Proximal Humerus Fractures

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Disclosures

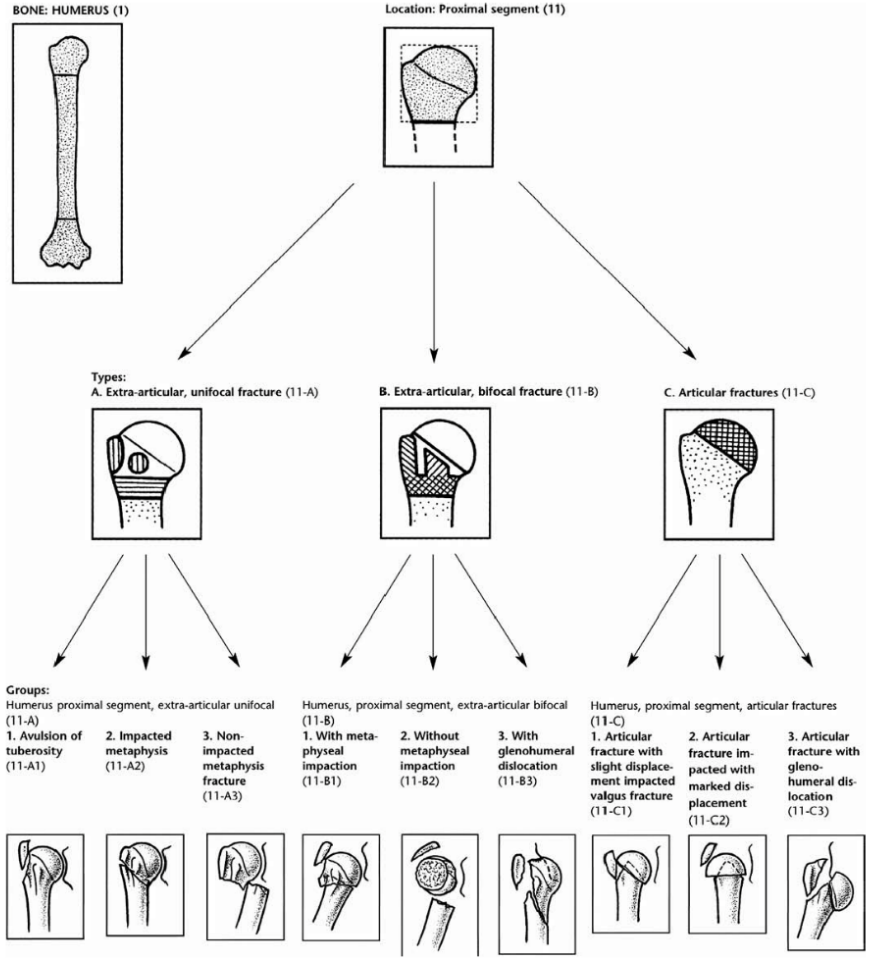
- **None**

Objectives

- Review the principles of diagnosis and management of proximal humerus fractures
- Review fracture classification schemes
- Review decision making and treatment options
- Review outcomes and evidence
- Review available resources for further education pertaining to proximal humerus fractures

Proximal Humerus Fractures

- **Defined as fractures occurring at or proximal to the surgical neck**



Epidemiology

- **Females > Males**
- **Bimodal distribution – young males, older females**
- **Incidence increases with age**
  - **As population ages the incidence of proximal humerus fractures is expected to increase**
- **Highest risk in white females**
- **Osteoporosis related fracture**
  - **3rd most common nonvertebral osteoporotic fracture**

Risk Factors

- **Other risk factors:**
  - **Poor vision, Hearing aids, Diabetes, Depression, Alcohol consumption, Anticonvulsant medications, Maternal history of hip fracture, Personal history of spinal or extremity fracture**
- **Protective Factors:**
  - **Hormonal therapy, Calcium intake**

Mechanisms of Injury

- **Ground level fall**
  - **Vast majority**
- **High energy trauma in younger population**
- **3 Main Loading Modes:**
  - **Compressive – Humeral head impacts at glenoid**
  - **Bending – Angular forces at surgical neck**
  - **Tension – Rotator cuff pulling on greater and less tuberosities**
- **Fall on outstretched hand**
  - **Valgus impacted proximal humerus fracture**
- **Fall directly onto lateral shoulder**
  - **Varus deformity with posterior rotational deformity**

Associated Injuries

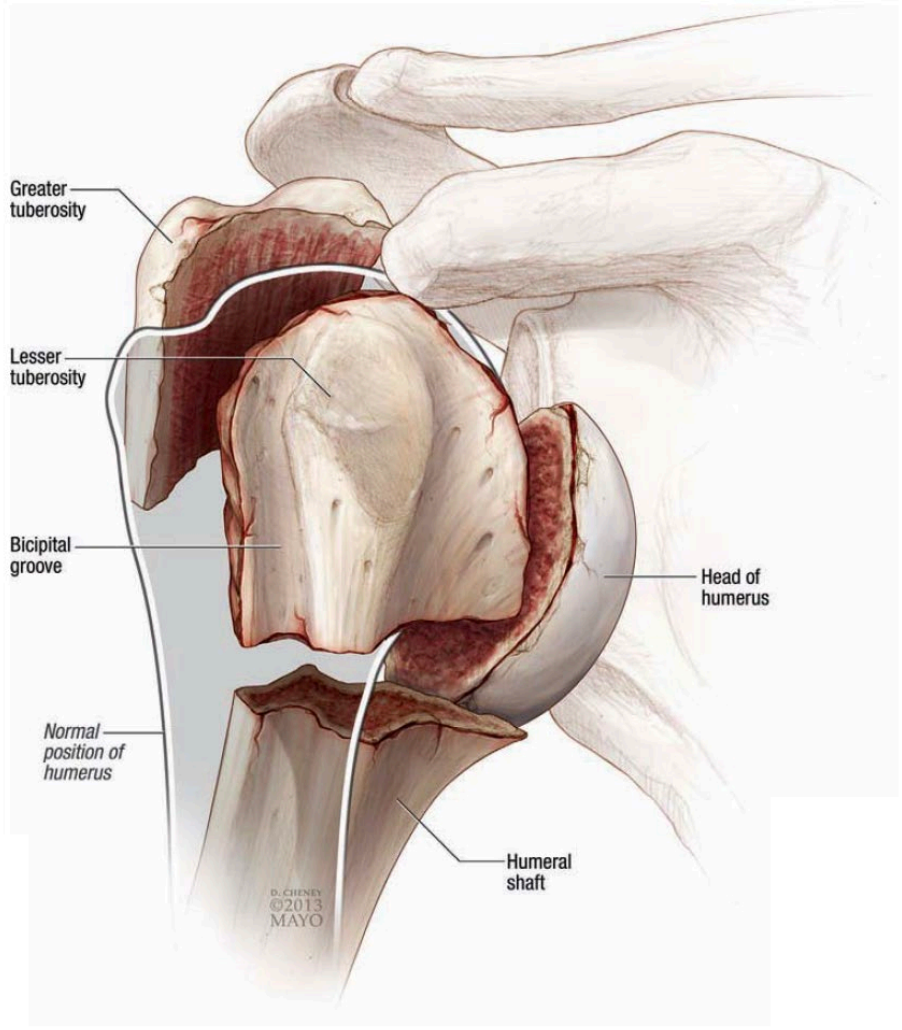
- **Majority are isolated low energy injuries**
- **Other MSK injuries:**
  - **Ipsilateral distal radius**
  - **Hip fracture**
  - **Pelvic fracture**
  - **Head injury / Subdural hematoma**
  - **Nerve palsy – Suprascapular, Axillary, Musculocutaneous or Brachial plexus palsy possible**
  - **Vascular injury – Fracture dislocations at risk for axillary artery/vein injury**

Clinical Presentation

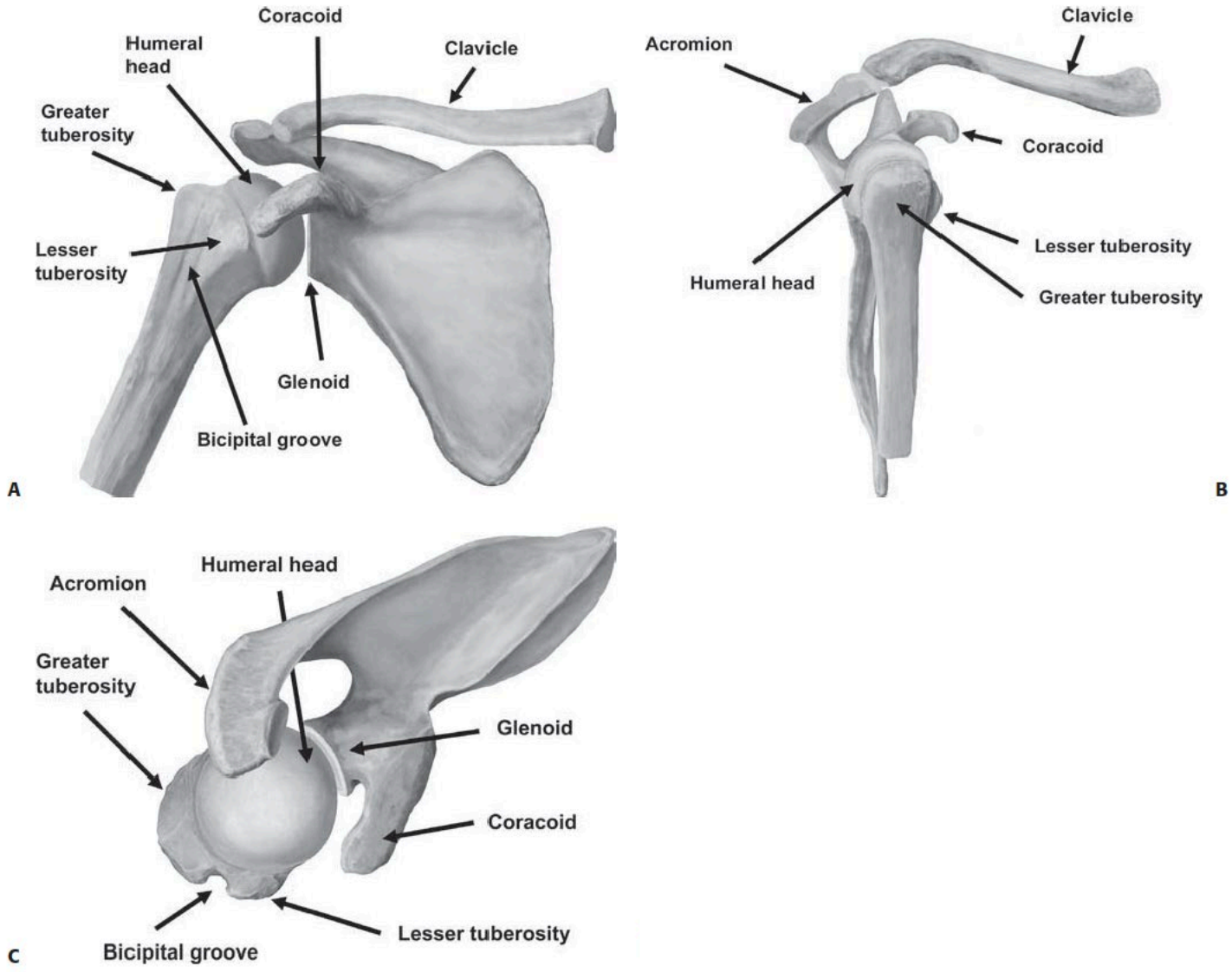
- **Shoulder pain worse with motion**
- **Immobility**
- **Ecchymosis**
- **Soft tissue swelling**
- **Open fractures may occur in axilla but are rare**
  - **Usually occur at lateral aspect of axilla as pec major displaces shaft medially**

Anatomy/Deforming Forces/Parts

- **Parts:**
  - **Head**
  - **Greater tuberosity**
  - **Lesser tuberosity**
  - **Shaft**

