Proximal Humerus Fractures

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Abbreviations

AN	Anatomical neck
CRPP	Closed reduction percutaneous pinning
GT	Greater tuberosity
IMN	Intramedullary nail
LT	Lesser tuberosity
ORIF	Open reduction internal fixation
SN	Surgical neck

Epidemiology

- Proximal humerus fractures are relatively rare and represent 4–5% of all fractures [1]:
  - The majority of proximal humerus fracture are not significantly displaced, and do not require surgery.
  - Can be associated with shoulder dislocation and rotator cuff tears.
- Patient population: Trauma, young individuals with high-velocity mechanism of injury, such as MVC
  - Associated injuries: soft tissue destruction, injuries to thorax such as rib fractures and pnuemothorax, and distracting injuries to other extremities
- Individuals >50 years of age with fall as mechanism of injury, osteoporotic bone
  - 4:1 Female to male ratio [11]

Anatomy

- The humeral head is retroverted 30–45° [6, 14].
- Deforming forces to the 4 osseous segments of the proximal head occur. Understanding the osseous segments and deforming forces is key to fracture classification and treatment.
  - *4 proximal humerus osseous segments:*
    - *Humeral head.*
    - *Lesser tuberosity (LT):* attachment site of the subscapularis tendon; will displace medially.
    - *Greater tuberosity (GT):* attachment site of supraspinatus, infraspinatus, and teres minor; will displace superiorly and posteriorly.
    - *Humeral shaft:* attachment site of deltoid, proximal segment will displace medially; attachment site for pectoralis major; shaft will displace medially [4, 6, 9, 11].
  - Other osteology:
    - *Anatomic neck (AN):* area below humeral articular surface, above tuberosities

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- *Surgical neck (SN):* begins at metaphyseal flare below tuberosities [6, 14]

– Neurovascular supply:
  - Vascular: rich vascular supply makes osteonecrosis secondary to fracture a rare complication
    – Anterior humeral circumflex artery: includes anterolateral ascending branch and terminal arcuate artery
      • *Pearl:* fractures of anatomic neck, "danger area" due to blood supply
    – Posterior humeral circumflex artery: runs in quadrangular space
      • May play a greater role in perfusion to humeral head than previously believed [1, 9, 14]
  - Neuro: Axillary nerve, more susceptible to injury with anterior dislocations
    – Course off posterior cord, anterior inferior to glenoid humeral joint, lies posterior to axillary artery, anterior to subscapularis muscle, then courses through quadrangular space with posterior humeral artery
      • Motor: deltoid and teres minor
      • Sensory: superficial lateral cutaneous nerve of arm [6, 9, 14]

Presentation and Evaluation

- Presentation: Patient may present with arm held close, swelling, tenderness, ecchymosis, and decreased range of motion
- Evaluation: a neurovascular exam is crucial, especially with respect to the axillary nerve:
  – Axillary nerve: motor may be unable to obtain secondary to pain, but sensation over lateral proximal arm and deltoid can be tested, Hornblower's test.
  – Distal upper extremity neurovascular exam should also be obtained and documented.
- Radiographs: 3 views
  – AP shoulder
  – Axillary
    - Velpeau and West point are alternative views if axillary unobtainable secondary to pain.
  – Scapular Y
  – CT scan: indicated for preoperative planning, fractures with significant intra-articular involvement, and fracture patterns where location of displaced tuberosity or humeral head is unclear on plain films [6, 4, 9, 11, 16]

Classification and Treatment

- Several different classification schemes have been created, but the Neer classification is the most commonly and consistently used system.
- *Neer classification*: based on humeral osseous segments, parts, and displacement (see Table 11.1)
  – *Part*: fragment with >1 cm displacement or 45° of angulation
    - One-part fractures are almost exclusively treated nonoperatively, whereas two-part and greater fractures generally have operative indications.
  – Valgus impacted: not in original Neer classification, four-part fracture, humeral articular surface impacted on shaft in valgus position [4, 6, 9, 11, 14, 16].
- Fracture-dislocations: occur, anterior most common, attempt closed reduction although may not be possible
- Nonoperative treatment
  – Closed reduction and sling immobilization 2–3 weeks (see section V.), surgeon preference for initiation of range or motion exercises.
  – Patient's age, pre-injury shoulder function, bone quality, compliance, activity level, dominance, occupation, and associated injuries should all be taken into account [4, 6].
- Operative treatment
  – CRPP (closed reduction percutaneous pinning)
  – ORIF plate fixation most common
    - locking screws options, possible fixation of rotator cuff with sutures through plate
    - IMN less commonly used

