

# 근위 상완골 골절

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## PROXIMAL HUMERAL FRACTURES

- Incidence: Most proximal humeral fractures - minimally displaced  
20% - displaced fractures<sup>10</sup>
- More common with increasing age & osteoporosis
- Prognostic factor: associated soft tissue injury (neurovascular, rotator cuff), preexisting shoulder abnormalities, patient factors

## ANATOMY

- Four segments:
  - ”çGreater tuberosity ”éLesser tuberosity ”éArticular segment ”êHumeral shaft
- Vascular anatomy:
  - ”çAscending br. of Anterior humeral circumflex artery
    - supplies most of the articular segment
    - related with osteonecrosis
  - ”éPosterior humeral circumflex artery
    - posterior medial aspect of the humeral head & smaller part of the articular segment

## CLASSIFICATION

- Neer Four-part Classification System
  - : >45° angulation or >1 cm displacement (Greater tuberosity: >5 mm)
- AO/ASIF/OTA Comprehensive Long Bone Classification System
  - : Valgus impacted fracture - partial preservation of the vascularity to the articular segment unlike true four-part fractures.

## ASSOCIATED INJURIES

- Peripheral nerve injuries: More common with increasing age
  - Axillary nerve (most common), brachial plexus injury
- Vascular injuries: Rare, Axillary artery or vein

Distal pulse can be palpated even in vascular injury

## EVALUATION

- History: comorbid conditions, preexisting shoulder problems, mechanism of injury
- Physical examination
  - : Associated neurologic injury - Voluntary isometric muscle contraction
    - Sensory examination (can be misleading)
    - EMG/NCV (after 3 weeks)
- Radiographic examination
  - : Shoulder trauma series<sup>10)</sup>
    - True AP in the scapular plane, Scapular lateral view(Y view), Axillary lateral view
- CT, 3D-CT, MRI
- Intraoperative assessment of the fracture pattern

## TREATMENT

- Considering factor
  - fracture location and pattern
  - patient's factor (age, activity level, quality of bone, ability to comply with PT)

## NONSURGICAL TREATMENT

- Nondisplaced, impacted or stable fractures
  - : early range-of-motion exercises (within 2 to 4 weeks after the injury)
- Anterior greater tuberosity fracture-dislocation
  - : reduced anatomically with closed reduction
- The amount of acceptable displacement
  - Greater tuberosity displacement
    - : very little tolerance
    - Superior and posterior displacement
      - Impingement (> 5mm), athletes or labors in overhead activity (> 3mm)
  - Lesser tuberosity displacement
    - : Medial displacement
      - ∩ internal rotation weakness, block internal rotation, subcoracoid impingement
  - Surgical neck angulation
    - : directed apex anterolateral
      - ∩ limitation of shoulder elevation and abduction, subacromial impingement

## SURGICAL TREATMENT

- 20% of all proximal humeral fractures
- Goal: obtain nearly anatomic reduction and stable fixation to allow early range of motion<sup>9</sup>
- Less invasive open procedure (minimizing periarticular scarring, decreasing the risk of vascular insult to the articular humeral head segment)<sup>11-13</sup>

### *Treatment Method*

Closed reduction and Percutaneous pinning

- Two-part surgical neck fractures (best result), some three- or four-part fractures
- Early motion should be avoided
- Ix) acute injury(7~10 days old), good bone quality, minimal comminution
- CIx) comminuted, unstable fractures, severe osteopenia
- A retrograde lateral pin, a retrograde anterior pin, a retrograde anterolateral pin, an antegrade superolateral pin

## ORIF

- interosseous sutures or wires, pins, screws, plates and screws, intramedullary rods
- important to achieve both interfragmentary and axial stability without excessive soft-tissue dissection
- Medial comminution at the surgical neck or proximal shaft area
  - ∩æ difficult to maintain humeral length and the position of the articular segment
  - ∩æ varus malunion
- Articular segment fractures ? risk of arthritis, osteonecrosis
- Valgus impacted four-part fractures ? low risk of osteonecrosis after ORIF
- Plate and screw fixation
  - : high complication rate, particularly in elderly patients<sup>3</sup>, extensive soft tissue stripping
  - Fixed angle blade plate, locking anatomic proximal humeral plate

Humeral head replacement (Hemiarthroplasty or Total shoulder arthroplasty)

- Ix) Primary surgical option: most four-part fractures and fracture-dislocations, Head splitting fractures with more than 40% articular surface involvement, Anatomic neck fractures, Dislocations present for longer than 6 months, Selected three-part fractures with osteopenia, fragmentation of the articular surface and severe osteoporosis, especially comminuted fractures in the elderly
- Early prosthetic replacement of proximal humeral fractures has a better outcome than late prosthetic management<sup>2)</sup>.
- Late prosthetic surgery for failed early treatment is more technically difficult.
- Considering factor: risk of nonunion, malunion, osteonecrosis, bone quality, time from injury, need

for future surgery and revision.

- Prognostic factor: position of greater tuberosity, age, delay in time to treatment, presence of neurologic deficit
- Decision must be made on an individual basis considering several factors including patient age, expectation and anticipated result.