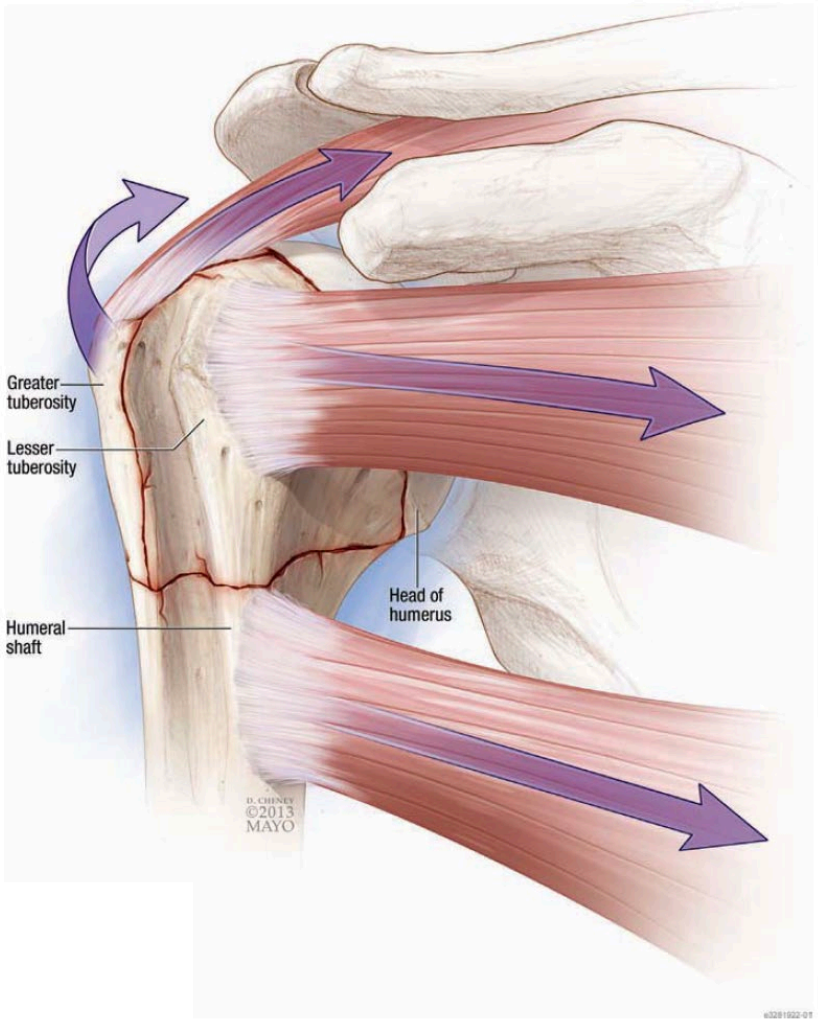


Anatomy/Deforming Forces/Parts



Anatomy/Deforming Forces/Parts

- **Deforming Forces**
  - **Supraspinatus/Infraspinatus**
    - **Displaces greater tuberosity superiorly and posteriorly**
  - **Subscapularis**
    - **Displaces lesser tuberosity medially**
  - **Pectoralis major**
    - **Displaces humeral shaft medially and anteriorly**
  - **Deltoid**
    - **Displaces humeral shaft proximally**



Imaging

- Radiographs
  - Standard
    - Grashey (True AP) view
    - Neer (Scapular Y) view
    - Axillary lateral view
  - Additional
    - Velpeau view
    - Traction view
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound

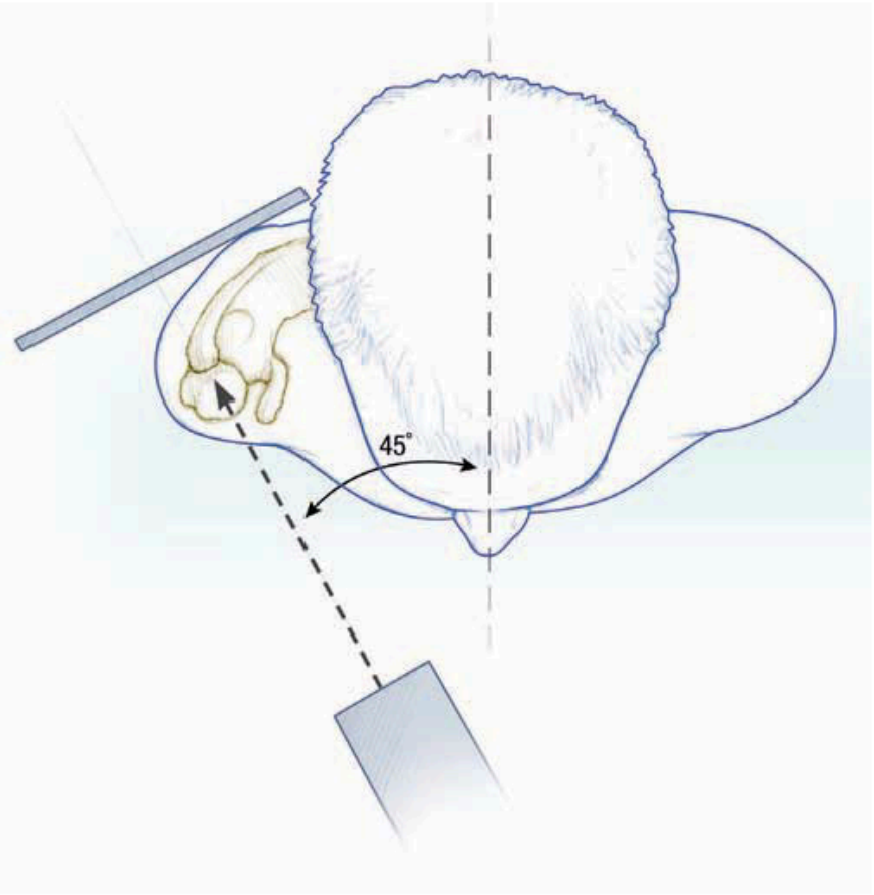


FIGURE 37-6 AP Grashey view of the shoulder. The patient's torso is rotated 30–45 degrees bringing the side opposite to the injured shoulder forward. The x-ray beam is thereby aimed perpendicular to the plane of the scapula, imaging the glenoid in profile and avoiding overlap between the glenoid and the humeral head.

Imaging

- Radiographs
- Radiographs
  - Standard
    - Grashey (True AP) view
    - Neer (Scapular Y) view
    - Axillary lateral view
  - Additional
    - Velpeau view
    - Traction view
- Computed Tomography (CT)
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- Ultrasound

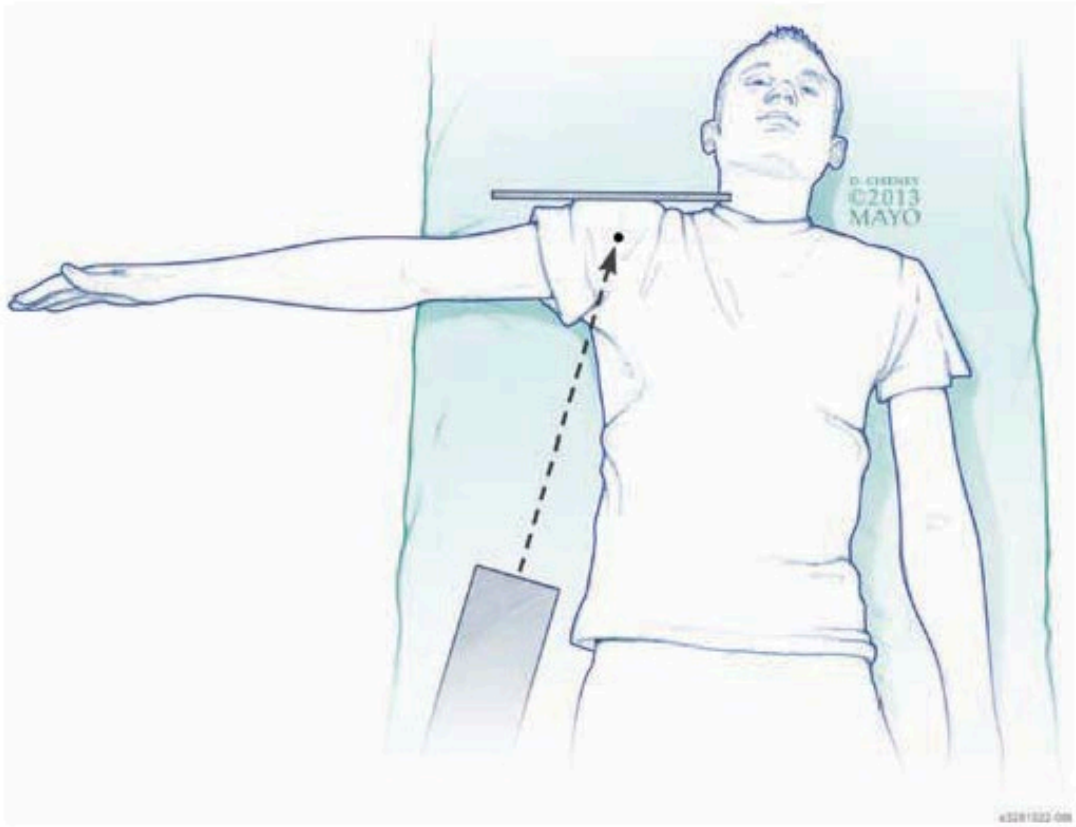


FIGURE 37-8 Axillary view of the shoulder. The arm is abducted as much as possible, with the patient supine and the x-ray beam projected from the axilla onto the cassette located on top of the shoulder.

Imaging

- Radiographs
- Radiographs
  - Standard
    - Grashey (True AP) view
    - Neer (Scapular Y) view
    - Axillary lateral view
  - Additional
    - Velpeau view
    - Traction view
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound

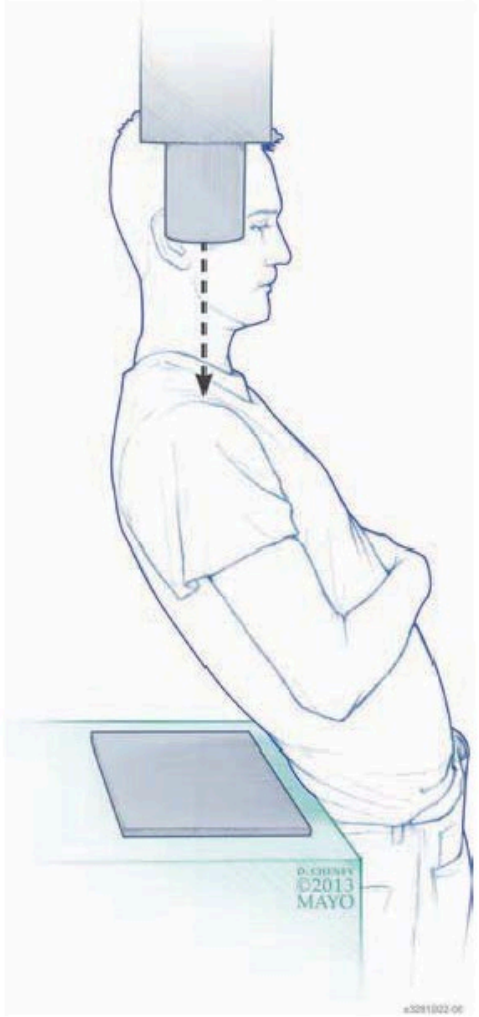


FIGURE 37-9 Velpeau axillary view of the shoulder. The x-ray beam is projected down perpendicularly onto a cassette. The patient is asked to lean back, to place the shoulder between the x-ray source and the cassette. This can be done with the upper extremity in a sling.

