

The Proximal Humerus Fracture in the Elderly

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Objectives



- **Review Principles of Evaluation and Management of Geriatric Proximal Humerus Fractures**
- **Review Proximal Humerus Classification Systems**
- **Develop an Understanding of Unique Considerations & Geriatric-Specific Risk Factors**
- **Understand the Indications for Operative Versus Nonoperative Management**
- **Review Treatment Options**
- **Understand Rehabilitation Protocols for Operative and Non-Operative Management**
- **Review Outcomes and Evidence**

Demographics



- Elderly population is growing
- As population is aging the number of proximal humerus fractures is expected to increase
- 3rd most common osteoporotic fracture
 - (Distal Radius & Hip)
- Females > Males
- Highest risk in Caucasian females

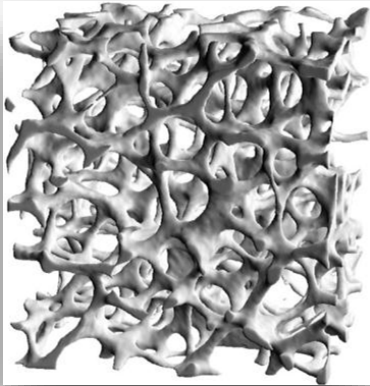
Why Are Geriatric Fractures Different?



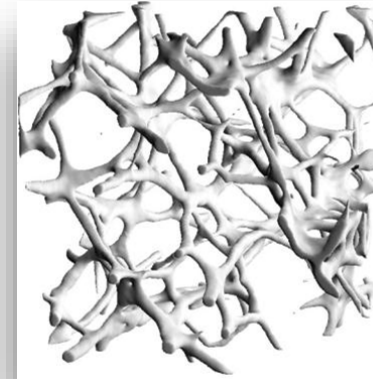
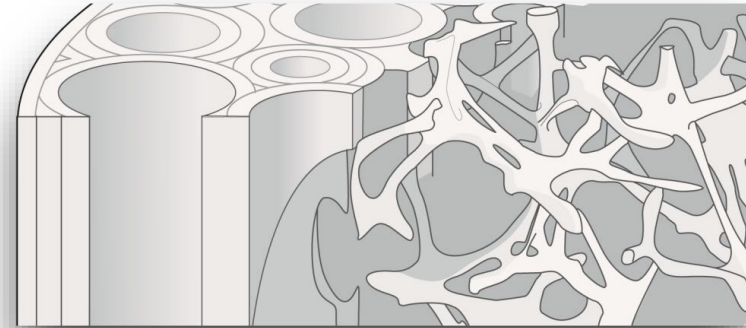
- **Osteoporotic Bone**
- **Mechanism**
 - Ground level fall vs high energy in younger patients
- **Fracture Patterns**
- **Concomitant Injuries**
- **Treatment Goals**
- **Surgical Considerations & Indications**

Why Are Geriatric Fractures Different?

- **Normal Bone**



- **Osteoporotic Bone**



Geriatric Risk Factors



- **Osteoporosis**
 - Low Bone Mineral Density
 - Makes obtaining AND maintaining reduction challenging
- **Impaired vision / hearing**
- **Balance Issues**
- **Polypharmacy**
- **Social Isolation**

Mechanism of Injury



- **Ground level fall**
 - Majority
- **High energy trauma**
 - More common in younger population

Clinical Presentation



- Shoulder pain
- Arm held close to body / supported by contralateral
- Ecchymosis about upper arm
- Swelling

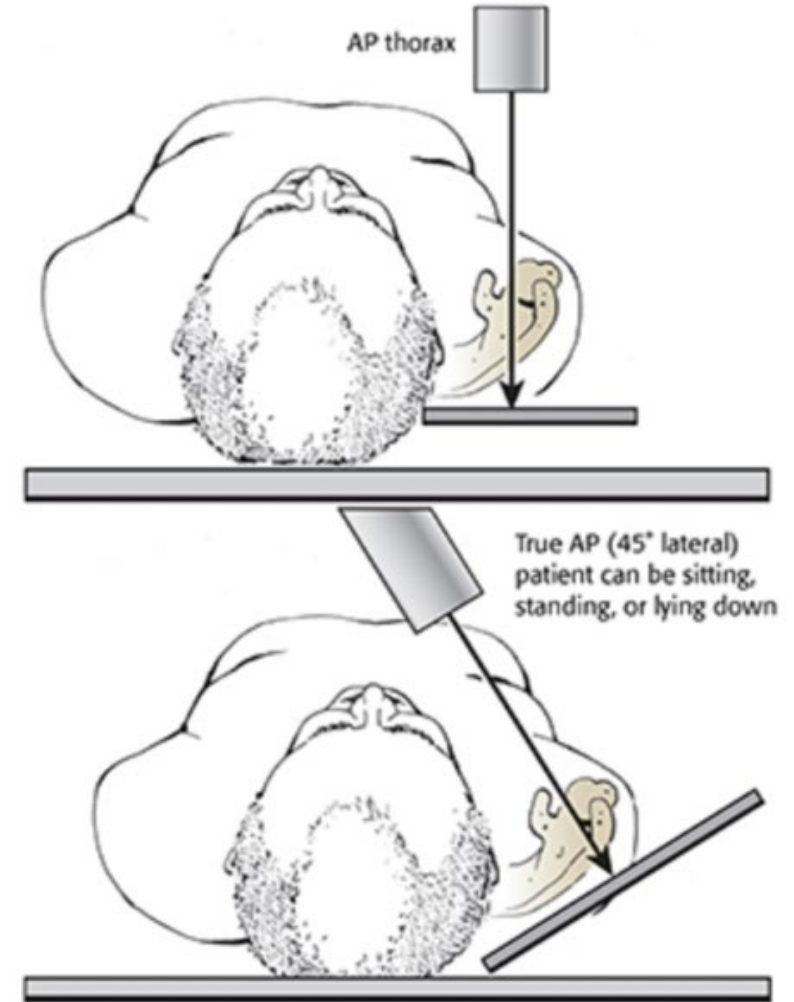
Assessment



- Physical Examination
- Identify Concomitant Injuries
- Imaging
- Comorbidities
- Anticoagulation?

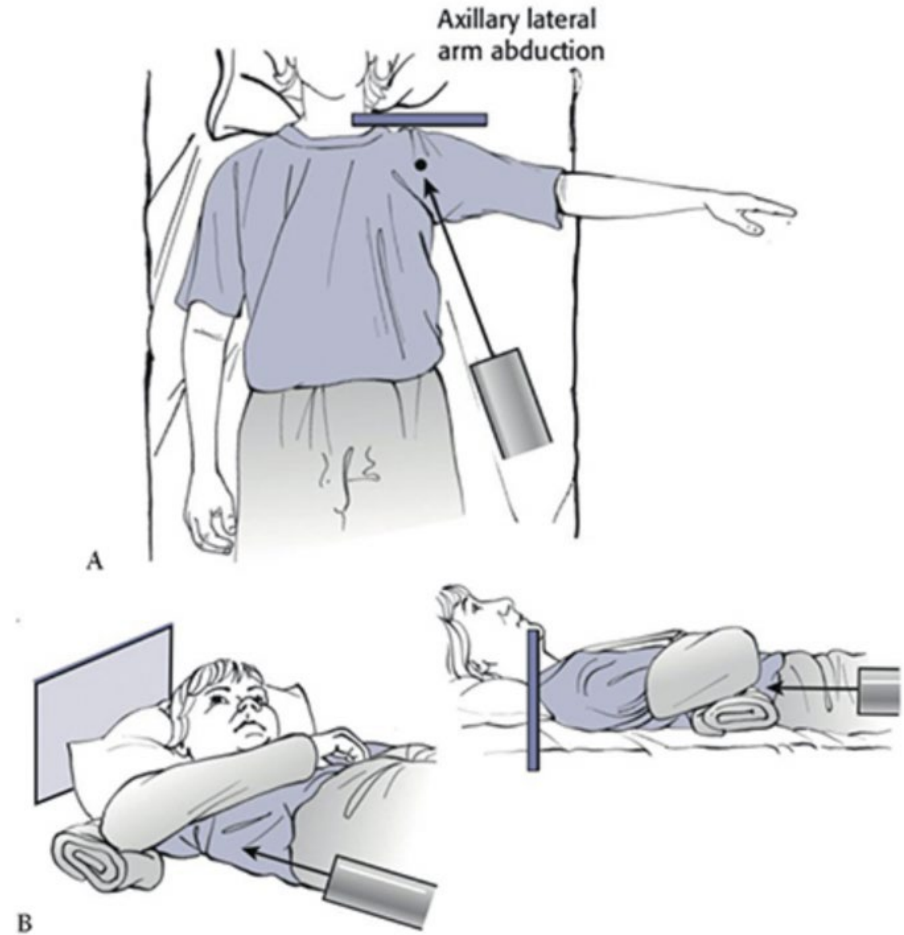
Imaging

- **Radiographs**
 - Grashey
 - Neer / Scapular Y
 - Axillary
 - Velpeau
 - (if needed / unable to obtain axillary)
- **Computed Tomography (CT)**
- **Magnetic Resonance Imaging (MRI)**
 - Rare need in elderly population



