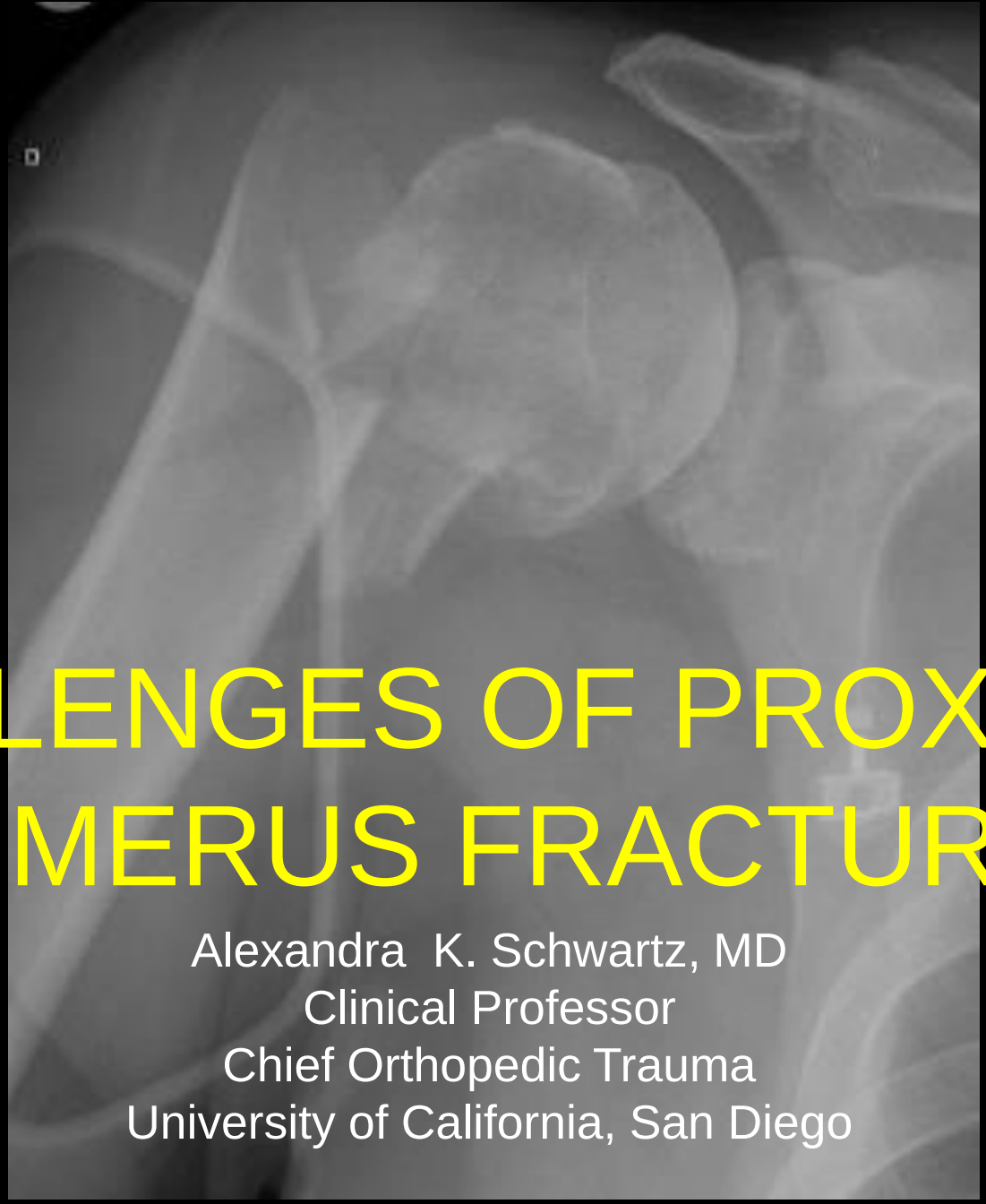


CHALLENGES OF PROXIMAL HUMERUS FRACTURES

Alexandra K. Schwartz, MD
Clinical Professor
Chief Orthopedic Trauma
University of California, San Diego