Imaging

- Radiographs
- Radiographs
  - Standard
    - Grashey (True AP) view
    - Neer (Scapular Y) view
    - Axillary lateral view
  - Additional
    - Velpeau view
    - Traction view
- Computed Tomography (CT)
- Magnetic Resonance Imaging (MRI)
- Ultrasound

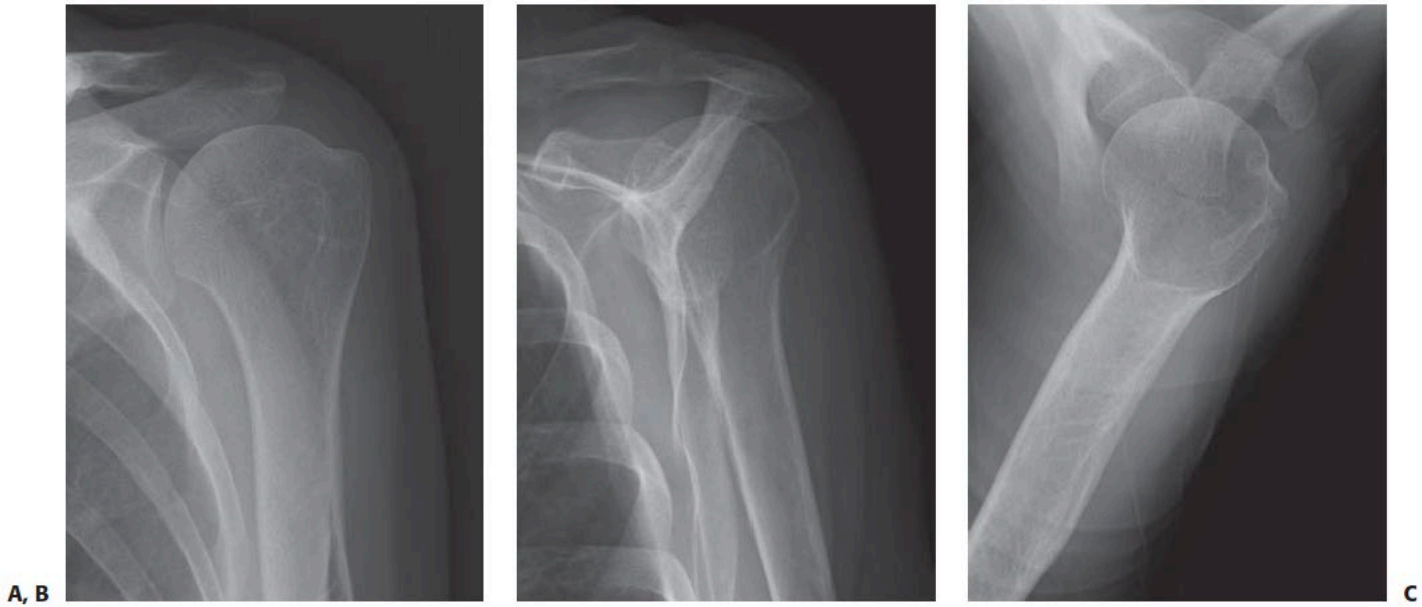


FIGURE 37-4 Radiographic trauma series. **A:** AP Grashey view of the left shoulder. Note the tangential view of the glenoid articular surface. **B:** Neer lateral (Y) view of the left shoulder. **C:** Axillary view. Note how the humeral head is centered on the glenoid in the transverse plane.

Classification

- **Neer**
  - **4 Parts**
    - **Head**
    - **Greater Tuberosity**
    - **Lesser Tuberosity**
    - **Shaft**
  - **In the Neer Classification, a part must be:**
    - **Displaced ≥ 1 cm, or**
    - **Angulated ≥45^0**
- **Greater tuberosity**
  - **More stringent indications – still evolving**
  - **> 5 mm of displacement may cause impingement**
  - **>2-3 mm displacement in an athlete may effect rotator cuff tension**

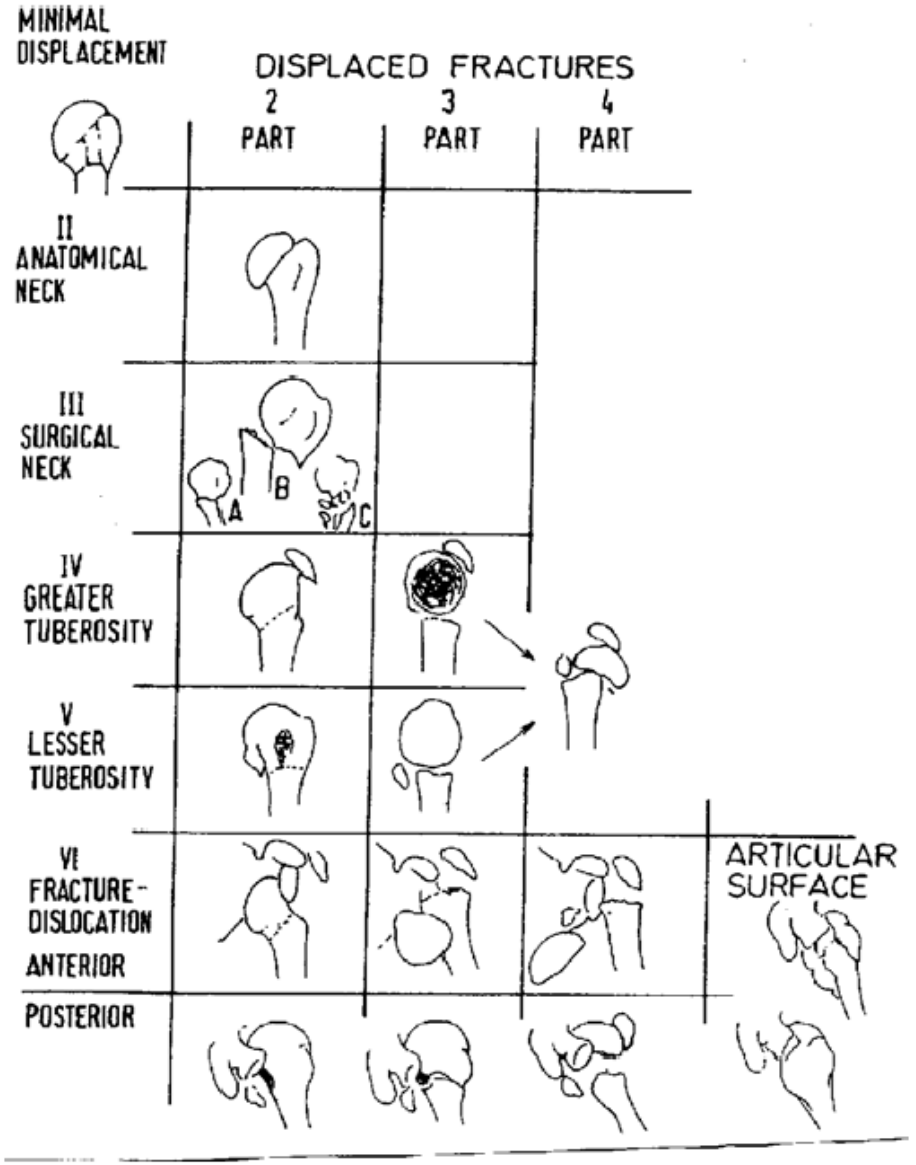


FIGURE 37-14 Neer's four-part proximal humerus fracture classification. From Neer.[287]

Classification

- **AO/OTA**
  - **Bone = 1**
  - **Segment = 1**
  - **Pattern**
    - **A = Extraarticular unifocal**
    - **B = Extraarticular bifocal**
    - **C = Intraarticular**

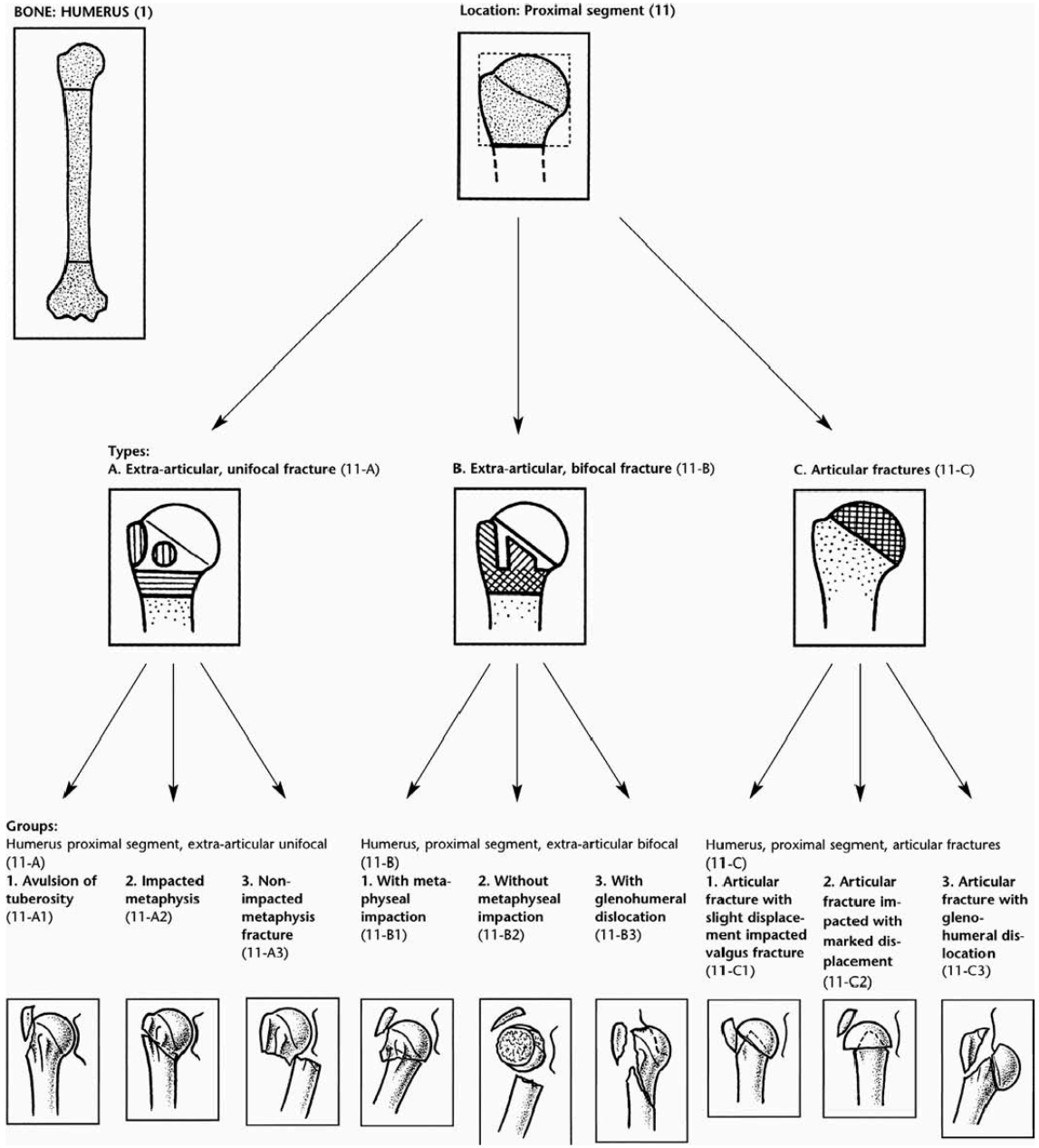


FIGURE 37-15 AO/OTA classification for proximal humerus fractures.[257,280]