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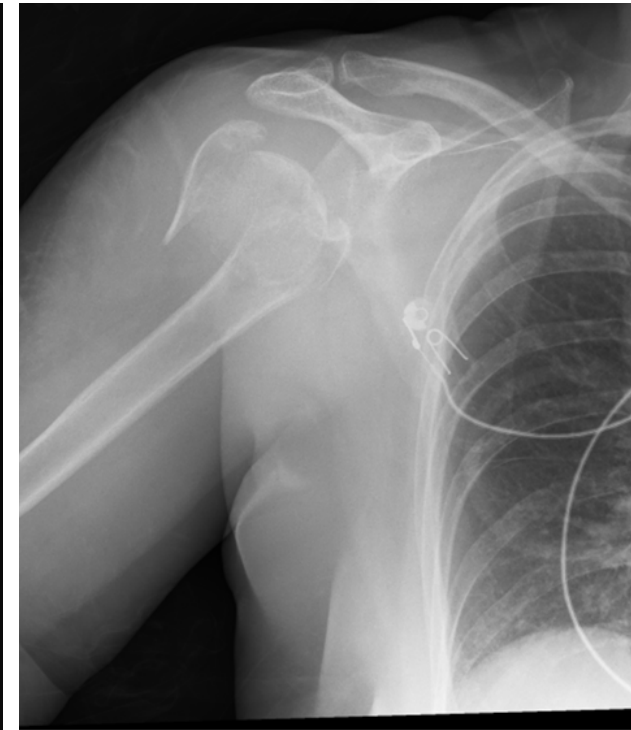
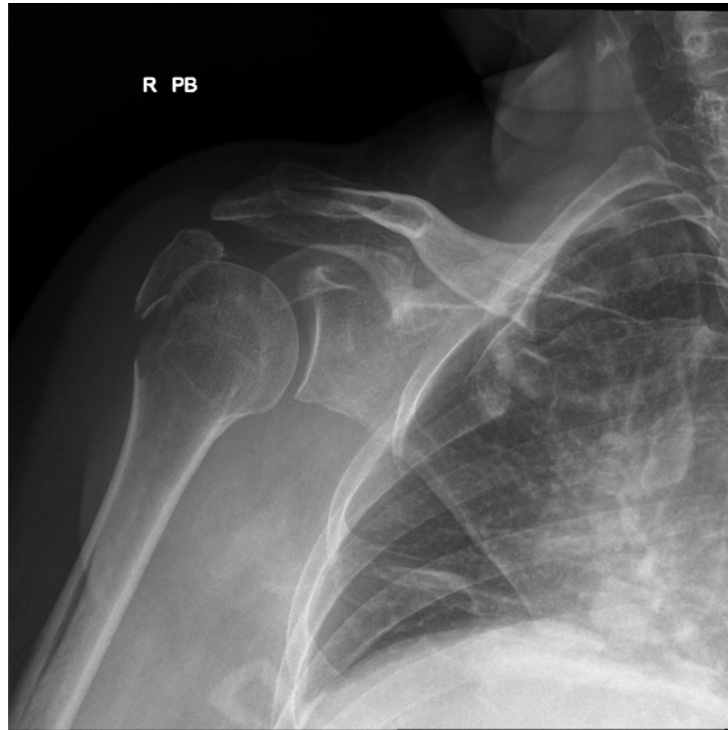
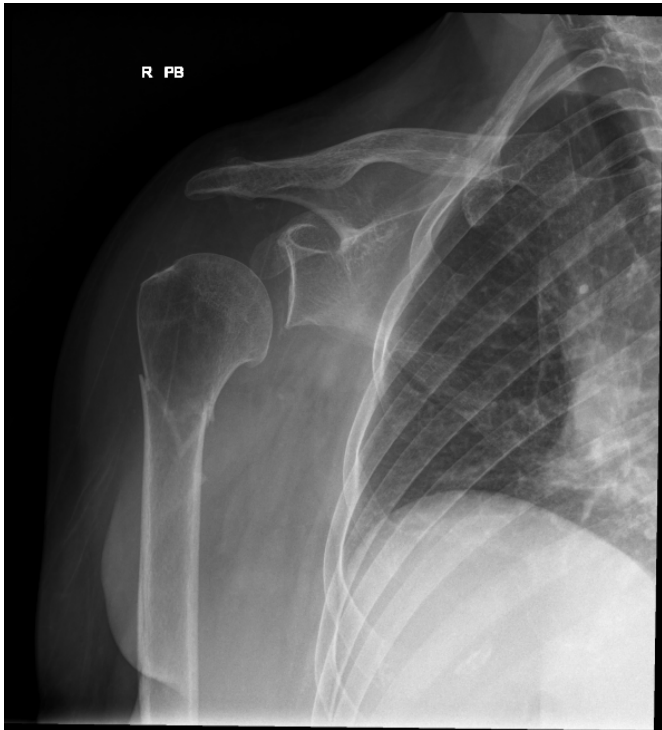
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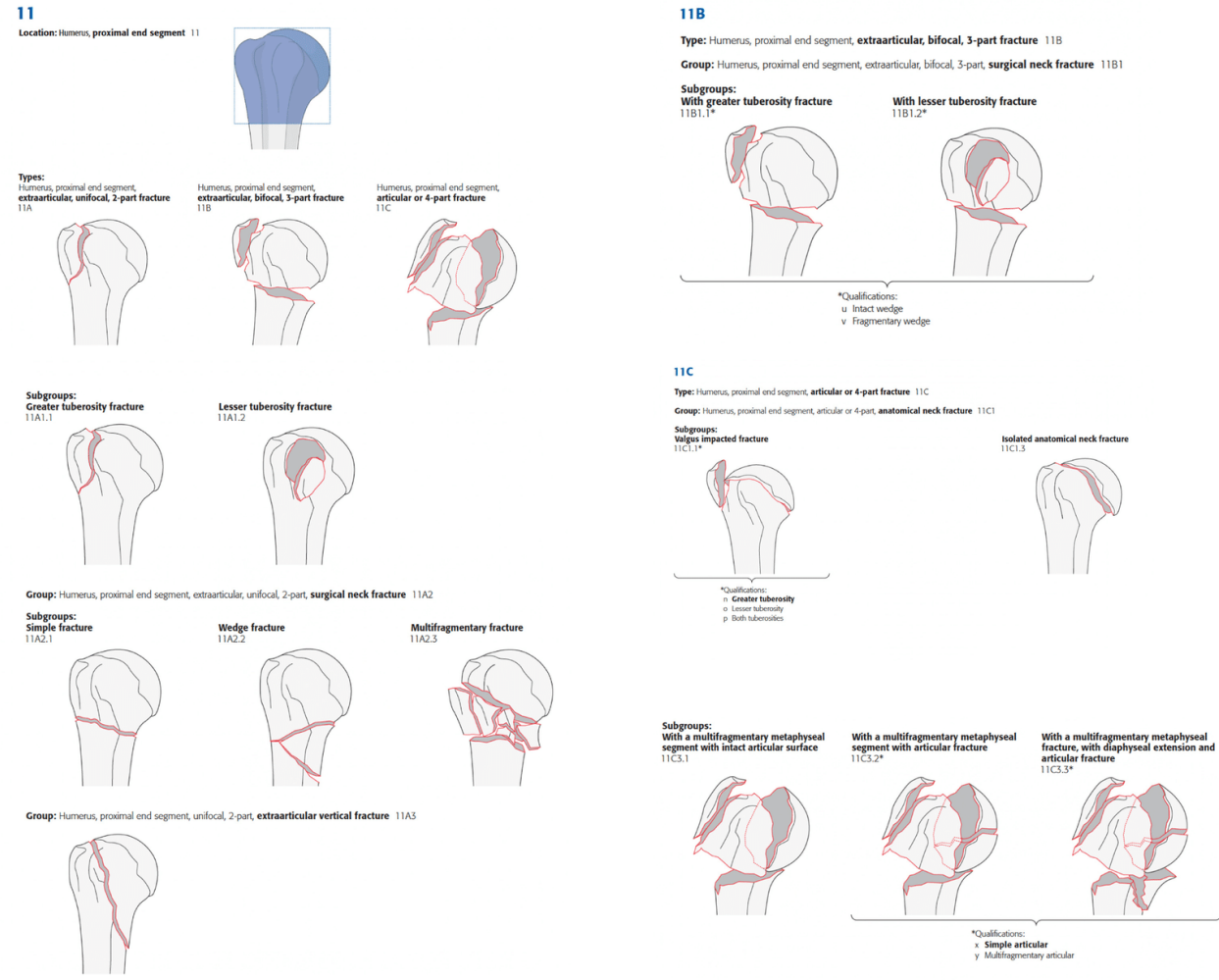