California Orthopedic Association June 1, 2014

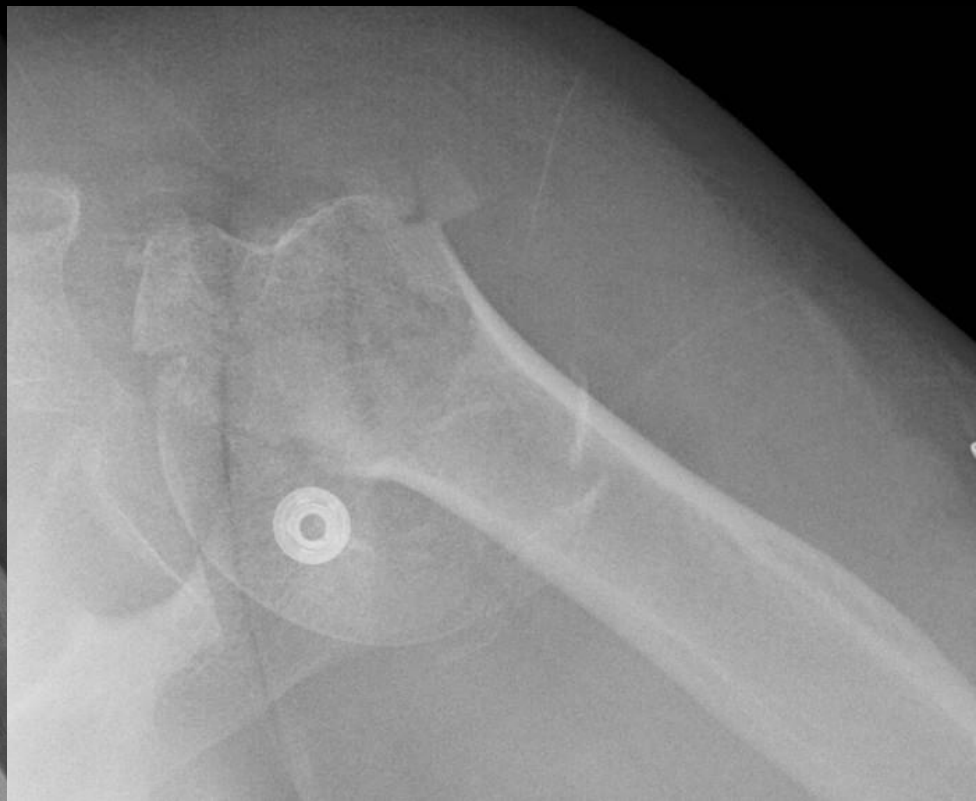
DISCLOSURES

- Spouse employee Zimmer
- Honoraria AO speaker Residents Course

82 year old female hx afib, hypothyroid. Lives independently

45 year old male s/p jump 3rd floor balcony
Severe CHI s/p bilateral craniectomies

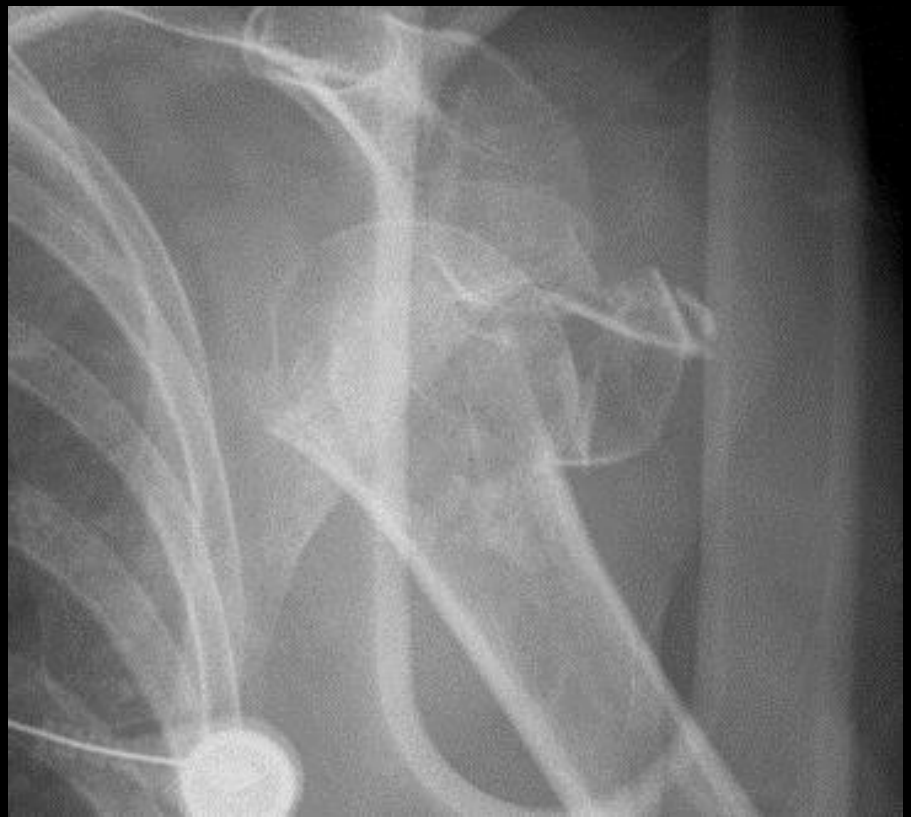
Cleared for proximal humerus 3 weeks post injury