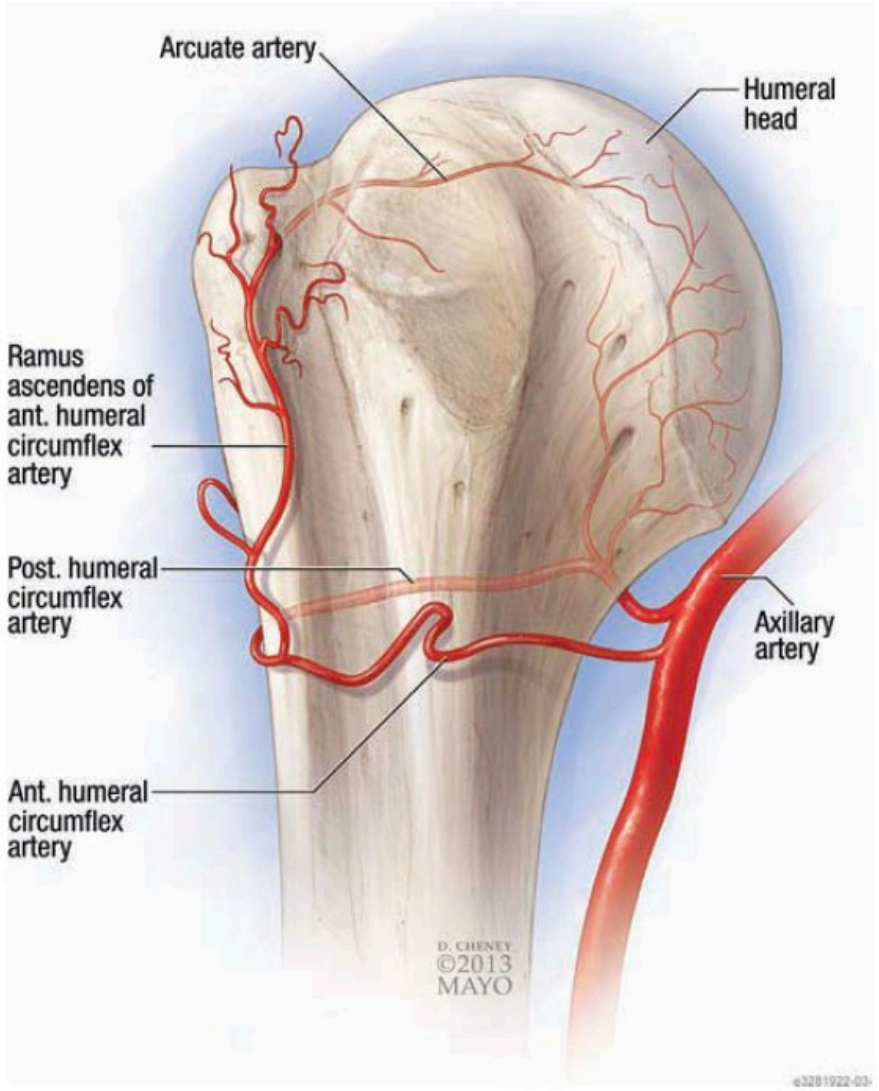
Classification

- **Greater tuberosity fragment surgical indications have evolved**
  - **<3mm displacement in overhead athletes**
  - **<5mm displacement in healthy adults**

Blood Supply to Humeral Head / AVN

- **Vascular supply to humeral head**
  - **Arcuate artery is the terminal supply to the humeral head from the anterior humeral circumflex artery**
    - **Disrupted with anatomic neck fractures**
  - **Posterior humeral circumflex artery supplies posteromedial metaphysis of humerus**
    - **Less likely to be injured at time of fracture displacement**
- **Predictors of Humeral Head AVN (Hertel's Criteria)**
  - **Distal metaphyseal extension <8 mm**
  - **Disruption of medial hinge at level of calcar (Medial displacement of shaft)**
  - **Fracture through the anatomic neck**

Blood Supply to Humeral Head



Hertel's Criteria

- **Recently called into question**
  - **Original study used intraoperative doppler flowmetry as well as visual bleeding from drill holes in the humeral head to determine vascular supply**
  - **A lack of return of bleeding from drill holes was associated with AVN**

  - **Campochiaro et al 2015**
  - **Series of patients assessed for AVN after proximal humerus fx**
  - **Hertel's criteria were less predictive of AVN, whereas poor reduction was highly predictive.**

Treatment Options

- **Nonoperative – majority (80%)**
- **Operative**
  - **Suture fixation**
  - **Arthroscopic assisted repair**
  - **Closed reduction and percutaneous pinning**
  - **Open reduction internal fixation**
  - **Intramedullary nail**
  - **Arthroplasty**

Nonoperative Treatment

- **Indications for nonoperative management:**
  - **Older age**
  - **Lower demand**
  - **Unfit for surgery**
  - **Stable nondisplaced or minimally displaced patterns**
  - **Valgus impacted 2 or 3 part fractures**
- **Sling**
- **Sling and swathe**
- **Sling with abduction pillow**
- **Shoulder immobilizer**

- **Early active-assisted motion including pendulums may prevent stiffness**

The PROFHER Randomized Clinical Trial

- **JAMA 2015**
- **1250 patients with proximal humerus fractures**
- **250 patients met surgical indications and were randomized to operative vs nonoperative treatment**
- **No difference in outcomes at 2 years follow up**
  - **Controversy regarding groups and treatment conversion**
    - **87 had “clear indication for surgery” and were not included in study**
    - **16/125 were randomized to surgery and did not receive surgery**
    - **66 surgeons involved**
- **Regardless, supports nonoperative management in select patients**

Treatment Options

- **Nonoperative**
- **Operative**
  - **Suture fixation**
  - **Arthroscopic assisted repair**
  - **Closed reduction and percutaneous pinning**
  - **Open reduction internal fixation**
  - **Intramedullary nail**
  - **Arthroplasty**

Positioning

- Beach chair
- Semi-supine

A

C

B

FIGURE 37-29 Patient positioning. Beach chair. **A:** A head holder is required to safely maintain control of the head during surgery. Intraoperative imaging can be obtained with a mini-C-arm (as seen) or a standard C-arm. **B and C:** If iliac crest bone graft is required as in this surgical neck nonunion, the contralateral iliac crest is prepared and draped. Intraoperative imaging can be obtained with a mini-C-arm (as seen) or a standard C-arm.

Positioning

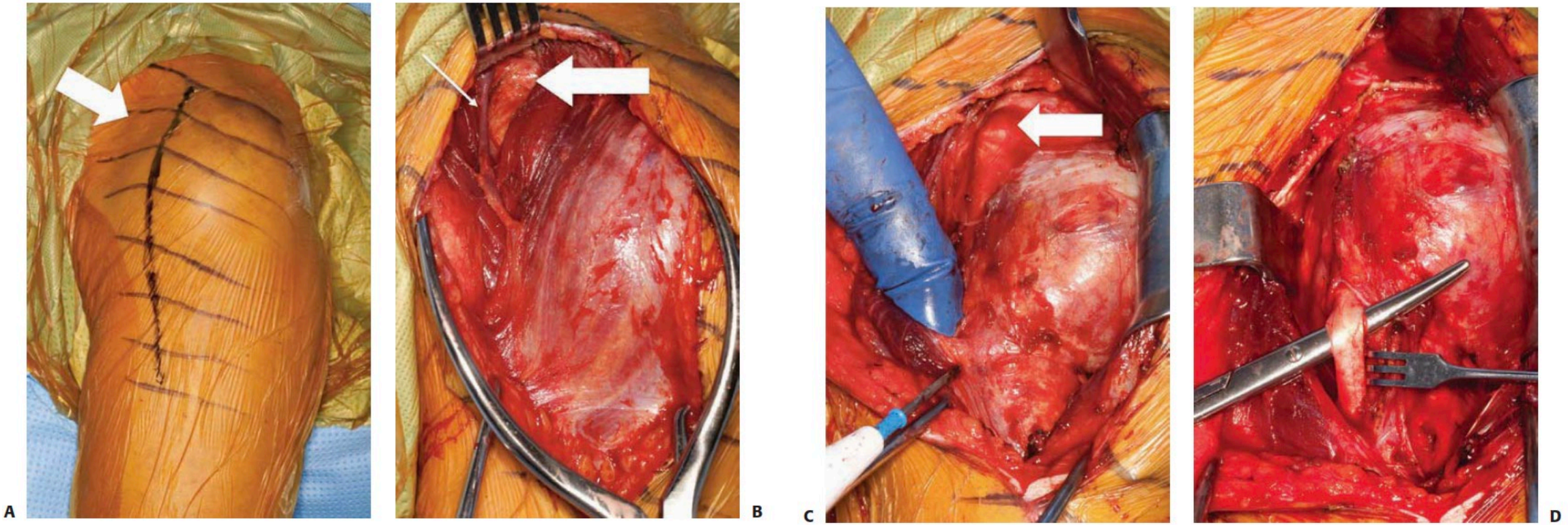
- Beach chair
  - Beware of blood pressure cuff on gravity dependent leg that will give incorrect indication of perfusion elsewhere (i.e. brain)
- Semi-supine

FIGURE 36-18 Positioning the patient for antegrade nailing.

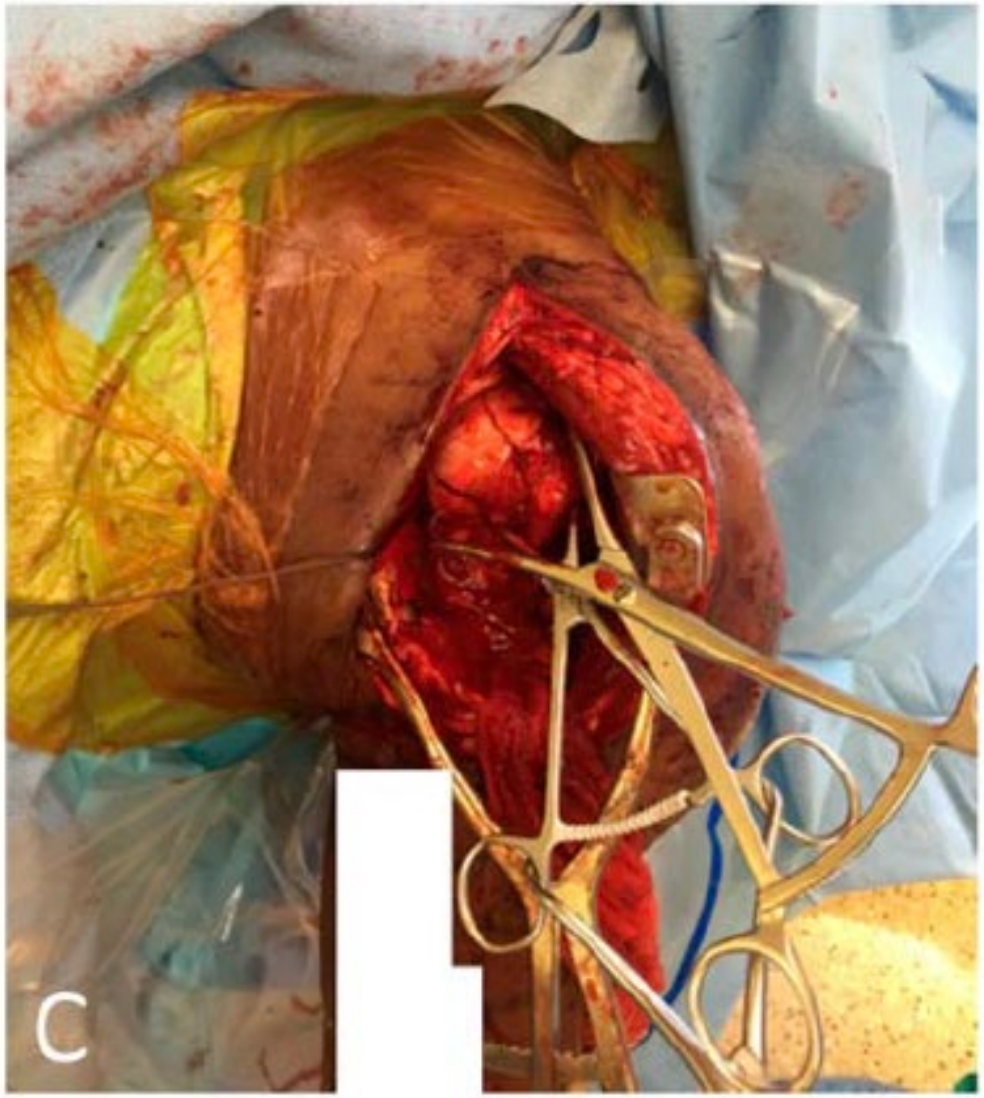
Approaches

- **Deltopectoral**
  - **Can visualize the joint for head split fractures with lesser tuberosity peel vs osteotomy**
  - **Extensile**
- **Deltoid Splitting**
  - **Easier plate placement laterally**
  - **Axillary nerve protection (5-7 cm inferior to acromion)**
  - **Less retraction and positioning needed for lateral plate placement**
  - **Can be extensile if you dissect and protect axillary nerve**