Not All Proximal Humerus Fractures Are Equal!



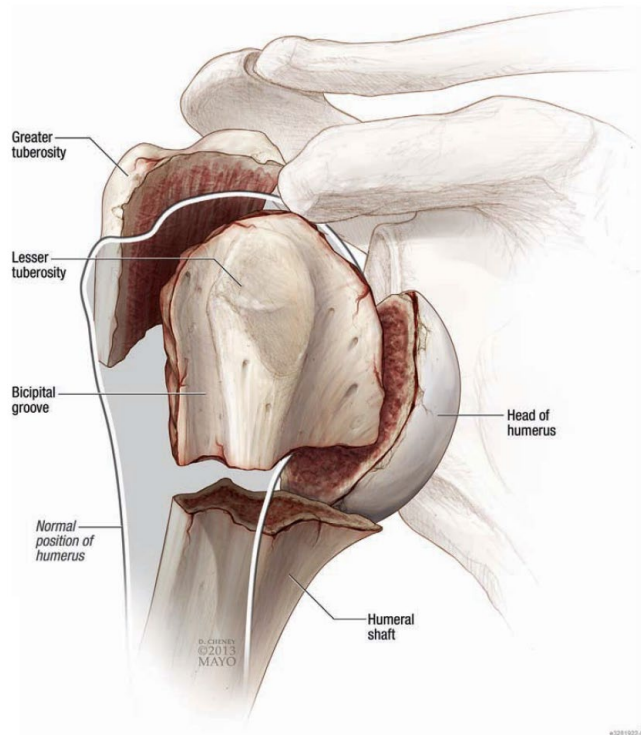
AO/OTA Classification

- **11A**
 - Extraarticular, unifocal, 2-part fracture
- **11B**
 - Extraarticular, bifocal, 3-part fracture
- **11C**
 - Articular or 4-part fracture



Meinberg EG, Agel J, Roberts CS, Karam MD, Kellam JF. Fracture and Dislocation Classification Compendium-2018. J Orthop Trauma. 2018 Jan;32 Suppl 1:S1-S170. doi: 10.1097/BOT.0000000000001063. PMID: 29256945.

Neer Classification



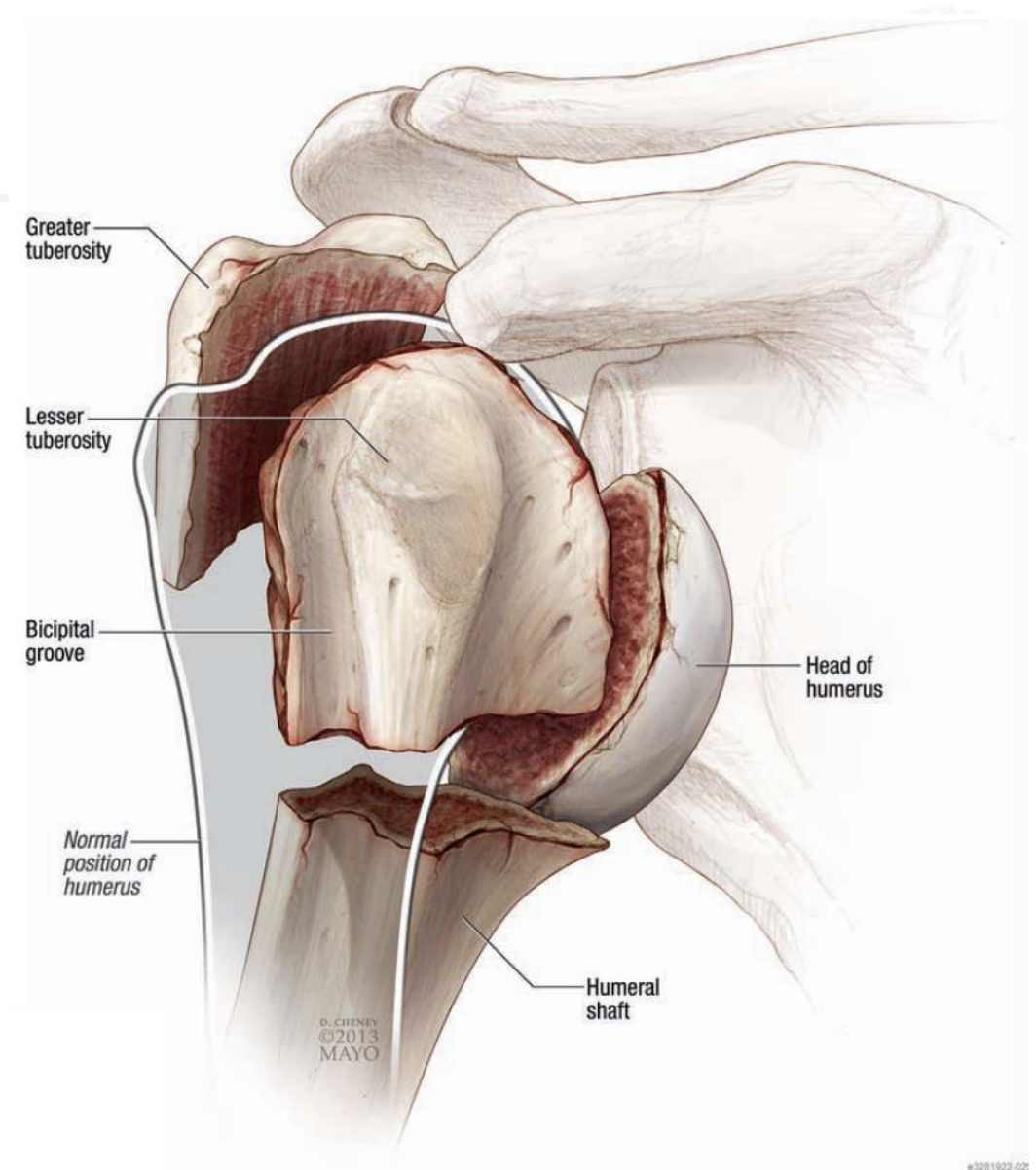
DISPLACED PROXIMAL HUMERAL FRACTURES

I MINIMAL DISPLACEMENT	DISPLACED FRACTURES			
	2 PART	3 PART	4 PART	
II ANATOMICAL NECK				
III SURGICAL NECK				
IV GREATER TUBEROSITY				
V LESSER TUBEROSITY				
VI FRACTURE - DISLOCATION				ARTICULAR SURFACE

Neer CS 2nd. Displaced proximal humeral fractures. I. Classification and evaluation. *J Bone Joint Surg Am.* 1970;52:1077-1089