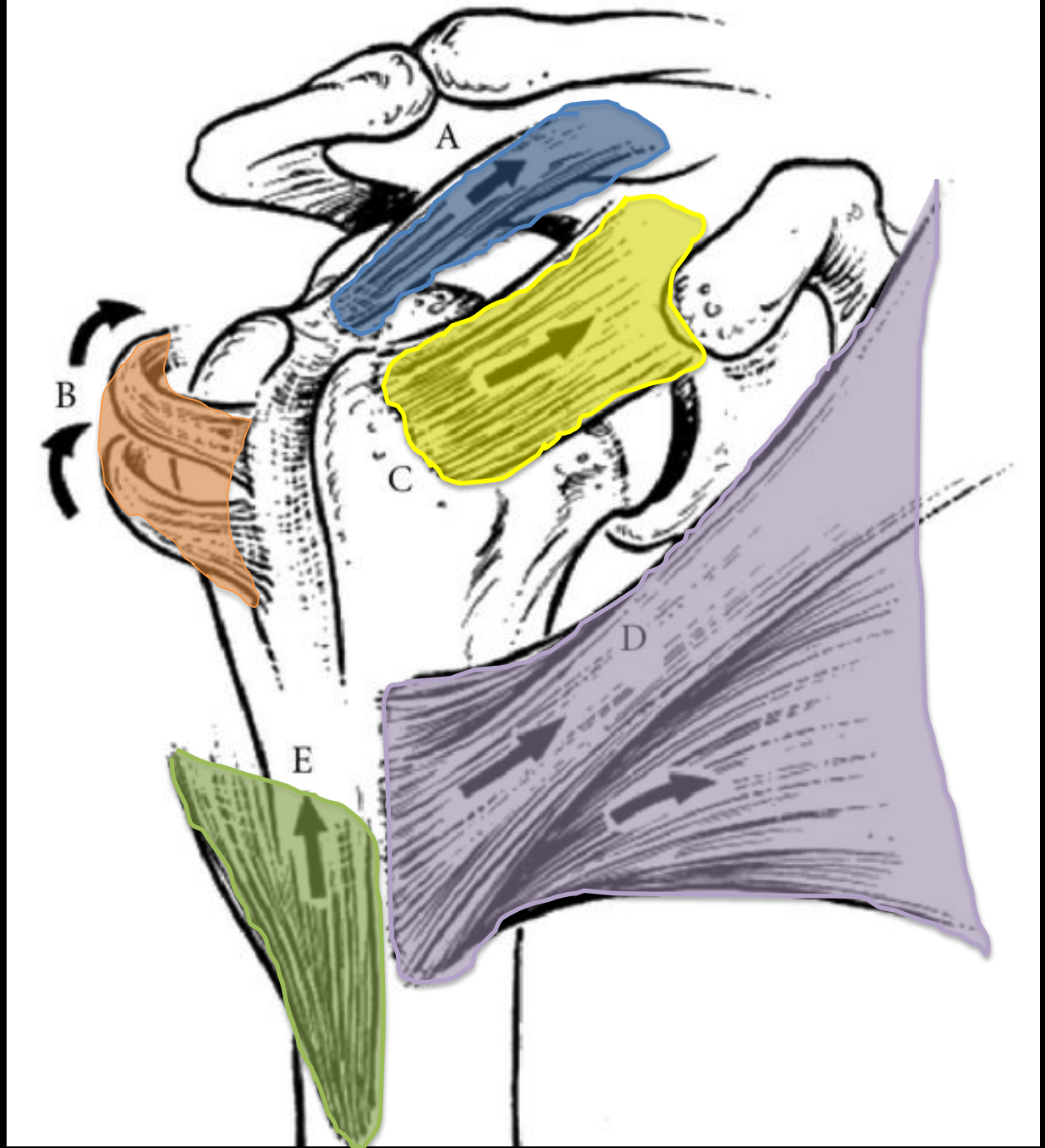


CHALLENGES

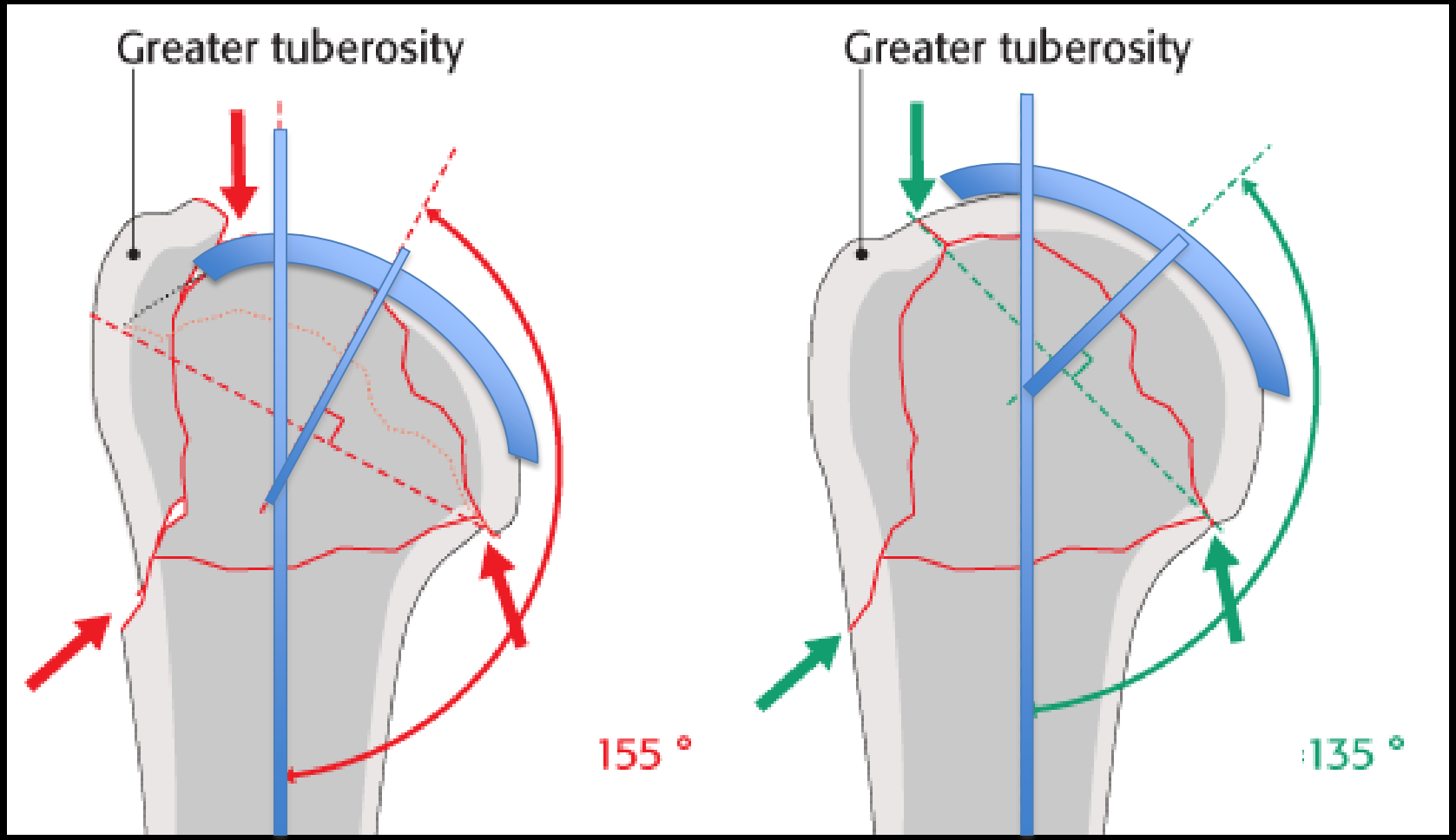
- Who needs surgery (ORIF)?
- How to achieve reduction?
- How to optimize fixation?
- How to avoid complications?
- When is a hemiarthroplasty indicated?