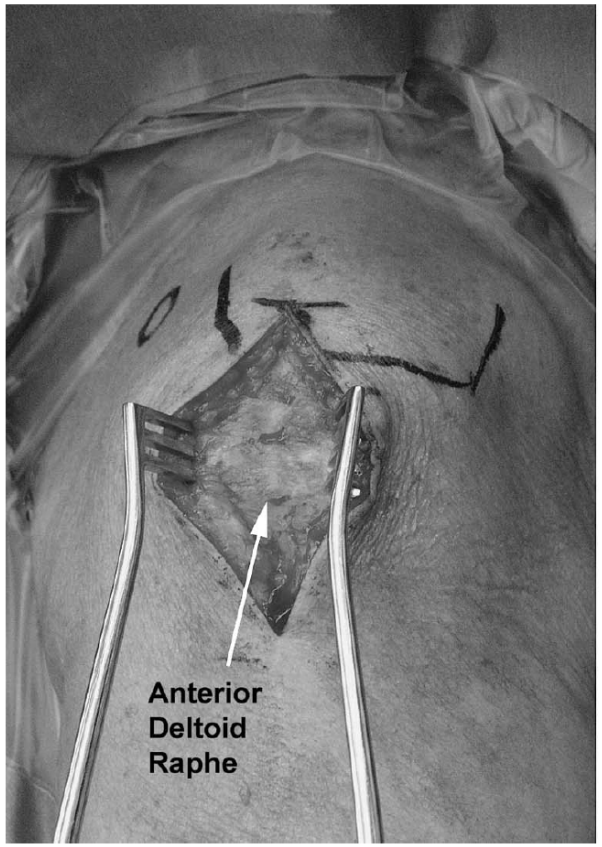
Approaches



Approaches



Approaches



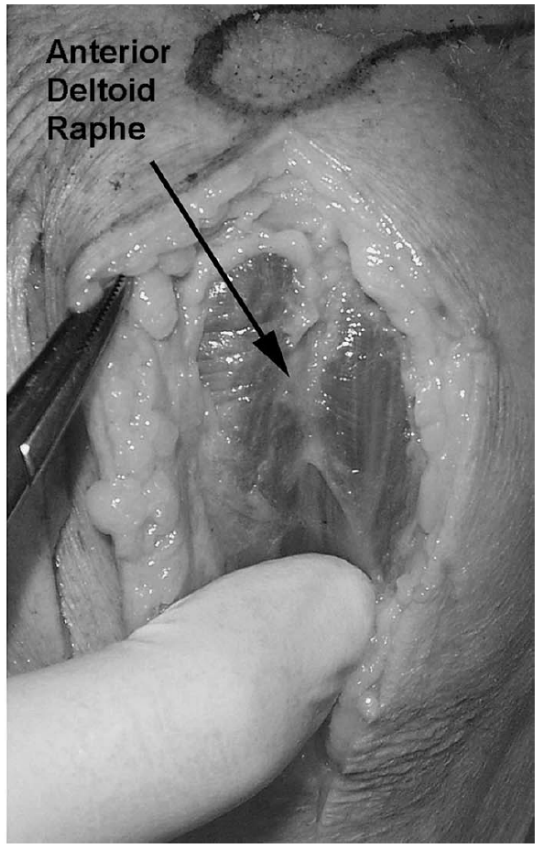


FIGURE 1. A skin incision is made beginning at the anterolateral edge of the acromion, extending distally approximately 10 cm.

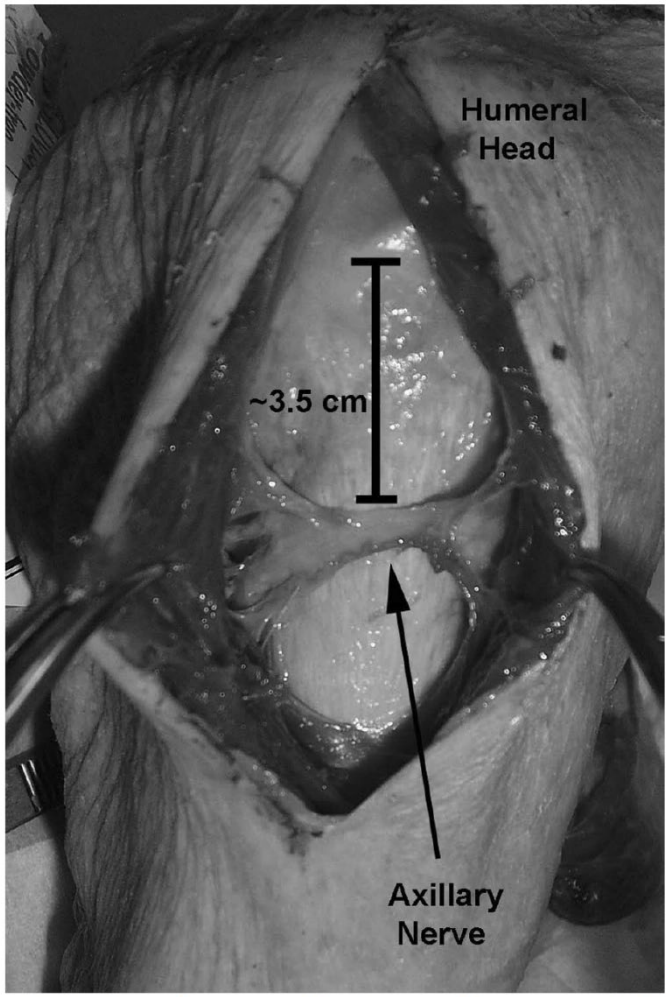
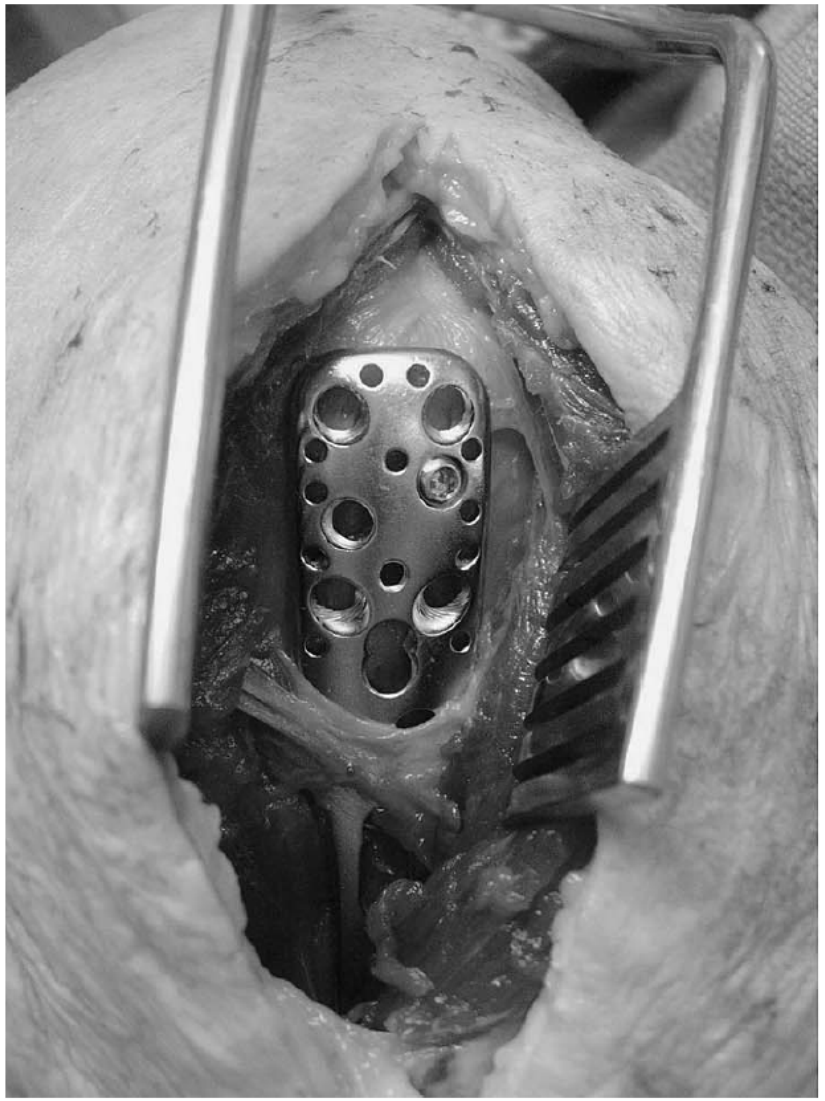
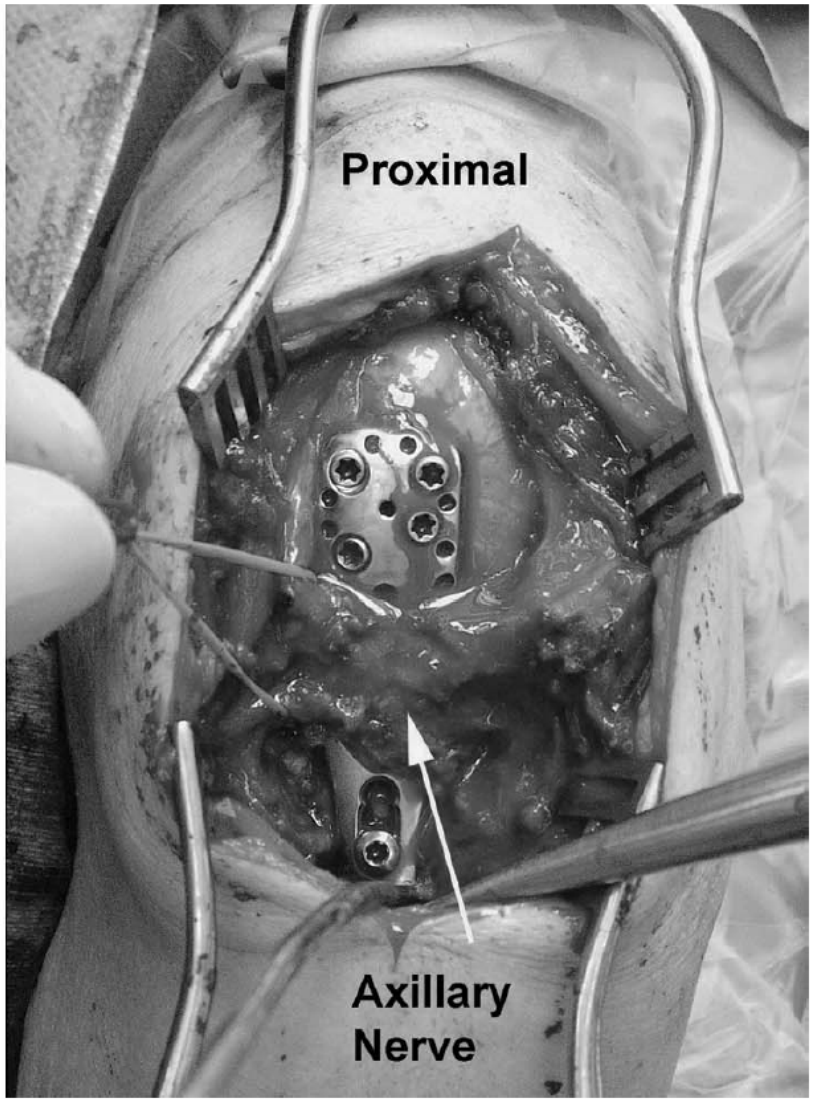


FIGURE 3. Cadaver example of the axillary nerve, which crosses the raphe approximately 3.5 cm from the prominence of the greater tuberosity.