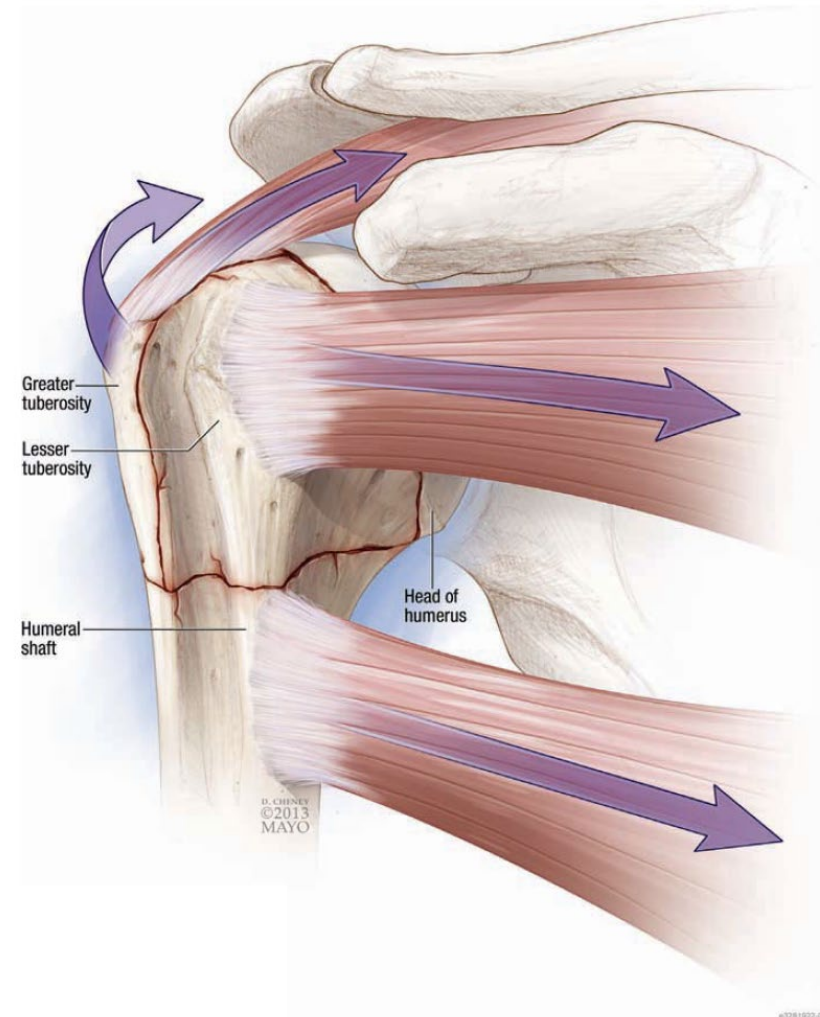
Neer Classification

- **Four Parts**
 - Head
 - Greater Tuberosity
 - Lesser Tuberosity
 - Shaft
- **Must be displaced ≥ 1 cm or angulated $\geq 45^\circ$**



Deforming Forces

- **Subscapularis**
 - Pulls lesser tuberosity medially
- **Supraspinatus & Infraspinatus**
 - Pulls greater tuberosity superiorly and posteriorly
- **Deltoid**
 - Displaces humeral shaft proximally
- **Pectoralis Major**
 - Displaces humeral shaft medially and anteriorly



Associated Injuries



- **Another Fracture (~17%)**
 - Proximal Femur (7%)
 - Distal Radius (2%)
 - Pelvis (2%)
 - Contralateral Proximal Humerus (<1%)
- **Rotator Cuff Tear (30%)**
- **Nerve Injury**
 - Axillary > suprascapular > radial > musculocutaneous > median > ulnar
- **Vascular Injury (Rare)**

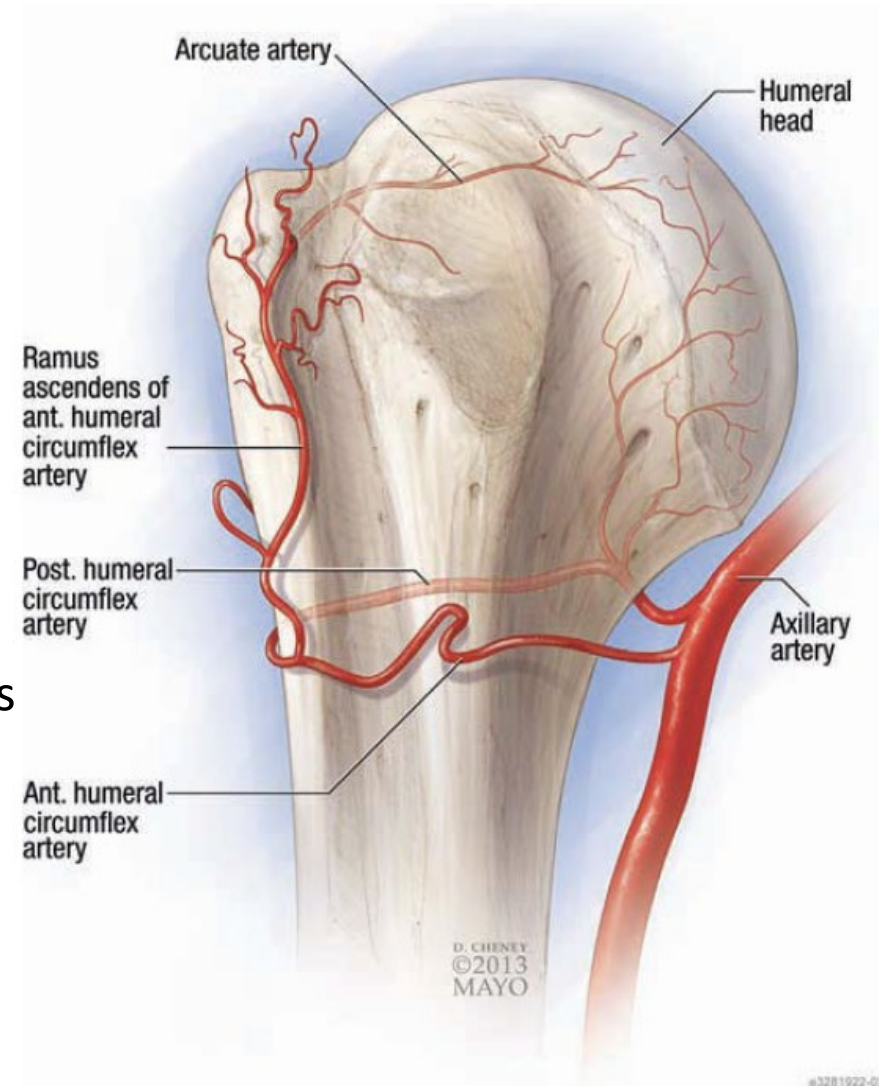
Treatment Goals



- **Young Patients**
 - Restore function
- **Elderly Patients**
 - Informed by functional demands, comorbidities, surgical candidacy
 - Maximize function
 - Pain relief