### Fracture Type

#### Isolated Fracture of the Greater Tuberosity

- Associated with an acute glenohumeral dislocation or a tear of the rotator cuff
- Usually reduced in a satisfactory position after reduction of the dislocation of the humeral head
- Nonsurgical treatment: < 5 mm of superior displacement, < 1 cm of posterior displacement
- Surgical technique:
  - ① superior deltoid splitting approach: small fracture fragments, fractures associated with cuff tear
  - ② deltopectoral approach: large fracture fragments with diaphyseal extension
  - ③ excision (< 2 cm size), ORIF(suture fixation, cancellous bone screw)
- Malunion: >5 mm superior displacement | ≈ subacromial impingement
  - Tx) Osteotomy and fixation of the tuberosity, Subacromial decompression and excision of the impinging fragment

#### Surgicak Neck Fracture

- High risk of malunion or nonunion
- Surgical technique
  - : Closed reduction and percutaneous pinning, Intramedullary fixation with use of combinations of rods, wires and sutures, Heavy sutures fixation (Parachute technique)<sup>1)</sup>, ORIF
- Closed reduction and percutaneous pinning
  - ① Ix) good quality of bone and minimal comminution
  - ② 2.5 mm terminally threaded pins, cannulated 4.0 mm screws
  - ③ Shoulder immobilization for 4~6 weeks and immediate pendulum exercise
  - ④ Removal of pins: 3 weeks(proximal pin on GT), 4~6 weeks(distal pins)

#### Three-Part Fractures

- Deforming forces
  - : must be neutralized to achieve a satisfactory reduction and fixation
  - “çThree-part fracture with a greater tuberosity fragment
  - : i) Greater tuberosity- displaced superiorly and posteriorly by the pull of the supraspinatus, infraspinatus and teres minor,
  - ii) Humeral head fragment- internal rotation by the subscapularis, retroversion by proximal pull of the deltoid
  - iii) Shaft- displaced anteriorly and medially by the pectoralis major

- Three-part fracture with a lesser tuberosity fragment
  - : i) Lesser tuberosity- displaced medially by the subscapularis
  - ii) Humeral head and greater tuberosity- adduction and external rotation
  - iii) Shaft- pulled anteriorly and medially by the pectoralis, proximally by the deltoid
- Interfragmentary fixation with sutures or wire<sup>4,5)</sup>, percutaneous pinning<sup>13)</sup>, plate and screw fixation, intramedullary fixation
- Surgical technique
  - 2 Goals- i) Anatomic reduction of the fracture fragments
    - ii) Neutralization of the deforming forces to prevent displacement of the fragments following fixation
  - Deltpectoral approach

#### Valgus Impacted Four-part Fractures

- Impaction of the lateral aspect of the humeral articular surface through a fracture of the anatomical neck → valgus deformity of the humeral head (articular surface faces superiorly, toward the acromion)
- Little or no displacement of the medial aspect of the humeral articular surface with respect to the medial aspect of the shaft
- The shaft, periosteum, displaced tuberosities, glenohumeral joint capsule and rotator cuff form a single continuous sleeve of tissue → nearly anatomic reduction of the tuberosities when the head is reduced
- Incidence of osteonecrosis: 5~10%<sup>6)</sup>
- Nonsurgical treatment: often results in painful malunion
- Surgical treatment: percutaneous reduction and internal fixation, ORIF, Hemiarthroplasty
- Percutaneous reduction and internal fixation (Steps)<sup>10)</sup>
  - : i) percutaneous reduction of the articular segment
  - ii) fixation of the head
  - iii) reduction and fixation of the greater tuberosity
  - iv) reduction and fixation of the lesser tuberosity
- ORIF
  - : careful to avoid complete perforation of the medial cortex
  - Packing of the allograft cancellous chips under the elevated head

## COMPLICATIONS

#### Refractory shoulder stiffness

- Contributory factors: severity of the initial injury, prolonged immobilization, articular surface malunion, patient noncompliance with rehabilitation
- Important to start supervised physical therapy less than 14 days after injury<sup>7)</sup>

#### Osteonecrosis

- Proportional to the complexity of the proximal humeral fracture and the extent of the surgical dissection of soft tissue
- Three- and four-part fractures (3~34%)<sup>8,15)</sup>
- Primary surgical option: prosthetic arthroplasty

#### Malunion

- Greater tuberosity: Superior displacement |æ mechanical block to overhead elevation, pain, weakness.  
Posterior displacement |æ limitation of external rotation
- Two-part surgical neck fractures: varus malunion |æ impingement

#### Nonunion

- In elderly patients with osteoporosis<sup>14)</sup>
- Contributory factors: soft-tissue interposition, hanging arm casts, inadequate ORIF, patient alcoholism, diabetes mellitus
- Primary surgical option: ORIF with bone graft

#### Heterotopic bone formation

- Incidence: 12%<sup>10)</sup>
- Predisposing factors: extent of soft-tissue injury, the number of repeated manipulations, the delay of reduction by more than 7 days.

#### Posttraumatic arthritis

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