Approaches



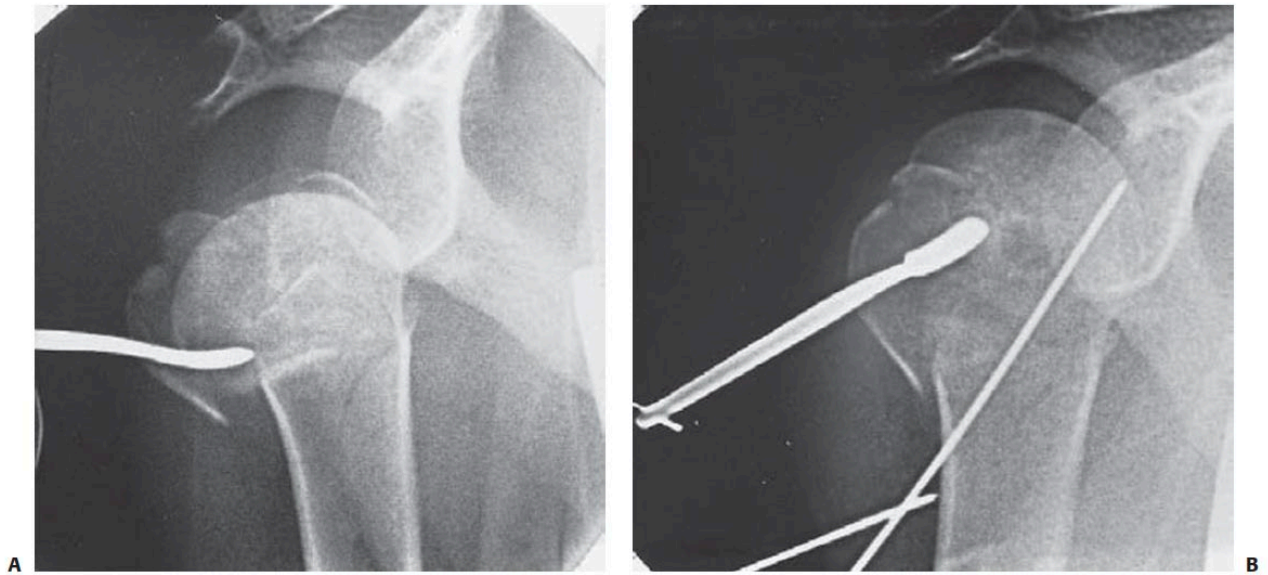


Reduction Techniques

- Closed reduction usually accomplished with arm abducted and externally rotated
  - Match the location of the proximal fragment with the distal segment
- If adequate reduction can be obtained by closed means, percutaneous fixation can follow with K wires, percutaneous screws, or retrograde intramedullary nails

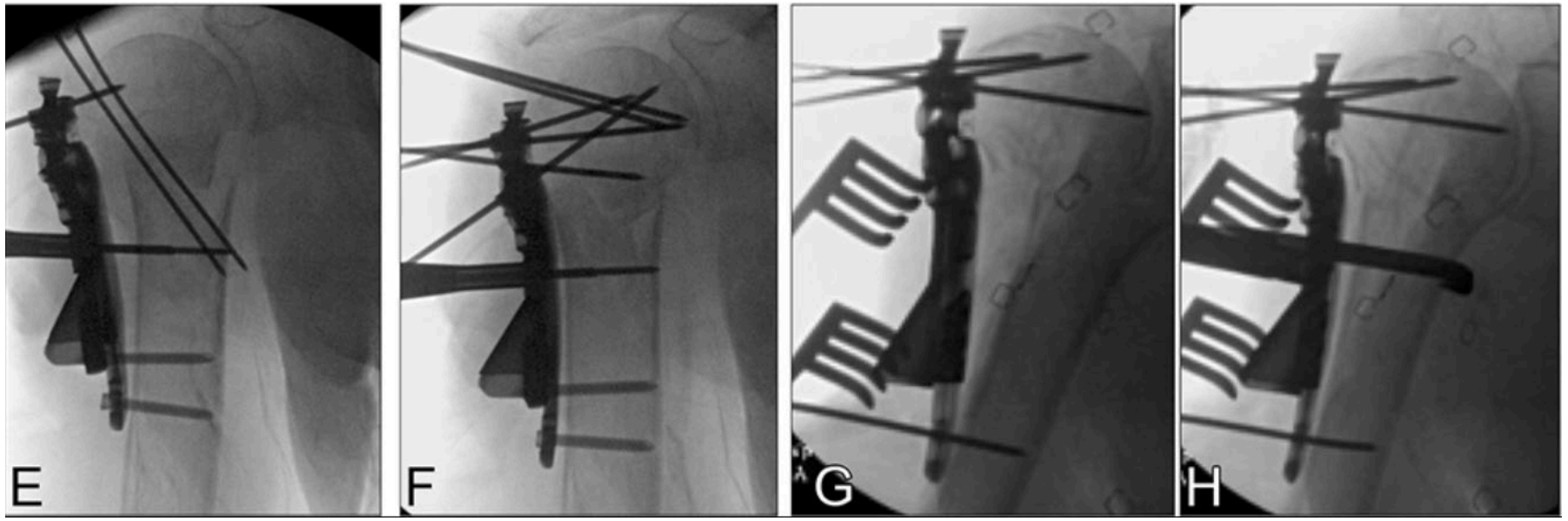
Reduction Techniques

- Work through greater tuberosity fracture line to manipulate head fragment
  - K-wire joysticks
  - Elevator as broad surface to manipulate head fragment
  - K-wire provisional fixation to shaft fragment



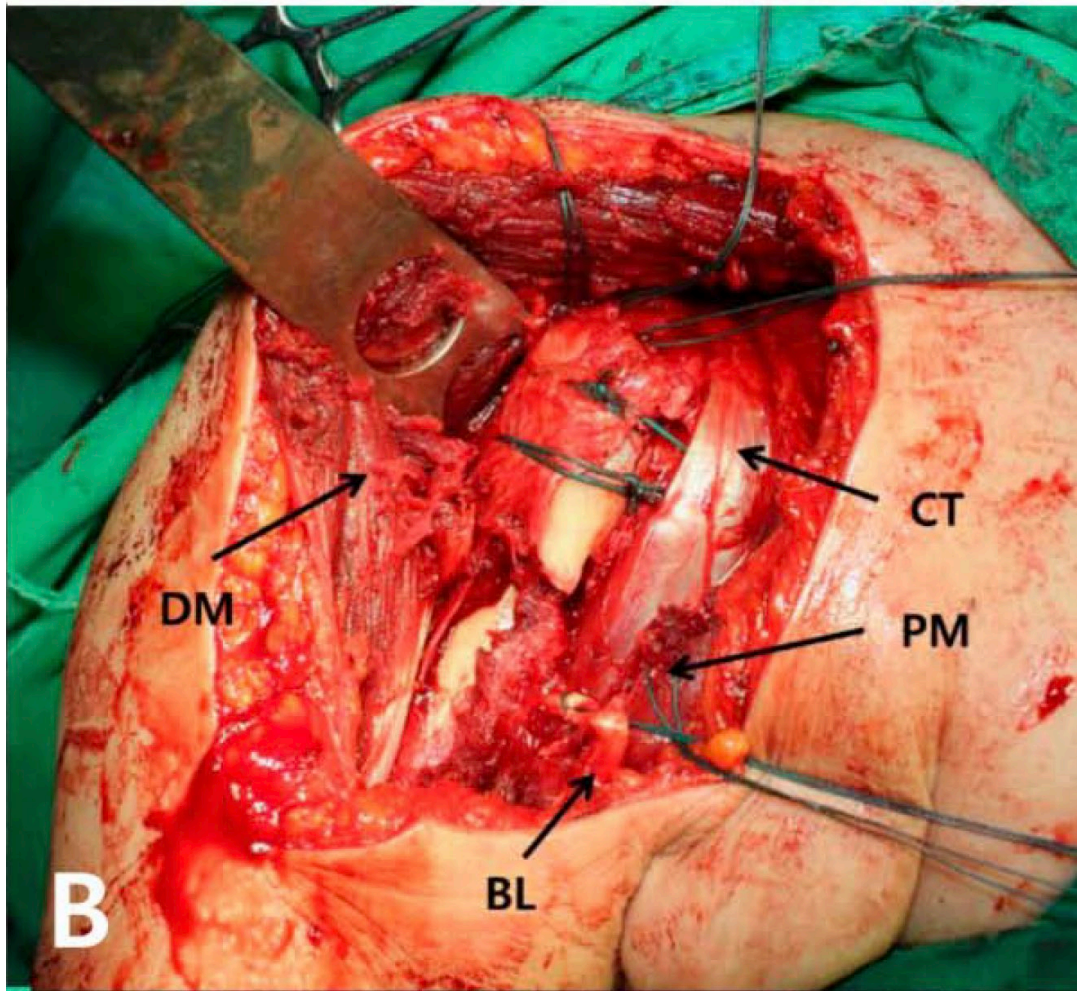
Reduction Techniques

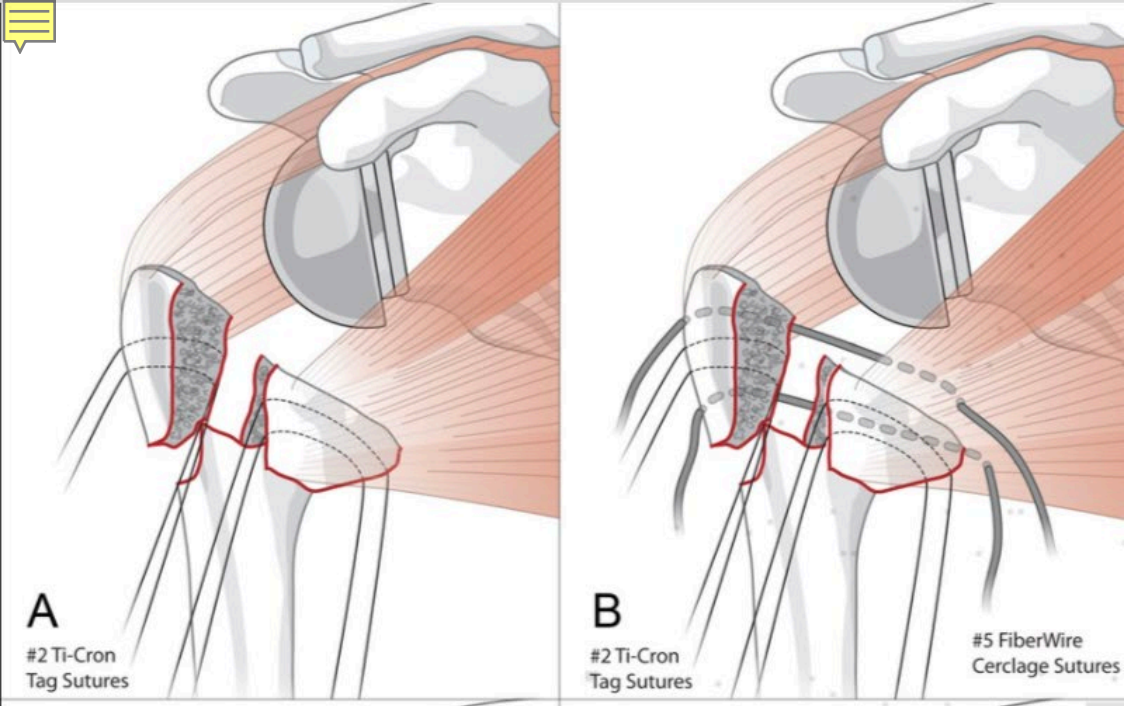
- Reduce the medial hinge with the head fragment in valgus
  - Common deformity
- Apply lateral plate to translate greater tuberosity fragment and improve valgus reduction