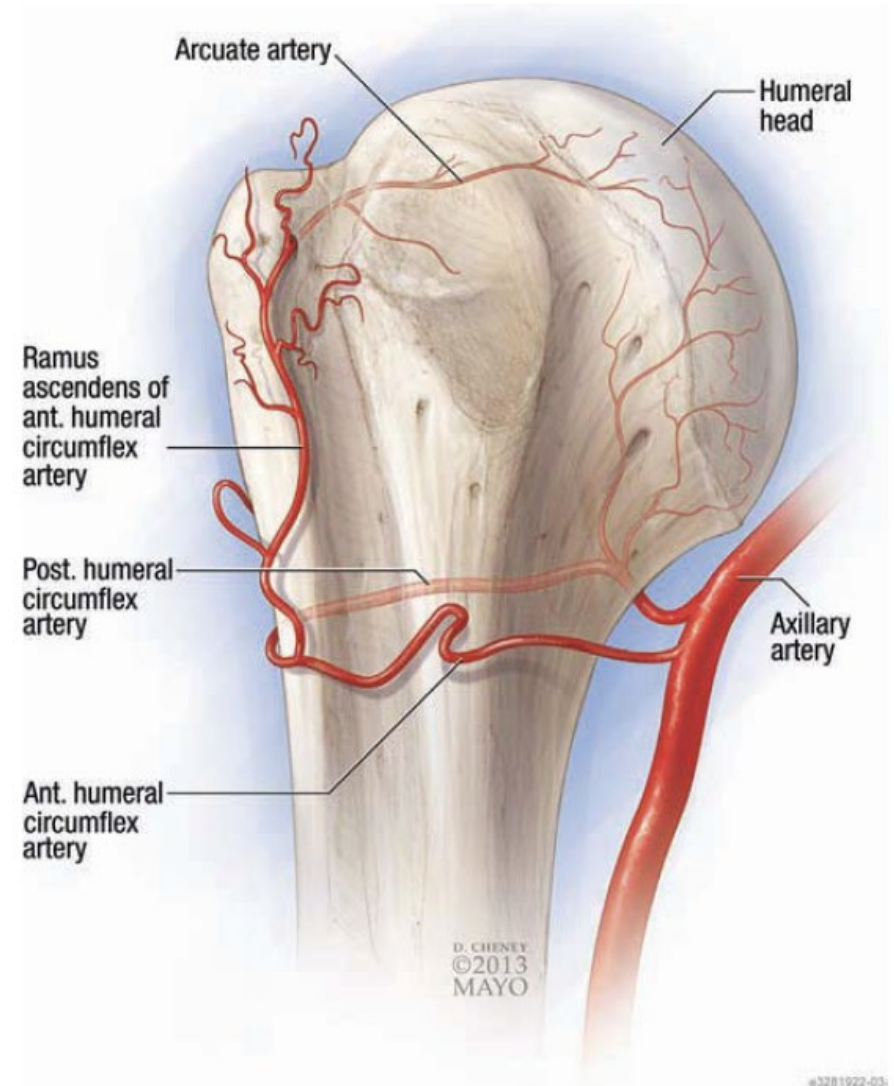
Blood Supply

- Vascular supply made up of the **anterior** and **posterior humeral circumflex arteries**
- **Arcuate artery** is the terminal branch of the **anterior humeral circumflex artery**
 - Can be disrupted by anatomic neck fractures
- **Posterior humeral circumflex** less likely to be injured



Predictors of AVN

- 4-part fractures
- Calcar disruption
- Fracture through anatomic neck
- Head splitting fractures



Surgical Management



- Indications
- Nonoperative management
- Principles of surgical fixation
- Arthroplasty indications

Relative Indications



- Modern Randomized Controlled Trial Inclusion Criteria
 - >45 valgus or >30 varus in a true anteroposterior projection
 - >45 angulation in a scapular Y projection with the arm in neutral rotation
 - >50% displacement of the humeral head against the metaphysis
 - 10 mm of displacement between the head and shaft fragments
 - fracture of the greater or lesser tuberosity with at least 10 mm of displacement.
 - 5mm superior displacement of the greater tuberosity

Indications - Controversy!



- Level 1 and 2 evidence does not support surgery for displaced proximal humerus fractures
- Trials:
 - Olerud (hemi) Level 1
 - Olerud (plate) Level 1
 - Boons Level 1
 - Launonen Level 1
 - Lopiz Level 1
 - Fjalestad Level 2
 - Rangan Level 2

Indications - Controversy!



- 22 Studies (7 level 1 and 2, 15 level 3) Surgical vs Conservative
- Findings:
 - Patient outcomes
 - **No** significant differences ($P = 0.208$)
 - Range of motion
 - **No** significant differences ($P = 0.275$)
 - Complications
 - **Lower** complication rates for conservative treatment ($P = 0.0001$).

Indications – Problems with RCT's



- Varying levels of surgeon experience within trials
- Heterogeneity within classification groups
 - Extensive differences in comminution and displacement amongst similarly classified fractures
 - Highly complex injuries excluded from some trials
 - PROFHER study

RCT issues – Experience Matters!



- Helfen et al – high volume surgeons
 - lower rates of revision surgery when treating 2-part proximal humeral fractures
- Min et al – high volume surgeons
 - better calcar reduction and tuberosity reduction
 - Lower rates of revision
 - “there may be individuals who have the unique ability to markedly provide better results”

RCT issues – Experience Matters!



- Dean Lorch, MD geriatric vs nongeriatric single surgeon series
 - Mean Constant-Murley score **82.7** (geriatric) vs **86.3** (non-geriatric)
 - Compared with Constant scores in the Level 1 RCT's
 - **61** (Olerud) RCT
 - **68** (Launonen) RCT

RCT issues - Heterogeneity



- Within classification groups, large discrepancies exist regarding fracture severity
- Would results change if only the most displaced fractures were evaluated?
 - PROFHER trial
 - Excluded severe fracture patterns
 - Significant **translation** performs particularly poorly

Translation issues

- Shahien et al - 80% translation associated with failure of nonoperative care = nonunion, symptomatic malunion, and potential surgery
- Cosic et al – patients with >100% displacement = improved health status and radiological outcomes after surgical fixation.



In Summary:



- RCT's do not support ORIF
- Trials may overlook the importance of:
 - Surgeon experience
 - Significant impact of severe displacement

Nonoperative Management



- Sling
- Non weight bearing
- Physical Therapy (PT) modalities to start at 3 weeks
 - Pendulums
 - Active/active assist and light passive modalities
- PT advanced at 6 weeks
 - Discontinue sling
 - Advance range of motion with active and passive maneuvers

Nonoperative Management - what to expect

- RCT data **VERY** helpful for understanding nonoperative implications
- Nonoperative groups similar in fracture patterns to operative group
- Findings:
 - Olerud – Constant Score **58.4** in the conservative group
 - Launonen – Constant Score **66** in the conservative group

Surgical Management: ORIF Relative Indications

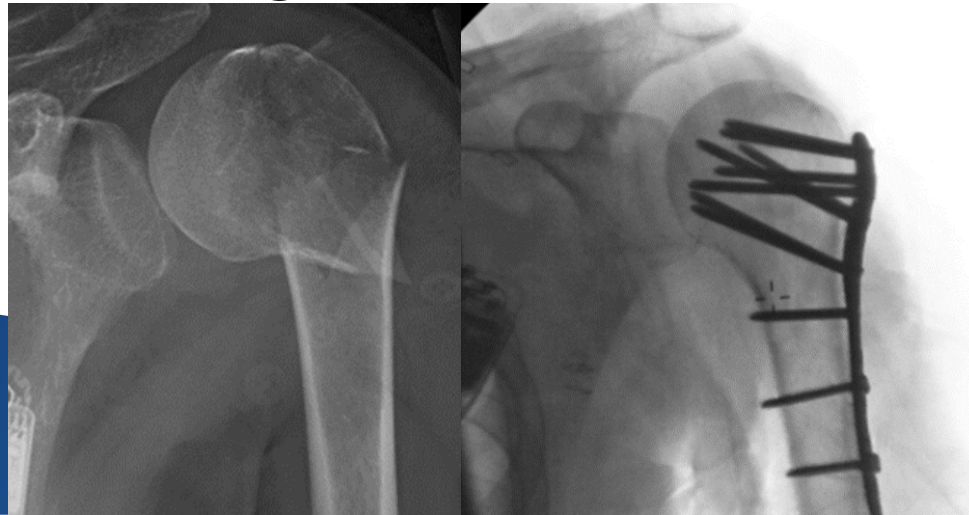
- Experienced surgeon
- 2, 3, or 4 part fracture
- Consider the following questions:
 - 1) Is the dominant head fragment viable?
 - 2) Can a reduction be obtained?
 - 3) Can the reduction be rigidly stabilized and maintained?
 - 4) Can the patient protect the arm and participate in Physical Therapy?