Table 11.1 Neer classification of proximal humerus fractures

Part	Description and segment(s)	Treatment
One (85%) [11] No displaced fragments, proximal humerus appears to be in "one part," can have several fracture lines present	Any proximal osseous segment	Nonoperative
Two	Surgical neck *Most common* [4, 9]	Operative, CRRP vs. ORIF based on fracture reducibility and bone quality
	Greater tuberosity *Anterior dislocation often associated*	Nonoperative and operative- operative treatment indicated for *>5 cm* displacement [4, 6, 7, 9]
	Lesser tuberosity *Rule out posterior dislocation*	Nonoperative and operative- closed reduction unless fragment prevents internal rotation, may need ORIF or excision of fragment
	Anatomic neck *Rare, higher incidence of osteonecrosis* [4, 9]	Operative, ORIF vs. hemiarthroplasty based on patient age and bone quality
Three Unstable, obtaining and maintaining reduction difficult	SN + GT Often associated with longitudinal rotator cuff tear	Operative, CRPP vs. ORIF
3–14% osteonecrosis	SN + LT Often has associated with longitudinal rotator cuff tear [1, 11]	Operative, CRPP vs. ORIF
Four-part 45% osteonecrosis [9]	Valgus impacted Less osteonecrosis, 11% [4], blood supply from posterior humeral circumflex artery maintained	Operative, ORIF, minimally displaced due to rotator cuff
	Articular surface and head splitting	Operative, ORIF vs. hemiarthoplasty based on patient age and bone quality, humeral head split

- Deltopectoral approach (shoulder anterior)
  - Positioning: supine with bump under medial scapula
  - Internervous plane: deltoid muscle and pectoralis major (axially nerve, medial and lateral pectoral nerve, respectively)
  - *Dangers:*
    1. Axillary nerve
    2. Musculocutaneous nerve
    3. Anterior circumflex artery
    4. Cephalic vein
- Deltoid splitting approach (shoulder lateral)
  - Positioning: supine with bump under ipsilateral scapula or "beach chair" with arm at edge of table
  - Internervous plane: no true plane, deltoid spilt
  - *Dangers:*
    1. Axillary nerve [1, 4, 6, 9, 11]
- *Pearl:* Axillary nerve runs 5–7 cm distal to tip of acromion [2].

- Arthroplasty: Hemiarthroplasty vs. reverse shoulder arthroplasty
  - Indicated for older patients with poor bone quality, complex fractures involving articular surface, and humeral head split [1, 6, 16]

- Nonunion
  - *Pearl:* Humeral height, the top of prosthesis head should sit 5.6 cm cephalad to tip of pectoralis major tendon insertion [12, 15].

Posttreatment Rehabilitation

- Frequent x-rays assure no increase in displacement, proper bone healing, and hardware placement.
- Sling or sling with abduction pillow.
- Begin motion early, advance in phases, surgeon preference:
  - Pendulum swings
  - Passive range of motion exercises, especially wrist and elbow
  - Active range of motion at 4–6 weeks
  - Resistance work at 6–12 weeks
  - Full function normally within 1 year [4, 6, 9, 11, 16]

Complications

- Axillary nerve injury
  - Initial injury: 5–30% complex fractures, especially with anterior fracture-dislocation [11]
  - Iatrogenic causes, lateral pin placement in CRPP [9]
- Vascular injury
- Osteonecrosis
- Nonunion
  - Treat with revision ORIF with allograft versus autograft bonegrafting, arthroplasty in older patients [1, 3, 5, 16]. Treatment based on patient level of pain, function, overall health.
- Malunion
  - Varus deformity in younger patient, treated with revision ORIF and osteotomy [13].
  - Greater tuberosity malunion treated with hemiarthroplasty [8].
- Infection
  - Rare due to rich vascular supply
  - *Pearl:* Propionibacterium infections may occur more with hemiarthroplasty [16].
- Adhesive capsulitis
- Myositis ossificans
- Stiffness and decreased range of motion
  - Secondary to prolonged immobilization
- Intra-articular screw penetration
  - Most common complication with locking plate use [10]

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