- 5-9% of all fractures
- Challenging
  - Osteoporosis in elderly
  - Comminution in young
  - Deforming forces of surrounding muscles




A
B
C
D
E

ANATOMY



TREATMENT

- 80%: Non or minimally displaced/ non-op
- 20%: Displaced/ require surgery

- Goal is to return patient to pain-free function

WHO NEEDS SURGERY?

- Historically based on radiographs and fracture classification
- Poor intra-observer reliability and poor correlation with outcome led to more complex decision making
- Indications continue to evolve
- Patient specific

PATIENT FACTORS

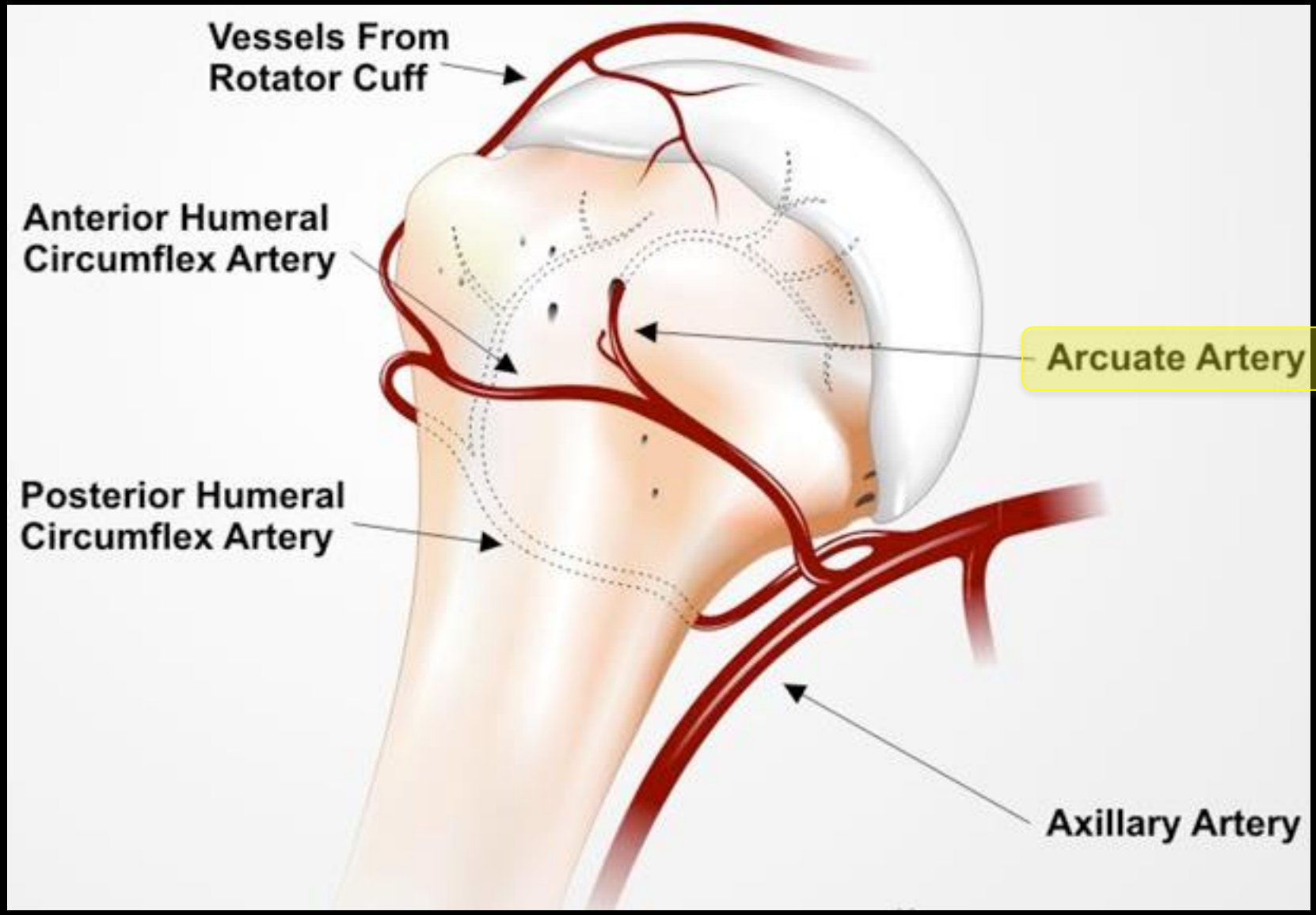
- Physiologic age
- Lifestyle
- Expectations

OTHER CONSIDERATIONS….

- Risk of AVN
- Extent of osteoporosis
- Pre-existing OA
- Pre-existing rotator cuff tear

Assess risk of AVN

BLOOD SUPPLY



- *Posterior humeral circumflex* artery provides *64% of the blood supply* to the humeral head
- Possible explanation for relatively low rates of AVN with displaced proximal humerus fractures
- Important to protect the posterior humeral circumflex artery