Surgical Management: ORIF goals



- **Reduction:**

- **improvements** in clinical outcome and **decreased** failure rates with anatomic reduction
- Intraoperative reduction targets
 - proximal displacement of the greater tuberosity less than 5 mm
 - headshaft displacement less than 5 mm
 - head-shaft coronal alignment within 120 to 150 degrees

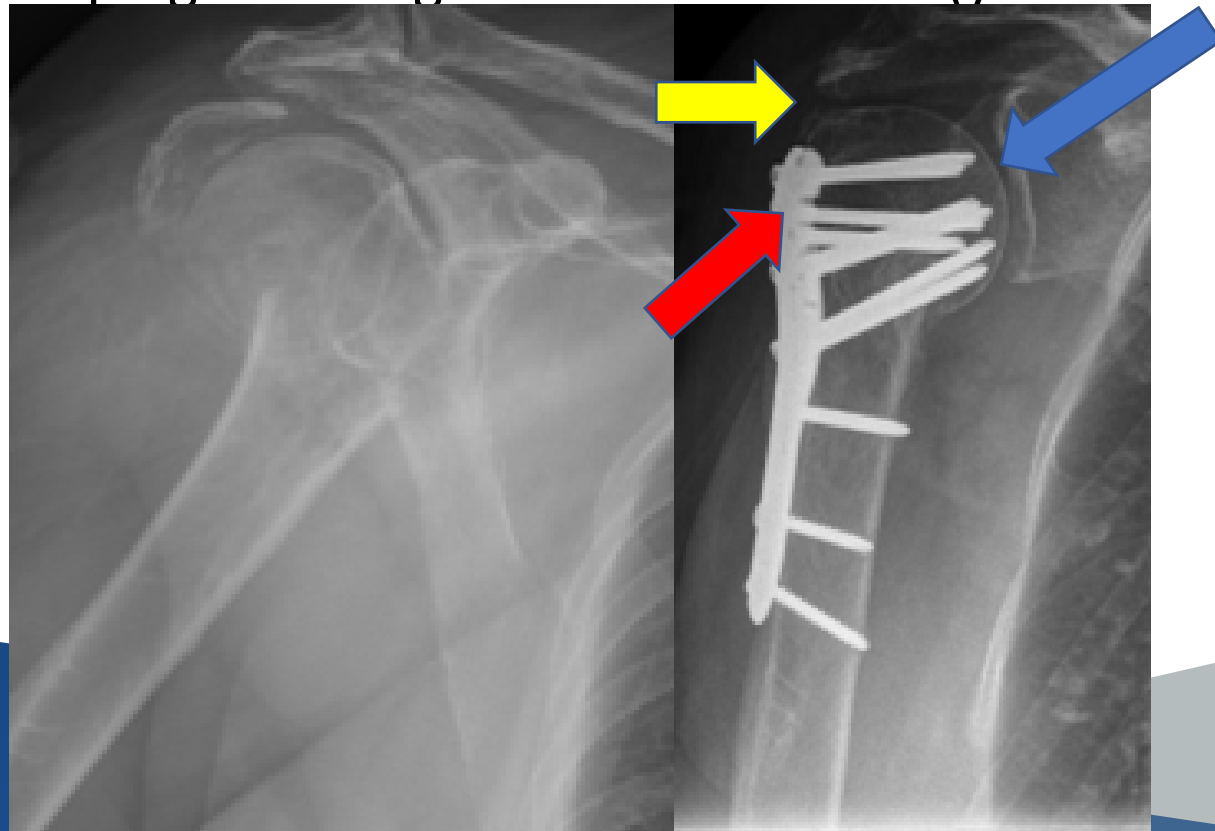


Surgical Management: ORIF goals

- **Fixation**

- Plate position

- maximizes the volume of the humeral head occupied by locking screws (blue arrow)
 - provides buttress support to a fractured greater tuberosity (red arrow)
 - avoids mechanical impingement against the acromion (yellow arrow)



Surgical Management: ORIF goals

- **Fixation**

- **Screw Choices**

- Divergent Screws
- At least 5 screws PLUS a calcar screw
- Screw length – within 5mm of subchondral bone



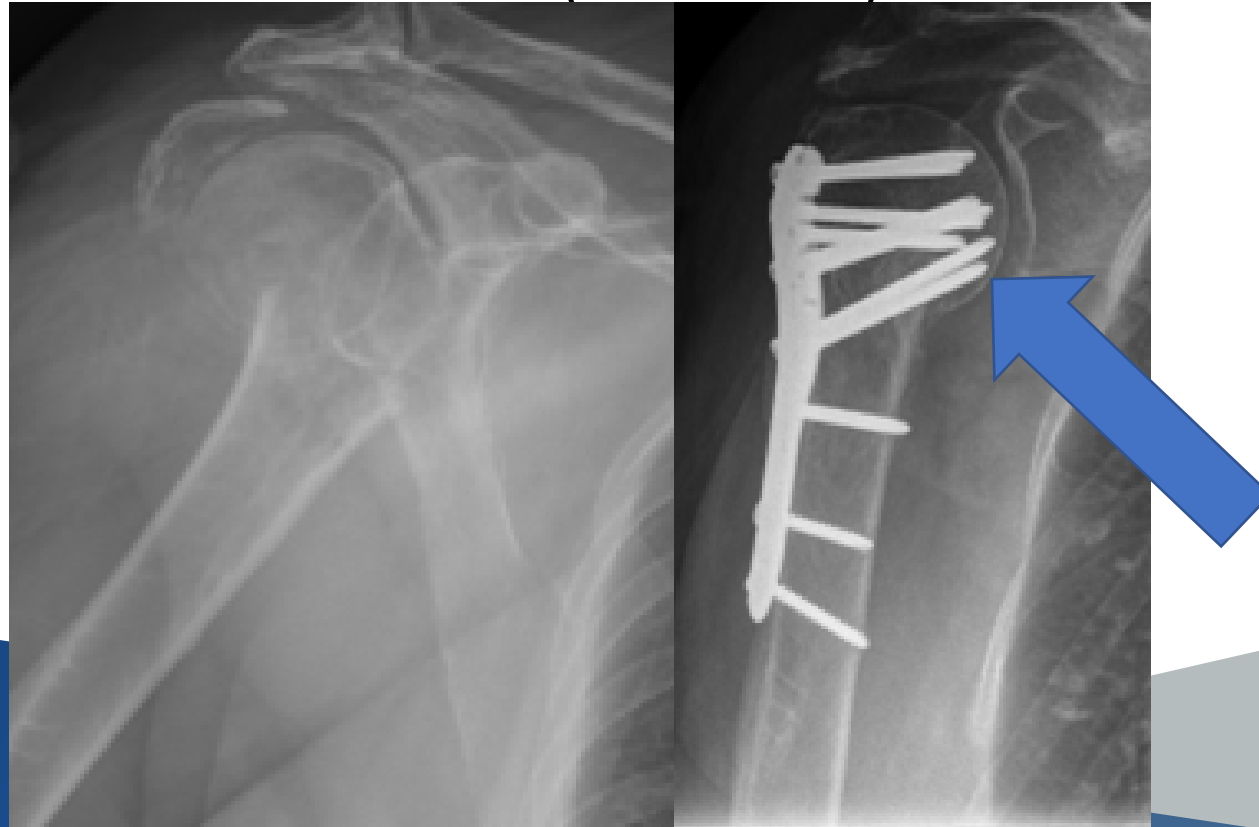
Surgical Management: ORIF goals



- **Fixation**

- **Calcar screw**

- Importance validated by numerous studies
- Placed into the inferomedial quadrant of the humeral head
- Goal = within 5mm of subchondral bone (blue arrow)



Surgical Management: ORIF Augmentation

- **Tuberosity repair**

- Tuberosities often too comminuted to hold screw fixation
- Sutures placed into rotator cuff and tied to plate reduce and secure the reduction of the tuberosity
- Leads to decreased collapse and failure
- Cuff sutures can be used alone with anchors for isolated comminuted tuberosity fractures



Surgical Management: ORIF goals



- **Osteoporosis and inadequate medial calcar support**
 - Goal: augment to fill voids and support reduction/fixation
 - Allograft fibula endosteal implant
 - Calcium phosphate