Reduction Techniques

- Sutures in rotator cuff insertions can be helpful to manipulate greater and lesser tuberosity fracture fragments
- Sutures can be incorporated into plate and may supplement fixation
- Unstable head fragment can be pinned to glenoid with K wires to provide provisional stability

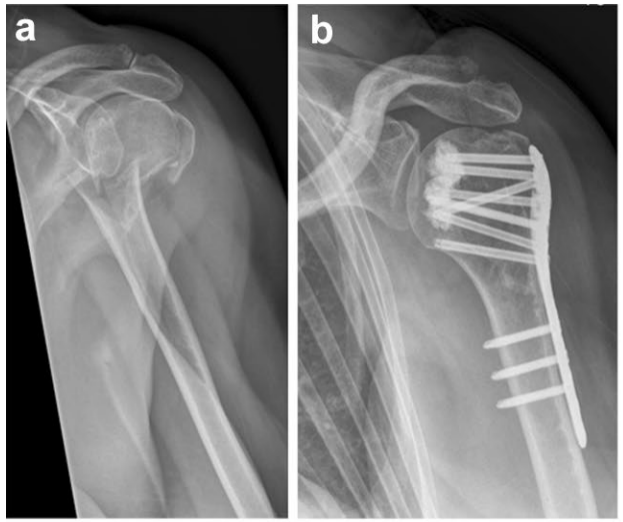


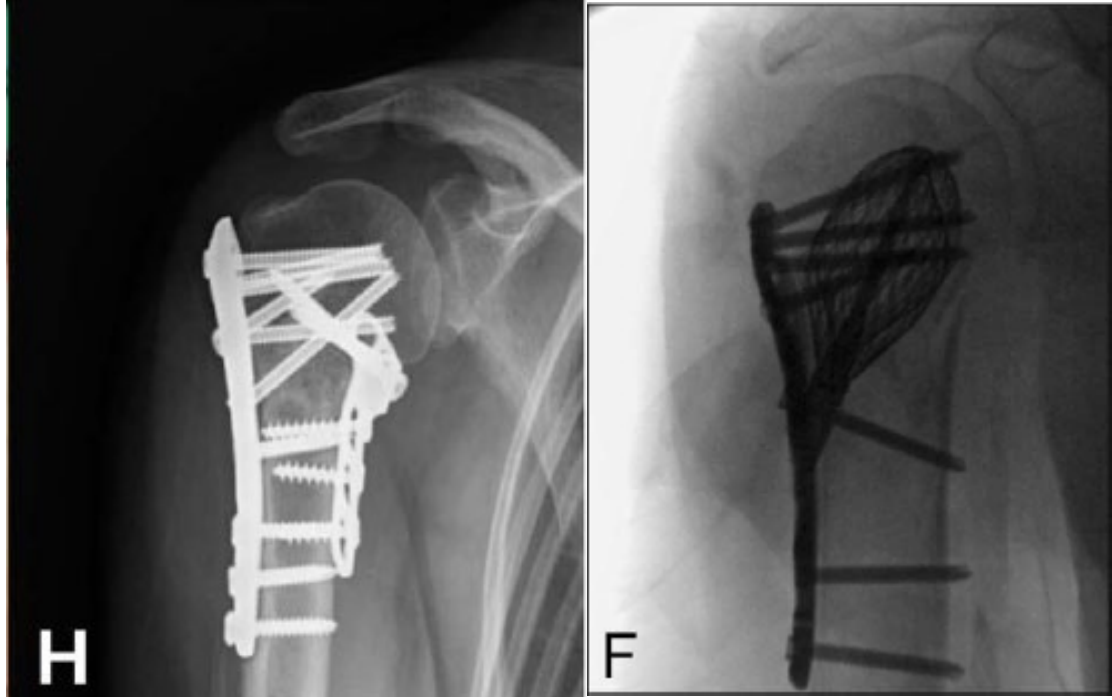

A
#2 Ti-Cron
Tag Sutures
B
#2 Ti-Cron
Tag Sutures
#5 FiberWire
Cerclage Sutures
C
D

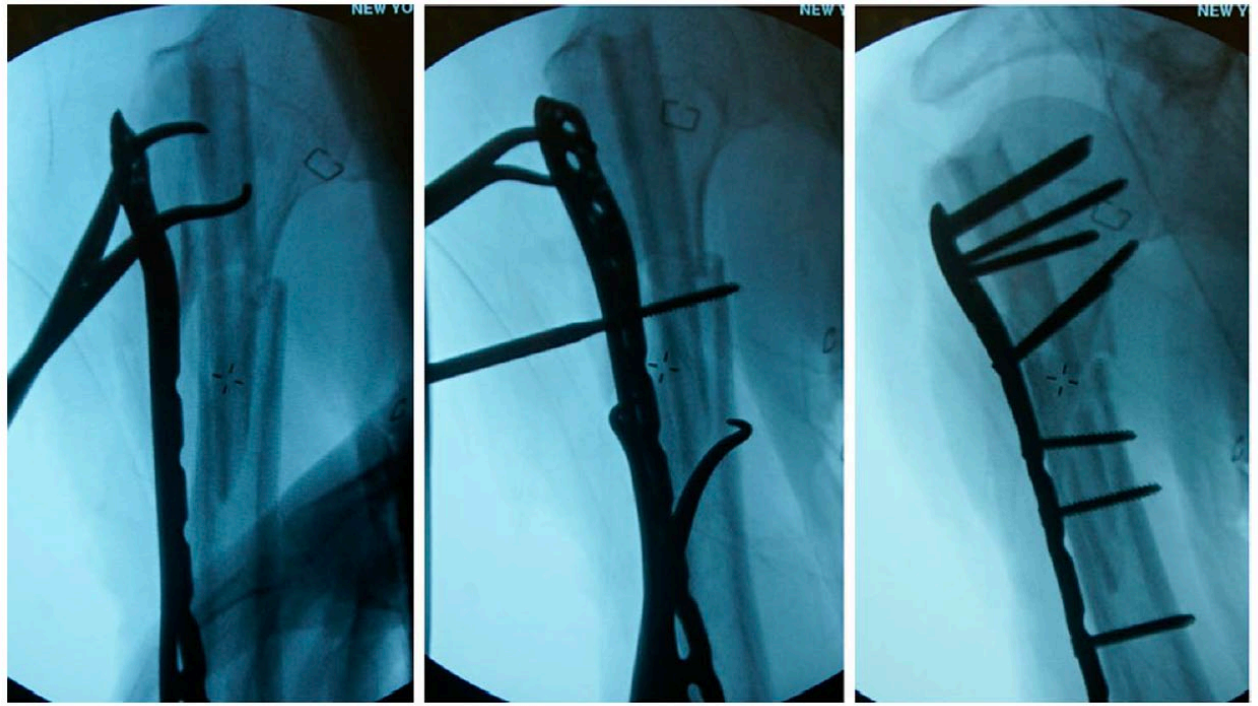

A
B

Augments to ORIF

- Medial buttress plate
- Rotator cuff sutures
- Intramedullary fibula allograft
- Titanium mesh cage
- PMMA/Calcium Phosphate





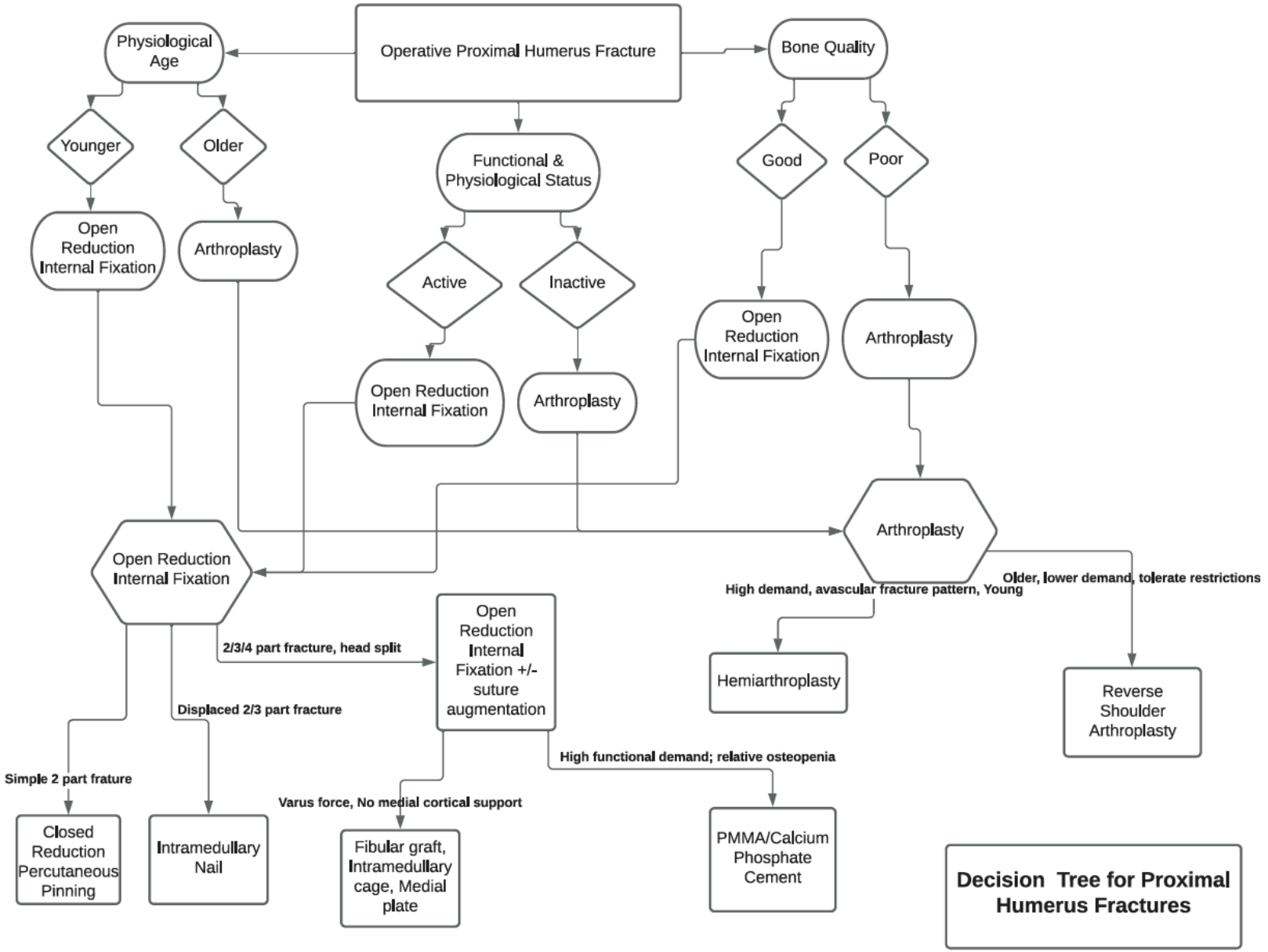


Arthroplasty

- **May be preferable in some patients for immediate motion and in presence of poor bone quality**
- **Reverse total shoulder arthroplasty outcomes are less dependent on tuberosity healing/reduction and have lower reoperation rate**

Decision Making

- Age, functional status, bone quality, and fracture pattern can all be used to guide surgical decision making and implant selection
- Younger patients with good bone quality and a viable humeral head are ideally treated with ORIF
- Older frail patients with lower functional requirements are ideally treated with arthroplasty


Operative Proximal Humerus Fracture
Physiological Age
Younger
Older
Open Reduction Internal Fixation
Arthroplasty
Functional & Physiological Status
Active
Inactive
Open Reduction Internal Fixation
Arthroplasty
Bone Quality
Good
Poor
Open Reduction Internal Fixation
Arthroplasty
Arthroplasty
Open Reduction Internal Fixation
2/3/4 part fracture, head split
Open Reduction Internal Fixation +/- suture augmentation
Displaced 2/3 part fracture
Simple 2 part frature
Closed Reduction Percutaneous Pinning
Intramedullary Nail
Varus force, No medial cortical support
Fibular graft, Intramedullary cage, Medial plate
High functional demand; relative osteopenia
PMMA/Calcium Phosphate Cement
High demand, avascular fracture pattern, Young
Hemiarthroplasty
Older, lower demand, tolerate restrictions
Reverse Shoulder Arthroplasty
Decision Tree for Proximal Humerus Fractures