Hettrich et al *JBJS* 2010

CALCAR SEGMENT

Less than 8 mm of bone

↓

0.84 accuracy predicting ischemia

Hertel et al *J Shoulder Elbow Surg* 2004

MEDIAL HINGE

Disruption

↓

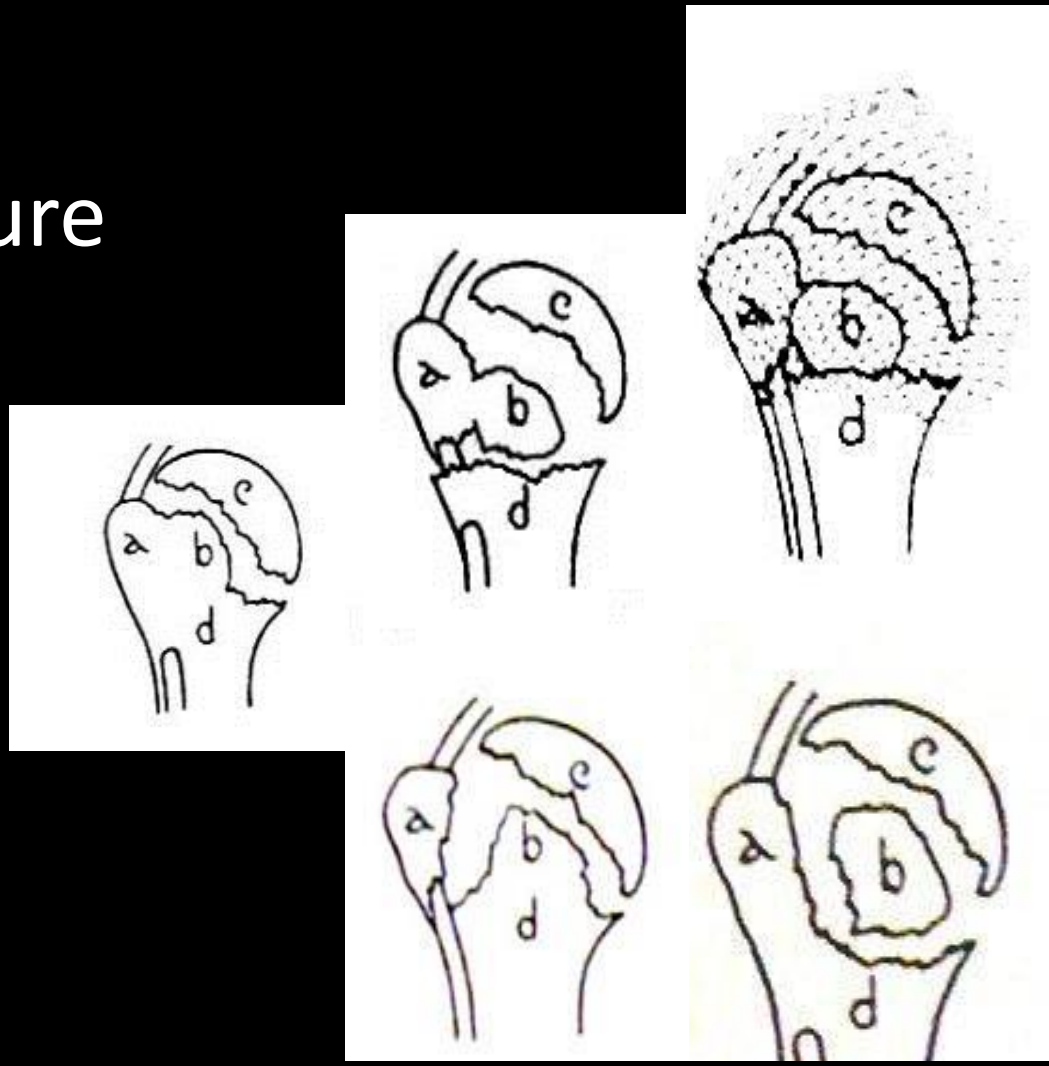
0.79 accuracy predicting ischemia

Hertel et al *J Shoulder Elbow Surg* 2004

FRACTURE PATTERN

Anatomic Neck Fracture

0.7 accuracy
predicting ischemia



Hertel et al *J Shoulder Elbow Surg* 2004

Assess severity of osteoporosis

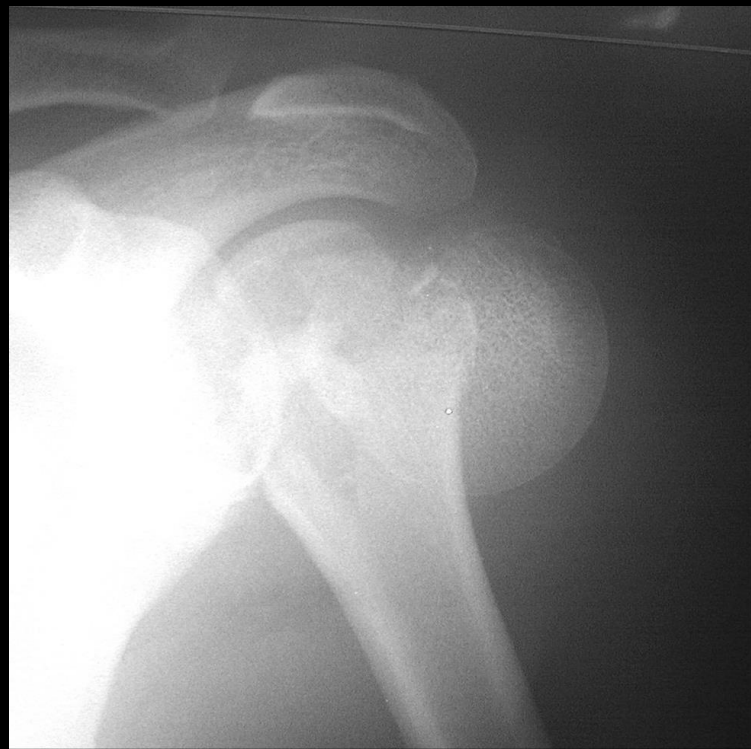
Combined cortical thickness <4 mm significantly lower BMD of the proximal humerus ($p < 0.01$)

Tingart et al *JBJB Br* 2003

Assess pre-existing OA and rotator cuff

ABSOLUTE INDICATIONS

- Open fractures
- Vascular injury
- Fracture/ dislocations (young)