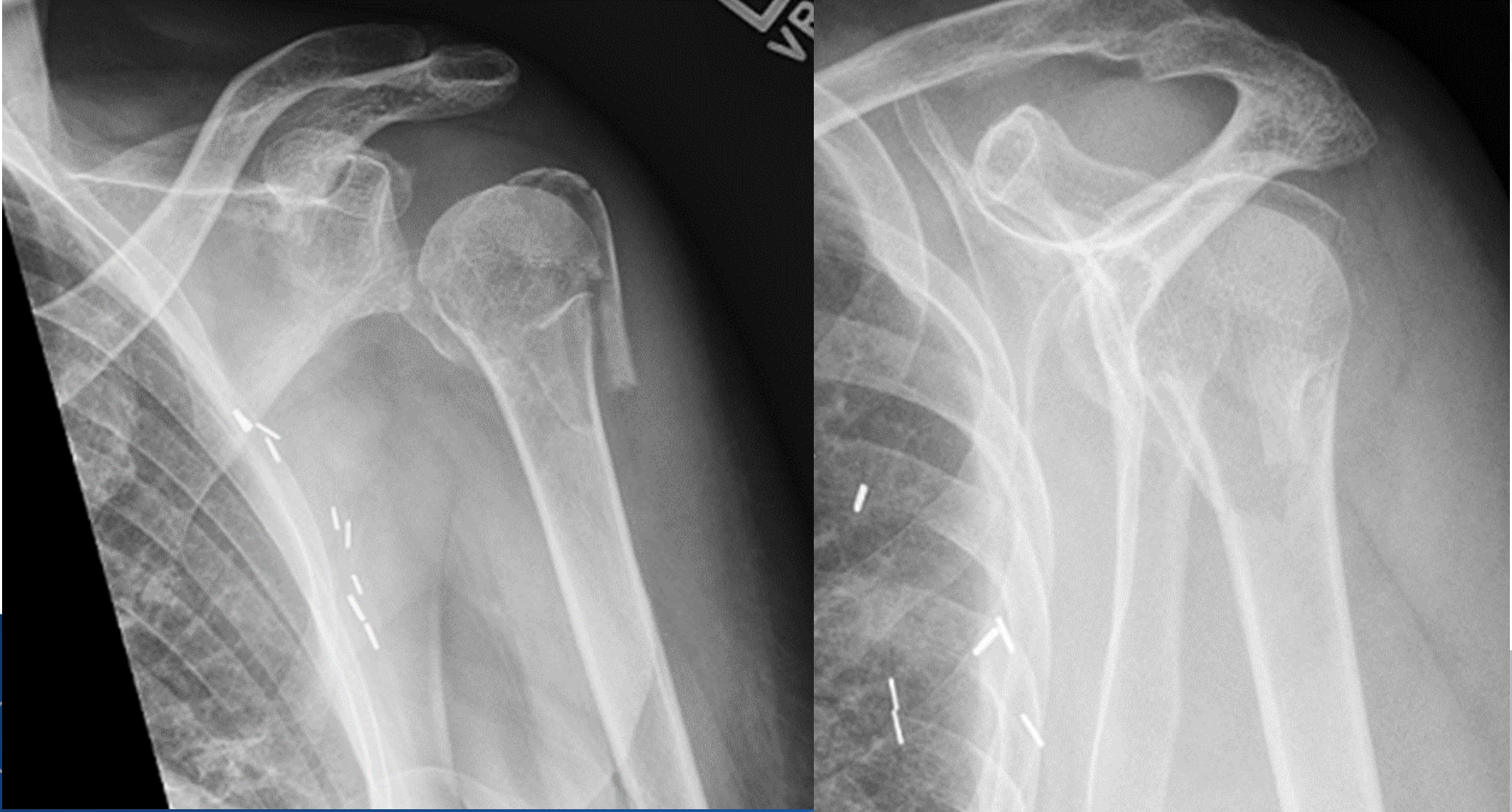
Surgical Management: ORIF goals



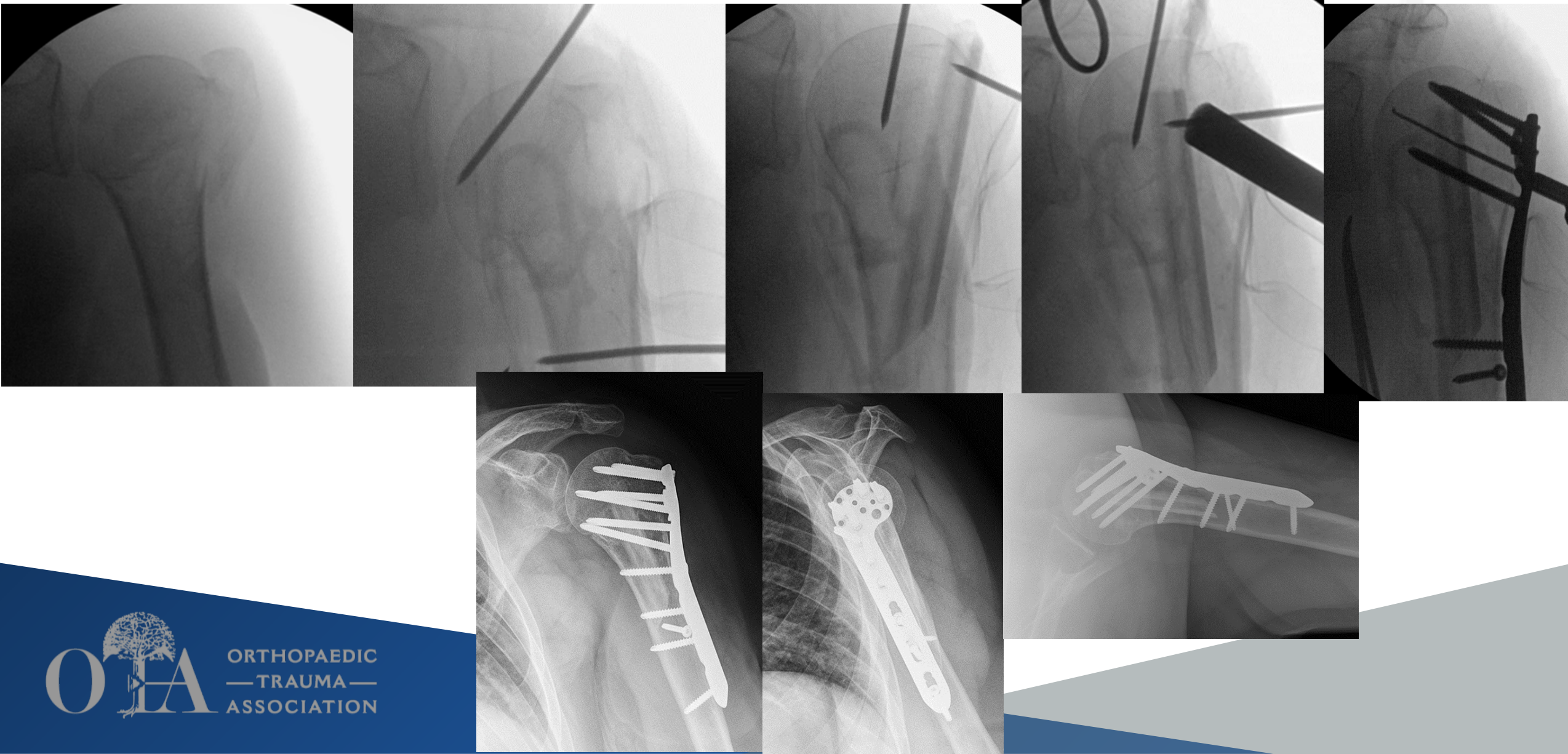
- Allograft fibula endosteal implant
 - improves construct stiffness
 - Improves load to failure
 - limits fracture displacement
 - Reduces complication rates in some series
 - Associated with better patient-reported outcomes in some series



Allograft Technique – 76 year old female



Allograft Technique



Surgical Management: ORIF goals



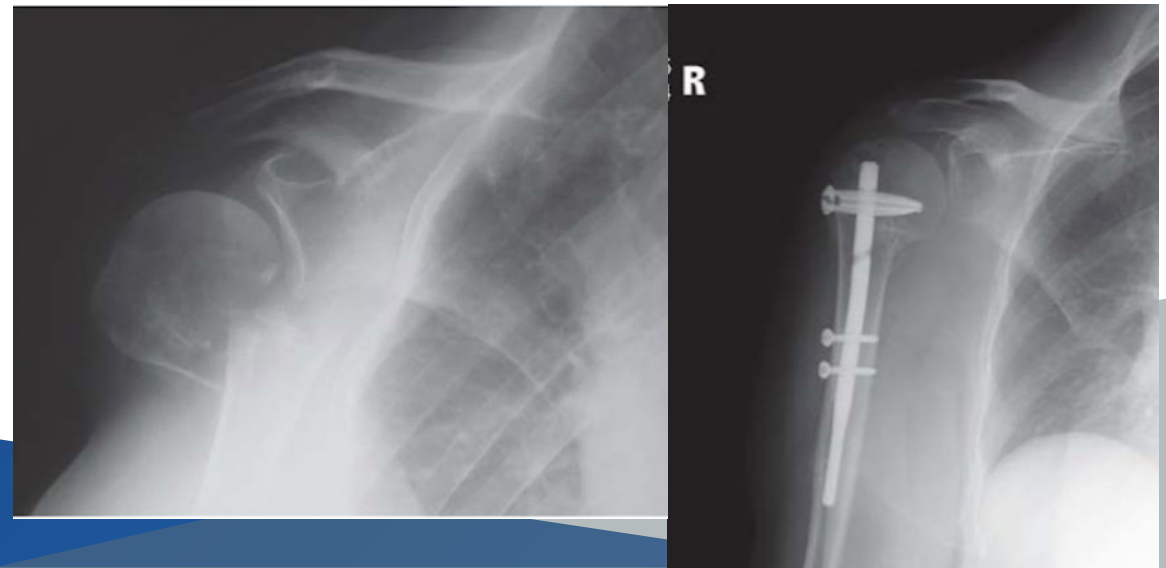
- **Osteoporosis and inadequate medial calcar support**
 - Calcium phosphate
 - superior to cancellous bone in the prevention of fracture settling and intra-articular screw penetration



