Forearm Fractures
Anatomy

- Forearm has very complex anatomy
- 6 articulations
- Combination of hinge, rotatory, and universal joints
- Radial bow critical to forearm rotation
- Provides stable base for spatial positioning of hand
Anatomy

- **Bony stabilizers of elbow**
  - Radiocapitellar articulation
  - Ulnohumeral articulation

- **Soft tissue stabilizers of elbow**
  - Medial ulnar collateral ligament (55% valgus stability at 90)
  - Lateral ulnar collateral ligament (9-14% varus stability flx → ext)
  - Anterior capsule
  - Annular ligament
  - Musculature
Anatomy

- Volar and dorsal radioulnar ligaments help stabilize DRUJ
- Interosseous membrane allows dynamic stabilization of radius and ulna during axial compression and somewhat during rotational activities
Muscular forces and unique, two-bone anatomy produce compression, angulation, and rotational deformities

- Biceps/supinator – exert rotational (supination) and angular (flexion) forces on proximal third radius fractures
- Pronator teres exerts rotational (pronation) and angular (central) forces across the midshaft level
- Pronator quadratus exerts similar forces to PT at the distal third
- Proximal muscle mass makes control of proximal fractures difficult
Deforming Forces

- Radius fractures occurring proximal to pronator insertion tend to assume apex volar angulation with proximal supination due to unopposed bicep/supinator pull.

- Radius fractures occurring distal to pronator insertion tend to maintain the proximal fragment in neutral while the distal fragment pronates.
Deforming Forces

- Isolated proximal third ulna fractures tend to assume apex radial deformities which can be very difficult to reduce.
- Fractures of the distal radius assume ulnarly angulated positions due to the pull of the long forearm and pronator quadratus muscles.
Approaches

- Radius
  - Thompson approach
    - Dorsal approach to radius
    - Recommended for approach to proximal and middle thirds of posterior surface of radius
    - Deep branch of radial nerve traverses supinator and must be protected
Approaches

- Posterolateral approach
  - Corresponds to distal limb of Kocher approach
  - Best approach for fractures involving radial head
  - Extensile proximally and distally
  - PIN fairly safe in this exposure but full pronation provides maximal protection
Approaches

- Anterior approach of Henry
- Allows access to entire volar shaft of radius
Approaches

- **Boyd approach**
  - Best for access to proximal third of ulna and fourth of radius
  - Excellent approach with proximal ulna fracture and concomitant radial head dislocation (Monteggia)
  - Provides access to proximal fourth of radius with less risk to deep branch of radial nerve
Nightstick/Simple Shaft Fractures

- Most often occur from direct blow
- Generally referred to as “nightstick” fractures
- May be simple or comminuted
- Deformity based on level of fracture:
  - Radial fracture deformation determined by level proximal/distal to pronator insertion
  - Ulnar fracture deformation determined by level proximal/distal to proximal third of bone
Nightstick Fractures

- **Treatment**
  - **Closed reduction**
    - Appropriate for children and for nondisplaced fractures in adults
    - Alignment of DRUJ, PRUJ, elbow and wrist articulations must be scrutinized
    - Long arm cast essential to control rotational forces
Nightstick Fractures

- **Treatment**
  - Intramedullary fixation
    - Triangular or star shaped nails with proximal/distal locking help control rotation
    - Completely internal
    - Discussed more fully in next section
  - ORIF
    - Rigid fixation
    - 3.5 DCP +/- locking required for stability
Nightstick Fractures

- **Treatment**
  - **ORIF**
    - Hole diameter must be less than 30% cortical diameter to reduce stress riser effect
    - Asymptomatic plate removal not recommended due to increased incidence of fracture
    - Plate removal not recommended prior to 6 months and preferably after 1-2 years
    - Immobilization/support required for 6-8 weeks following plate removal in order to prevent refracture through stress riser effect
Both Bone Fractures

- Occur with significantly more force than isolated fractures
- Often comminuted
- Soft tissue injury and compartment syndromes must be anticipated due to increased force transmission
Both Bone Fractures

- Muscle forces and soft tissue injury may produce significant deformity
- Must maintain anatomic relationship of elbow, DRUJ, PRUJ, wrist, and interosseous space in order to preserve function
- Malunion and non-union more common in this area due to presence of additional pro/supination forces that induce rotational and angular deformities
Both Bone Fractures

- Initial reduction essential for analysis of neurovascular status
- X-ray imaging may be difficult to interpret due to deformity
Both Bone Fractures