RELATIVE INDICATIONS

- Greater tuberosity > 3-5 mm displacement
- >20˚ deviation from normal neck/shaft angle
- > 50% head to shaft displacement

Court Brown et al *JBJS* 2002
Murray *JBJS Br* 2011

TREATMENT OPTIONS

- CRPP
- IMN
- ORIF
  - Locking plate

LOCKING PLATES

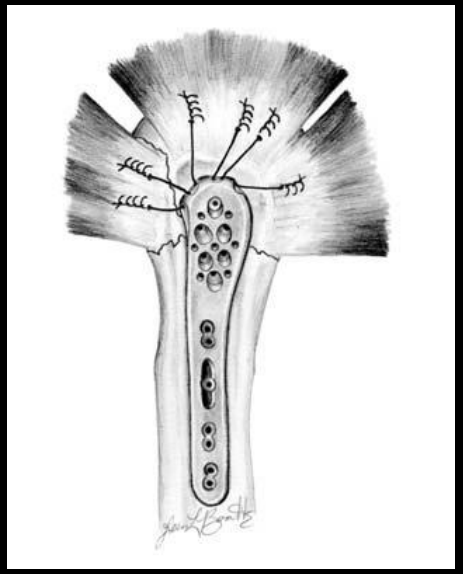
- Improved fracture stability
- Shorter period of immobilization
- Earlier rehabilitation
- Ability to treat more fractures with ORIF vs hemi or nonop
- Technical factors *critical*

- Locked plates thought to be the answer
- Still a very challenging problem
- Still significant complication rate

HOW TO ACHIEVE REDUCTION?

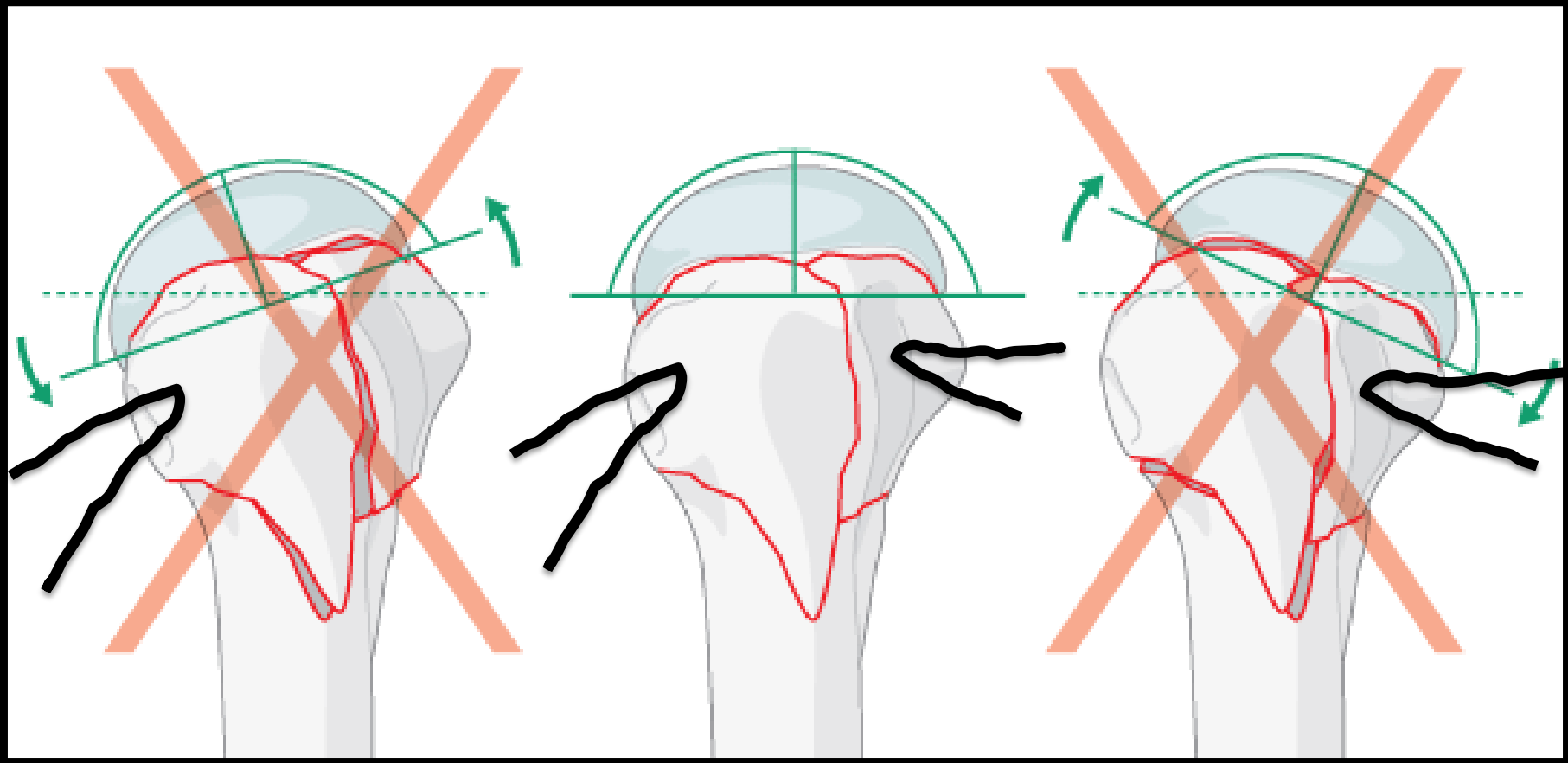
Badman et al *Tech Should Elb Surg* 2006

- Identify tuberosities and place holding sutures suprapinatus/ IS and TM/ subscap
- Nonabsorbable sutures placed at tendon/ bone junction to prevent cutting through tendons
- Done for tuberosity avulsion fractures as well as two-part neck fractures



