- In the acute setting, direct and active techniques are normally contraindicated (ie HVLA and ME)
- ST, MFR, CS, and lymphatic techniques can be utilized:
    - to reduce tension created by compensatory mechanisms the body employs to prevent further injury, thus reducing pain and swelling at both direct and referred sites
    - to increase circulation, which allows for better blood flow carrying oxygen and nutrients that can help increase the rate of healing

Upper extremity trauma usually involves a fracture of the shoulder or head of the humerus, dislocation of the humerus, humeral shaft fracture, elbow fracture, radial and ulnar fractures and wrist or hand fractures. Because a person in a motor vehicle accident often braces themselves with their hand, they fracture one or more bones in the upper extremity as the forces push into the hand from the motor vehicle accident and «give» somewhere along the course of the upper extremity. Upper extremity injuries can also include sprains and nerve injuries, such as carpal tunnel syndrome. Carpal tunnel syndrome occurs when the median nerve is impinged in the carpal tunnel of the wrist because of repetitive trauma or a sudden trauma that damages the carpal tunnel and causes impingement of the nerve.

Lower extremity trauma can be anything from a pelvic fracture, hip fracture, patellar fracture, tibia and fibula fracture, ankle fracture, or foot fracture. There can also be dislocations of the patella and the hip. Most of these injuries are caused by motor vehicle accidents. The force of the accident can cause the foot to brace in the footwell of the car, causing fractures of the long bones, the hip or the pelvis. The knee can be where the force originates, leading to things like «dashboard knee» or even a patellar fracture. The fractures can be displaced or nondisplaced, depending on the injury. Displaced fractures are more severe because the bony fracture segments are not in the correct position. They must be fixed by external reduction or internal reduction (in the operating room).

Nondisplaced fractures are easier to repair but still might need surgery for internal fixation of the fracture with plates, screws or rods, among other choices.

Causes of Extremity Fractures. Extremity fractures are common fractures that can be caused by any number of injurious conditions. They happen because of the following conditions:

- Automobile injuries
- Motorcycle accidents
- All-terrain vehicle accidents
- Falls from a great height
- Bicycle accidents
- Altercations
- Falls from a standing position
- Sports-related accidents

These things involve forces that can be so great they can cause an extremity sprain, strain or fracture, the most serious being a fracture.

Symptoms of an Extremity Fracture The symptoms of an extremity fracture vary widely according to the location of the fracture. The pain is usually located at the site of the injury, and there can be distal disruption of the nerves or blood vessels in any fracture that causes numbness, tingling or coldness to the part of the body distal to the fracture.

The main symptoms of an upper extremity fracture are:

- Pain and swelling in the affected area
- Obvious deformity at the site of the fracture
- Inability to effectively use the arm due to problems in the affected area
- Bruising, warmth, or redness of the affected area

The main symptoms of a lower extremity fracture include:

- Inability to walk on the affected leg
- Instability of the leg
- Deformity of the affected area
- Distal coolness, numbness or paralysis of the extremity
- Pain at the site of the fracture

It is up to the attending physician to take a thorough history and physical examination to find out the most obvious place of injury and proceed further with diagnostics.

Diagnosis of Extremity Injuries

The diagnosis of extremity injuries includes first doing a plain film x-ray on the affected area to look for fractures. Most fractures are easy to see on plain film x-ray. In situations in which a fracture is expected but not seen on plain film, a CT scan or MRI scan can look carefully at the bone so that non-displaced fractures can be seen. The MRI has the added advantage of being able to show any soft tissue damage or hematomas from the injury. If there is a suspected nerve injury, the doctor can use an electromyogram to check the nerve function of muscles distal to the injury. A nerve stimulation test can be done to see if the fracture or other injury had impinged on a nerve. Doppler ultrasound can assess the pulses distal to the injury to assess whether or not the arterial blood flow has been injured. This kind of injury requires emergent surgery to restore circulation to the affected arm or leg.

Treatment of Extremity Injuries

There are first aid and definitive treatment of extremity fractures. The first aid treatment of extremity injuries includes the following:

- Apply ice to the swollen or painful areas
- Do not move the extremity.
- Take Aleve, Advil, or Tylenol
- Brace the extremity if you have the tools for that.
- Activate EMS if needed for transport or for other injuries.

Once at the hospital or clinic, the patient needs to have a physical exam, history, and x-rays to determine the site of injury and makeup of fracture. The fracture can be treated with closed reduction and external casting, which is the easiest way to treat minor fractures. The doctor will use the X-rays to guide putting together the bony ends so that they are in anatomic configuration. In addition, the patient needs to use a splint or cast to keep the fracture in anatomic alignment for about 6 weeks. It's crucial to replace the cast if there is atrophy of the muscles making the cast not able to keep the fractured ends in anatomic alignment because the cast is too big. The doctor may rely on open reduction and internal fixation. This means doing surgery to put the fragments of bone into whatever alignment is most appropriate—hopefully completely anatomical. The surgery goes on to use hardware, such as an intramedullary rod, plates, and screws, or wires in order to fix the bone into place. There are multiple techniques for this that differ according to the part of the extremity and type of fracture involved. It will take about 3-6 weeks for the fracture to heal.

Complications of Extremity Fractures

Not all extremity fractures heal perfectly, and there can be long-term complications, including:

- Persistent deformity of the extremity
- Lack of complete function of the extremity
- Lack of nerve function distal to the injury
- Poor circulation past the injury
- Amputation secondary to failure of healing of the injury or severe crush injury.