Additional Fixation Options: Nails



- Reduction
 - Avoid varus/valgus
 - Align the shaft in parallel with the head
 - Reduce and provisionally fix tuberosities prior to nail insertion
- Entry point
 - More medial starting points can be used to **avoid the rotator cuff tendon insertion**
 - Alternatively, the lateral articular border of the humeral head can also be used as a point of entry
- Outcomes
 - Similar to ORIF with plates; no clear implant is superior or inferior (plate vs nail)
 - Tailor care to fracture type



Does age matter?



- If...
 - Bone amenable to fixation
 - Reduction optimized
 - Fixation supported by bone and augments
 - Patient can participate in rehab
- Then... **potentially** not
 - Lorch geriatric outcomes equivocal to young patients

Does age matter?



- Keep in mind:
ORIF Complication rate 44%
Reoperation rate 11%

Causes: unreduced calcar, unreduced GT, age > 80, osteoporosis, prior radiation



What about arthroplasty?

Always remember conservative treatment!



Trial of Nonoperative Management?

Minimal impact on the ultimate function of the arthroplasty in a delayed setting

- Equal Forward flexion
- Equal Outcome scores
- Equal Reoperation rates

When to consider replacement in the geriatric population?

- Head splitting patterns
- 4 part fractures
- 3 part fracture dislocations
- Pre-existing rotator cuff deficiency
- Poor bone quality

Hemiarthroplasty – Technical Considerations

- Head Height
 - Pectoralis insertion 5.6 cm distal to top of head
 - Biceps tension
- Medial Offset
 - Template from intact shoulder
- Version
 - Restore retroversion (30 deg)

Hemiarthroplasty – Outcomes



- Forward flexion of 105.7°
- Abduction of 92.4°
- External rotation of 30.4°
- **Mild/no pain in 85%**
- Constant score of 56
- **>40% considered unsatisfactory**

Hemiarthroplasty vs Reverse Total Shoulder (RTSA)

- Superiority of RTSA is trending in the literature
 - 2021 RCT from Sweden
 - 48 patients rTSA, 51 patients Hemi
 - Constant score
 - 58.7 vs 47.7
 - Greater mean satisfaction
 - Flexion
 - 125° vs 90°

More RTSA data



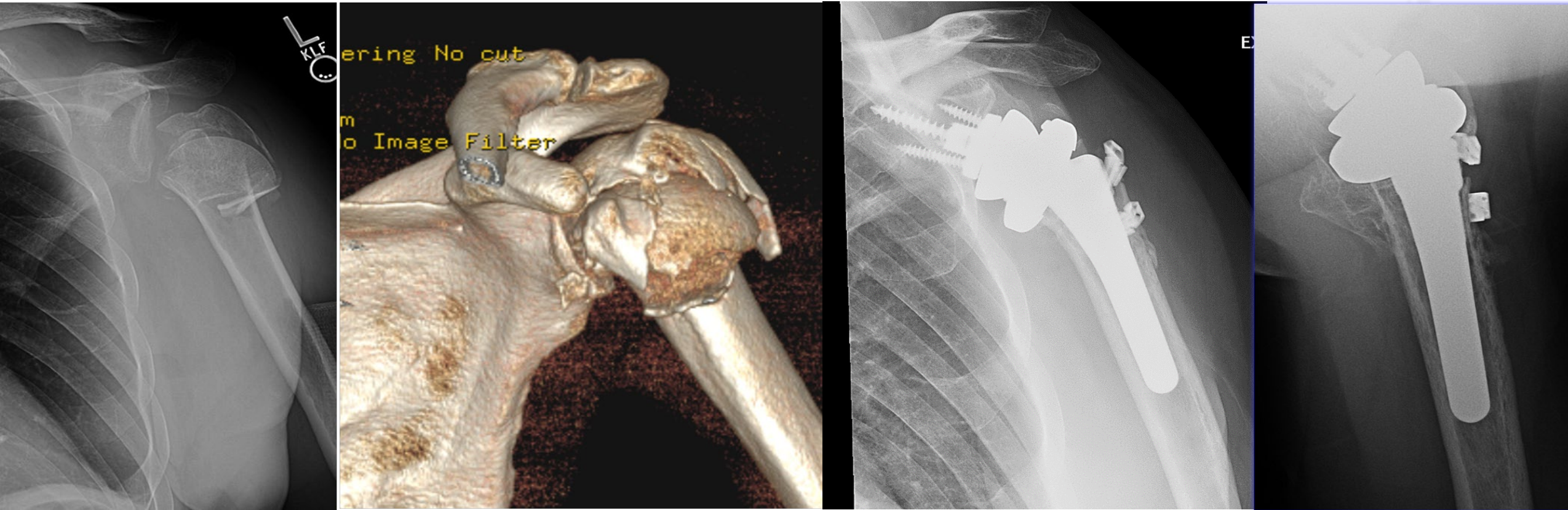
- 2024 SHERPA Trial – RTSA vs Hemiarthroplasty
 - Level 1 RCT of 18 patients 65 and older
 - Constant scores of **51** for RTSA
Constant scores of **34** for hemiarthroplasty
 - No differences in failure

RTSA – Technical Considerations



- Glenoid Preparation
 - Excise Labrum
 - Focus exposure to visualize inferior glenoid
 - Place Baseplate
 - INFERIOR on Glenoid as possible
 - Tilt INFERIORLY
- Humeral Preparation
 - 20-30 Degrees retroversion
 - Height 5.6cm from Pectoralis insertion
 - Tenotomize/Tenodesis for biceps tendon
 - Repair Tuberosities

67 year-old physical therapist, fall from ladder



How does RTSA compare to ORIF?



- RCT from 2020 – 124 patients
- Inclusion criteria:
 - >65 years old
 - >45 valgus or >30 varus in a true anteroposterior projection,
 - >45 angulation in a scapular Y projection with the arm in neutral rotation
 - >50% displacement of the humeral head against
 - The degree of tubercle displacement was not critical for inclusion.
- Constant Scores
 - 68.0 RTSA
 - 54.6 ORIF

Take Home Message



- RTSA reliably returns constant scores in the 50's-60's
- Well done ORIF by experienced surgeons **can** result in constant scores in the 80's but has not shown superiority in the RCT setting
 - Indicate patients carefully, the choice for ORIF or RTSA cannot be made for an entire population based on an RCT - each case must be individually assessed and indicated
 - ORIF only if fracture pattern, bone quality, and patient participation are optimal
 - Always remember that conservative care is an option

Summary



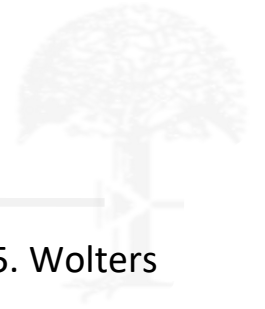
- Geriatric proximal humerus fractures are continuing to increase
- They present unique management challenges distinct from those in younger patients
- Treatment goals are informed by functional demands and comorbidities and include pain relief while maximizing function
- The majority can be treated nonoperatively, however both ORIF and arthroplasty have a role in any treatment algorithm

Learn More



- **OTA Online Education Resources**
 - [OTA Online Evidence Based Resource List](#)
 - [OTA FractureBook](#)

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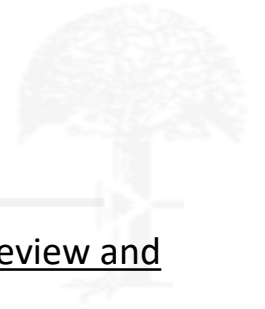
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