Badman et al *JAAOS* 2008

Sutures used to reduce tuberosities as well as control varus/ valgus (superior suture) and rotation (anterior and posterior sutures)

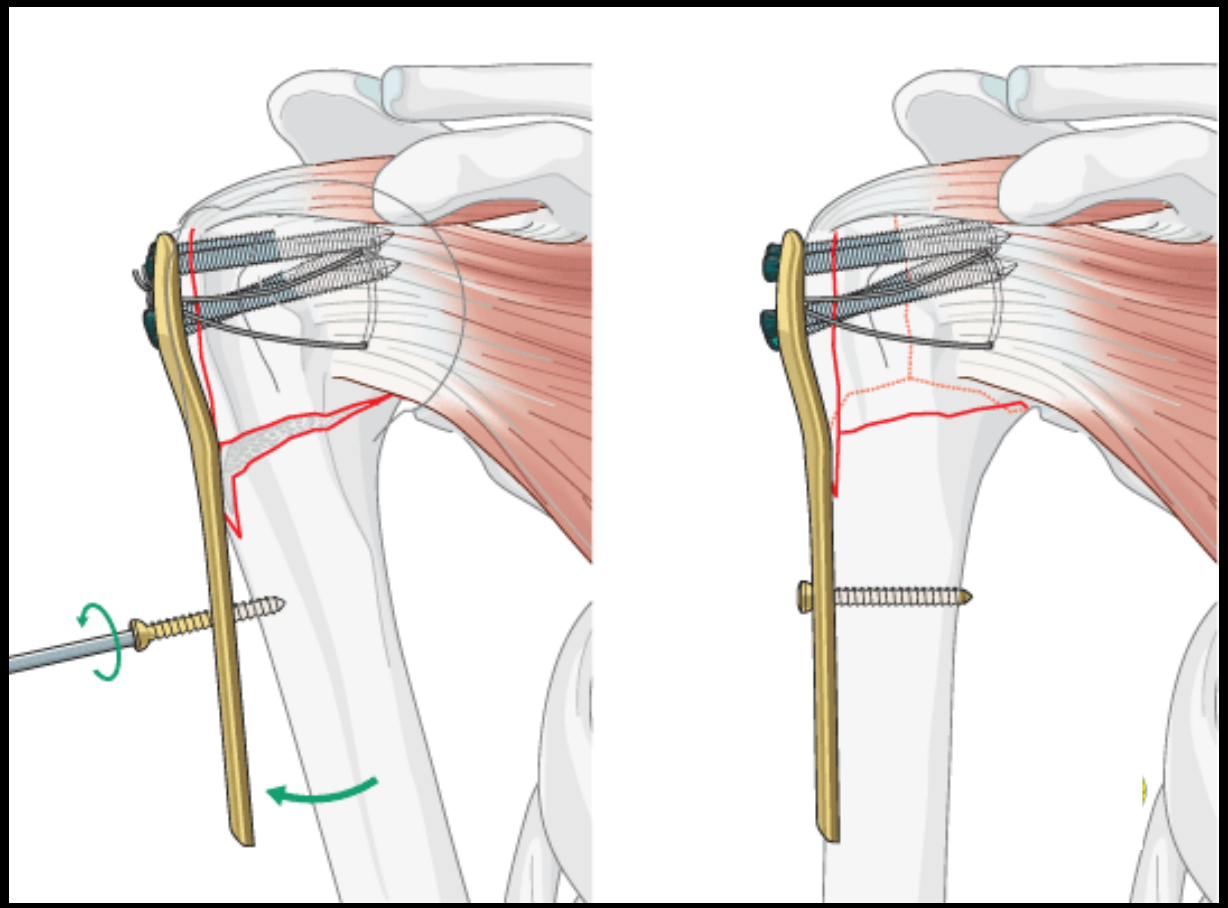


REDUCTION TECHNIQUES

1. Use plate to assist with reduction
2. Sutures in tuberosities
3. Joy sticks
4. Elevators