Complications

- **AVN**
- **Impingement**
- **Screw cut out**
- **Loss of reduction**
  - **Medial support, calcar screw placement**
  - **Combined cortical thickness**
  - **Deltoid tuberosity index**
- **Nonunion**
  - **Risk factors: Smoking, Alcohol abuse, Osteoporosis, Inflammatory arthropathy**
- **Malunion**
  - **Tuberosity malunion can cause symptoms of rotator cuff weakness or impingement**
- **Stiffness**
- **Infection**

Complications

- **Impingement**
  - **Avoid with ideal plate placement just lateral to bicipital groove and 5-8 mm distal to greater tuberosity**
  - **Tx: Hardware removal after union if symptomatic**
- **Screw cut out**
  - **Avoid screws in superior head**
  - **Advance screws to subchondral bone without penetrating articular surface for ideal purchase**
  - **Pre-op CT thickness of central humeral head is predictive of screw cut out**
    - **> 25 mm thickness is protective, <15 mm thickness predictive of screw cut out**
  - **Tx: May remove prominent screws without removal of all hardware if fracture unites in acceptable position**

Complications

- **Risk factors for loss of reduction**
  - **Older age**
  - **Osteoporosis**
  - **Varus displacement**
  - **Medial comminution**
  - **Inadequate reduction**
  - **Insufficient medial support**

Complications

- **Malunion**
  - **Not all malunions are symptomatic**
  - **Tuberosity malunion may cause rotator cuff dysfunction**
  - **Symptomatic malunions are often salvaged with arthroplasty**
- **Nonunion**
  - **Tx: Repair of nonunion vs arthroplasty**
- **AVN**
  - **Minor humeral head collapse is often tolerated with minimal symptoms**
  - **Symptomatic AVN often salvaged with arthroplasty**

More Resources:

- **OTA Videos**
  - OTA Techniques and Procedures: Proximal Humerus
- **OTA Online Education Resources**
  - OTA Online Education

References

- Reuther F, Peterman M, Stangl R. Reverse Shoulder Arthroplasty in Acute Fractures of the Proximal Humerus: Does Tuberosity Healing Improve Clinical Outcomes? J Orthop Trauma 2019;33:e46-e51.
- Mutch JAJ, Rouleau DM, Laflamme G, Hagemeister N. Accurate Measurement of Greater Tuberosity Displacement Without Computed Tomography: Validation of a Method on Plain Radiography to Guide Surgical Treatment. J Orthop Trauma 2014;28:445-451.
- Reid JS. Fractures of the proximal humerus. Current Opinion in Orthopaedics 2003;14:269-280.
- Gupta AK, Harris JD, Erickson BJ, Abrams GD, Bruce B, McCormick F, Nicholson GP, Romeo AA. Surgical Management of Complex Proximal Humerus Fractures – A Systematic Review of 92 Studies Including 4500 Patients. J Orthop Trauma 2015;29:54-59.
- Iyengar JJ, Devcic BS, Sproud RC, Feeley BT. Nonoperative Treatment of Proximal Humerus Fractures: A Systematic Review. J Orthop Trauma 2011;25:612-617.
- Merendez ME, Ring D. A Comparison of the Charlson and Elixhauser Comorbidity Measures to Predict Inpatient Mortality After Proximal Humerus Fracture. J Orthop Trauma 2015;29:488-493.
- Wu C, Ma C, Yeh J, Yen C, Yu S, Tu Y. Locked Plating for Proximal Humerus Fractures: Differences Between the Deltopectoral and Deltoid Splitting Approaches. J Trauma 2011;71:1364-1370.
- Court-Brown, CM, McQueen MM. Nonunions of the Proximal Humerus: Their Prevalence and Functional Outcome. J Trauma 2008;64:1517-1521.
- Lescheid J, Zdero R, Shah S, Kuzyk PR, Schemitsch EH. The Biomechanics of Locked Plating for Repairing Proximal Humerus Fractures With or Without Medical Cortical Support. J Trauma 2020;69:1235-1242.
- Goodnough LH, Campbell ST, Githens TC, DeBaun MR, Bishop JA, Gardner MJ. Intramedullary Cage Fixation for Proximal Humerus Fractures Has Low Reoperation Rates at 1 Year: Results of a Multicenter Study. J Orthop Trauma;2020:193-198.
- Shah KN, Sobel AD, Paxton S. Fixation of a Proximal Humerus Fracture Using a Polyaxial Locking Plate and Endosteal Fibular Strut. J Orthop Trauma 2018;32:S8-S9.
- Gardner MJ. Proximal Humerus Fracture Plating Through the Extended Anterolateral Approach. J Orthop Trauma 2016;30:S11-12.

References

- Cherney SM, Murphy RA, Achor TS, Choo AM. Subscapularis Peel for Open Reduction and Internal Fixation of Proximal Humerus Fractures With a Head Split. J Orthop Trauma 2018;2018;32:e487-e491.
- Park S, Ko Y. Medial Buttress Plating for Humerus Fractures With Unstable Medial Column. J Orthop Trauma 2019;33:e352-359.
- Walker R, Casteneda P, Putnam JG, Schemitsch EH, McKee MD. A Biomechanical Study of Tuberosity-Based Locked Plate Fixation Compared with Standard Proximal Humeral Locking Plate Fixation for 3-Part Proximal Humeral Fractures. J Orthop Trauma 2020;34:e233-e238.
- Belayneh R, Lott A, Haglin J, Konda S, Zuckerman JD, Egol KA. Osteonecrosis After Surgically Repaired Proximal Humerus Fractures Is a Predictor of Poor Outcomes. J Orthop Trauma 2018;32:e387-e393.
- McDonald E, Kwiat D, Kandemir U. Geometry of Proximal Humerus Locking Plates. J Orthop Trauma 2015;29:e425-e430.
- Donohue DM, Santoni BG, Stoops K, Tanner G, Diaz MA, Mighell M. Biomechanical Comparison of 3 Inferiorly Directed Versus 3 Superiorly Directed Locking Screws on Stability in a 3-Part Proximal Humerus Fracture Model. J Orthop Trauma 2018;32:306-312.
- Arvesen JE, Gill SW, Sinatra PM, Eng M, Bledsoe G, Kaar SG. Biomechanical Contribution of Tension-Reducing Rotator Cuff Sutures in 3-Part Proximal Humerus Fractures. J Orthop Trauma 2016;30:e262-266.
- Traver JL, Guzman MA, Cannada LK, Kaar SG. In the Axillary Nerve at Risk During a Deltoid-Splitting Approach for Proximal Humerus Fractures? J Orthop Trauma 2016;30:240-244.
- Nowak LL, Davis AM, Mamdani M, Beaton D, Kennedy C, Schemitsch EH. A Systematic Reivew and Standardized Comparison of Available Evidence for Outcome Measures Used to Evaluate Proximal Humerus Fracture Patients. J Orthop Trauma 2019;33:e256-e262.
- Gardner MJ, Weil Y, Barker JU, Kelly BT, Helfet DL, Lorich DG. The Importance of Medial Support in Locked Plating of Proximal Humerus Fractures. J Orthop Trauma 2007;21:185-191.
- Jung S, Shim S, Kim H, Lee J, Lim H. Factors that Influence Reduction Loss in Proximal Humerus Fracture Surgery. J Orthop Trauma 2015;29:276-282.
- Davids S, Allen D, Desarno M, Endres NK, Bartlett C, Shafritz A. Comparison of Locked Plating of Varus Displaced Proximal Humeral Fractures With and Without Fibula Allograft Augmentation. J Orthop Trauma 2020;34:186-192.

References

- Carofino BC, Leopold SS. The Neer Classification for Proximal Humerus Fractures. Clin Orthop Relat Res 2013;471:39-43.
- Wallace MJ, Bledsoe G, Moed BR, Israel HA, Kaar SG. Relationship of Cortical Thickness of the Proximal Humerus and Pullout Strength of a Locked Plate and Screw Construct. J Orthop Trauma 2012;26:222-225.
- Berkes MB, Little MTM, Lazaro LE, Cymerman RM, Pardee NC, Helfet DL, Dines JS, Lorich DG. Intramedullary Allograft Fibula as a Reduction and Fixation Tool for Treatment of Complex Proximal Humerus Fractures with Diaphyseal Extension. J Orthop Trauma 2014;28:e56-e64.
- Mehta S, Chin M, Sanville J, Namdaria S, Hast MW. Calcar screw position in proximal humerus fracture fixation: Don't miss high! Injury 2018:624-629.
- Campochiaro G, Rebuzzi M, Baudi P, Catani F. Complex proximal humerus fractures: Hertel's criteria reliability to predict head necrosis. Musculoskelet Surg 2015;99:S9-S15.
- Dillon MT, Prentice HA, Burfeind WE, Chan PH, Navarro RA. The increasing role of reverse total shoulder arthroplasty in the treatment of proximal humerus fractures. Injury 2019:676-680.
- Rouleau DM, Mutch J, Laflamme G. Surgical Treatment of Displaced Greater Tuberosity Fractures of the Humerus. J Am Acad Orthop Surg 2016;24:46-56.
- Vallier HA. Treatment of Proximal Humerus Fractures. J Orthop Trauma 2007;21:469-476.
- Sobel AD, Shah KN, Paxton ES. Fixation of a Proximal Humerus Fracture With an Intramedullary Nail. J Orthop Trauma 2017;31:S47-S49.
- Spross C, Meester J, Mazzucchelli RA, Puskas GJ, Zdravkovic V, Jost B. Evidence-based algorithm to treat patients with proximal humerus fractures – a prospective study with early clinical and overall performance results. J Shoulder Elbow Surg 2019;28:1022-1032.

References

- Court-Brown CM, Heckman JD, McQueen MM, Ricci WM, Tornetta P. Rockwood and Green's Fractures in Adults. 2015. Wolters Kluwer Health.
- Konrad G et al. Open Reduction and Internal Fixation of Proximal Humerus Fractures with Use of the Locking Proximal Humerus Plate: Surgical Technique. JBJS 2010;92:85-95.
- Gardner MJ, Henley MB. Harborview Illustrated Tips and Tricks in Fracture Surgery. Wolters Kluwer 2011.
- Jost B, Spross C, Grehn H, Gerber C. Locking plate fixation of fractures of the proximal humerus: analysis of complications, revision strategies and outcome. JSES 2013; 22:542-549.
- Stern L, Gorczyca MT, Gorczyca JT. Preoperative measurement of the thickness of the center of the humeral head predicts screw cutout after locked plating of proximal humerus fractures. JSES 2021;30:80-88.
- Jost B, Spross C, Grehn H, Gerber C. Locking plate fixation of fractures of the proximal humerus: analysis of complications, revision strategies and outcome. JSES 2013; 22:542-549.
- Knierzinger D, Crepaz-Eger U, Hengg C, Kralinger F. Does cement augmentation of the screws in angular stable plating for proximal humerus fractures influence the radiological outcome: a retrospective assessment. Archives of Orthopaedic and Trauma Surgery 2020; 140:1413-1421.
- Wright JO, Ho A, Kalma J, Koueiter D, Esterle J, Marcantonio D, Wiater JM, Wiater B. Uncemented Reverse Total Shoulder Arthroplasty as Initial Treatment for Comminuted Proximal Humerus Fractures. JOT 2019;33;7:e263-9.
- Adeyamo A, Bertha N, Perry KJ, Updegrove G. Implant Selection for Proximal Humerus Fractures. Orthop Clinics 2021;52:167-175.