- Treatment depends on age and degree of displacement/comminution
  - Closed reduction
    - Majority of childhood fractures
    - Casting aimed at preservation of interosseous space through A/P compression
    - Contraindicated in adults with any degree of displacement
    - Instability demands fixation
Both Bone Fractures

- Treatment
  - ORIF
    - “gold standard”
    - Rigid plates (3.5 DCP +/- locking) required to maintain reduction and apposition
    - Pre-bending necessary to avoid loss of radial bow or length
    - Larger systems (4.5 DCP or greater) contraindicated due to stress riser effect of large diameter holes
Both Bone Fractures

- **Treatment**
  - Intramedullary fixation
    - Originally described with rounded or rigid nails with dismal results and nonunion rates approaching 20% (Smith/Sage 1957)
    - Sage Nail developed in 1959 heralded technological breakthrough by using triangular nail with resilient stainless steel
Both Bone Fractures

- Intramedullary fixation
  - Require intact cortex for stability
  - Locked and unlocked devices available
  - Must resist torsional stresses
  - May provide advantage in segmental fractures
Both Bone Fractures

- Intramedullary fixation
  - Portals for placement in distal radius and olecranon tip
  - Less rigid than plating, but completely internal
Galeazzi Fracture Dislocation

- Combination injury with distal third radial shaft fracture and DRUJ dislocation
- Referred to as “fracture of necessity” by Campbell
- Often go unrecognized
- DRUJ dislocation should be suspected with any displaced fracture of the distal third radial shaft
Galeazzi Fracture Dislocation

- Treatment through closed reduction and casting has high rate of unsatisfactory results
- ORIF through Henry approach recommended
- Fixation with 3.5 DCP is treatment of choice in adults
- Reduction of radial fracture often reduces DRUJ
- Postoperative immobilization in supination maintains reduction of DRUJ (+/- K-wire in joint)
Essex-Lopresti Fracture Dislocations

- Typically results from hard fall on outstretched hand
- Fracture of radial head, DRUJ disruption, and tear of interosseous membrane result
- Because of loss of tethering effect of interosseous membrane, subsequent radial head resection has devastating consequences
Essex-Lopresti Fracture Dislocations

- Must be suspected prior to performing surgical correction
- Pain in the DRUJ with displaced radial head/neck fracture should alert surgeon
- Treatment involves ORIF of radial head/neck versus replacement
- Newest radial head replacements are vitallium alloy and avoid silastic complications
- DRUJ reduced with forearm supination +/- k-wire
Monteggia Fracture Dislocations
Monteggia Fracture Dislocations

- Result from combination of ulna fracture with dislocation of radiohumeral articulation with or without radial fracture
- Can often be treated conservatively in children but required ORIF in adults
- Divided by Bado into four types based on ulnar angulation and direction of radius dislocation
Type I Monteggia Variant

- Fracture of the middle or proximal third of ulna
- Apex anterior fracture angulation
- Anterior dislocation of radial head
Type II Monteggia Variant

- Fracture of middle or proximal third of ulna
- Apex posterior angulation of fracture
- Posterior dislocation of radial head often includes fracture
Type III Monteggia Variant

- Ulna fracture just distal to coronoid process
- Apex radial fracture angulation
- Radially dislocated radius
Type IV Monteggia Variant

- Fracture of proximal or middle third of ulna
- Fracture of proximal third of radius distal to biceps insertion
- Anterior radius dislocation
Monteggia Fracture Dislocations

- Type I variant represents the majority of cases

- Treatment
  - ORIF of ulna fracture
  - Accurate ulna reduction often allows for spontaneous or manual closed reduction of radial head
  - Open reduction of radial head may be required if capsule or annular ligament become interposed
Monteggia Fracture Dislocations

Treatment

- If Open reduction of the radial head dislocation is required, repair or reconstruction of the annular ligament is required
- Old injuries (> 6 weeks) with unreduced radial head dislocations or malreduced ulna fractures leading to recurrent radial head dislocation
  - Best treated with radial head excision/replacement
  - Ulnar fracture reduced or osteotomized with rigid fixation
Monteggia Fracture Dislocations

- Postoperative management
  - Long arm posterior mold splint in 90 degrees or more for two weeks
  - Following suture removal at two weeks, another 2-4 weeks of long arm cast immobilization are required
  - Once cast removed, gentle pro/supination are allowed followed by gradual reintroduction of extension