Use plate to achieve reduction

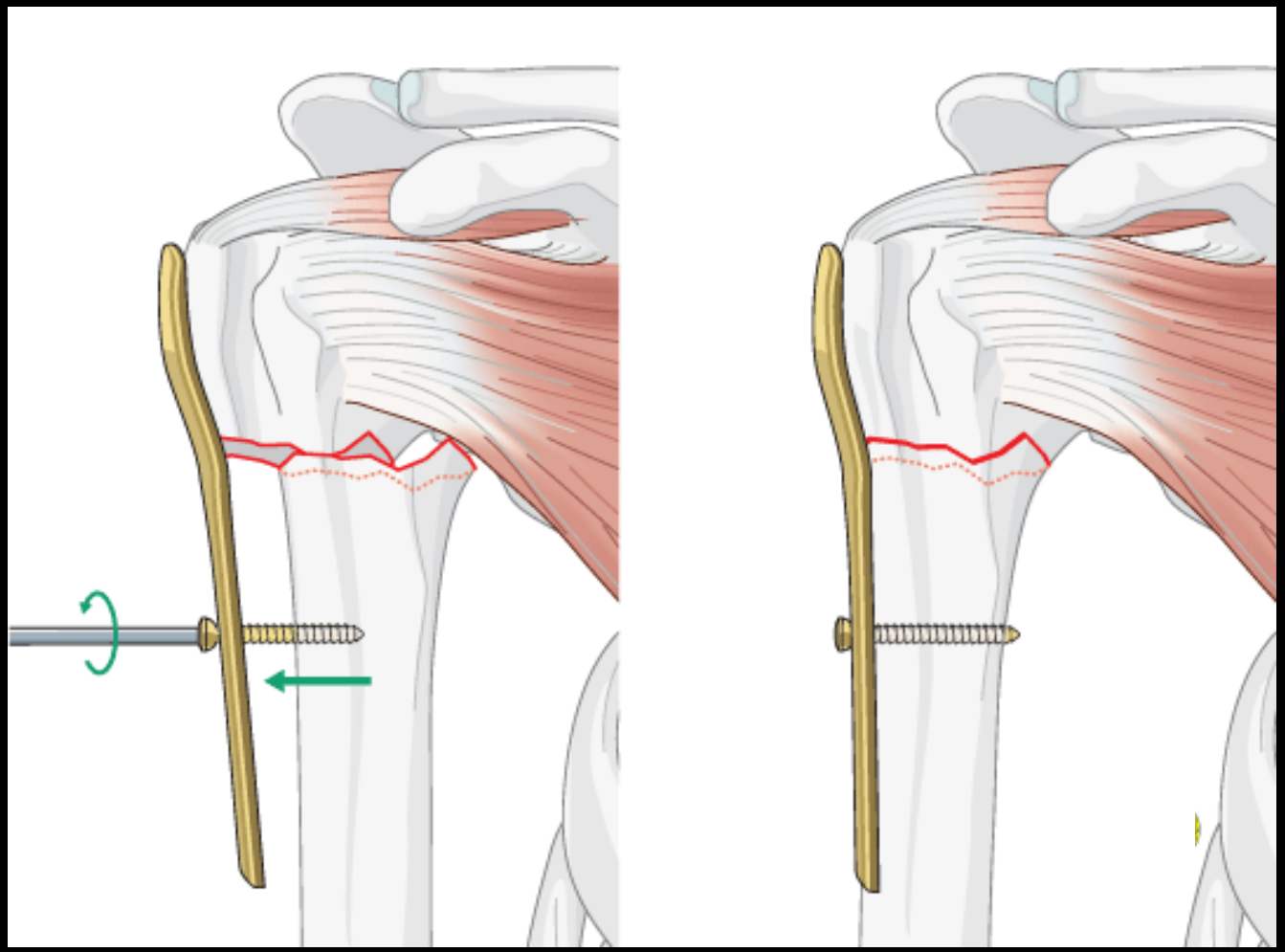
- Affix plate to proximal humerus and use nonlocking screw through plate to reduce the shaft



OR:

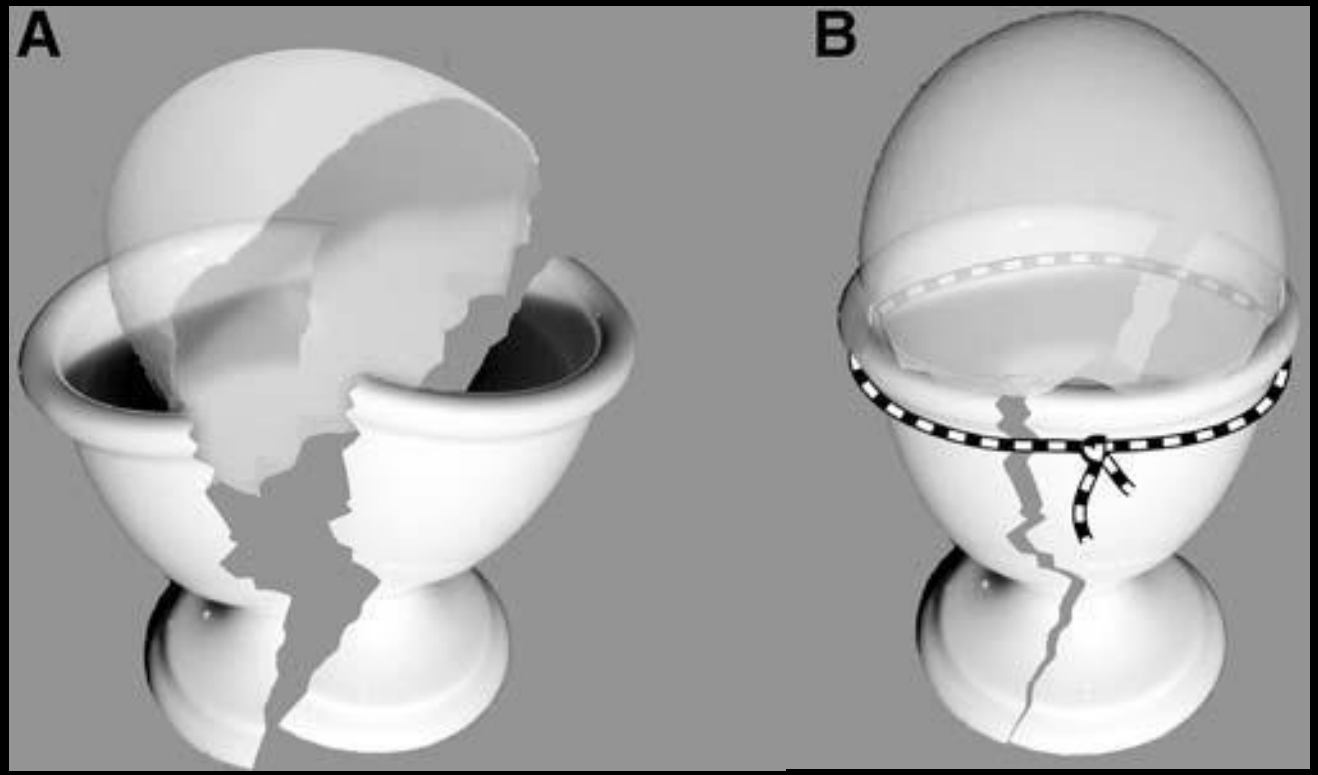
– Affix with nonlocking screw to shaft (to lateralize)

– Align head to plate, then secure with proximal screws

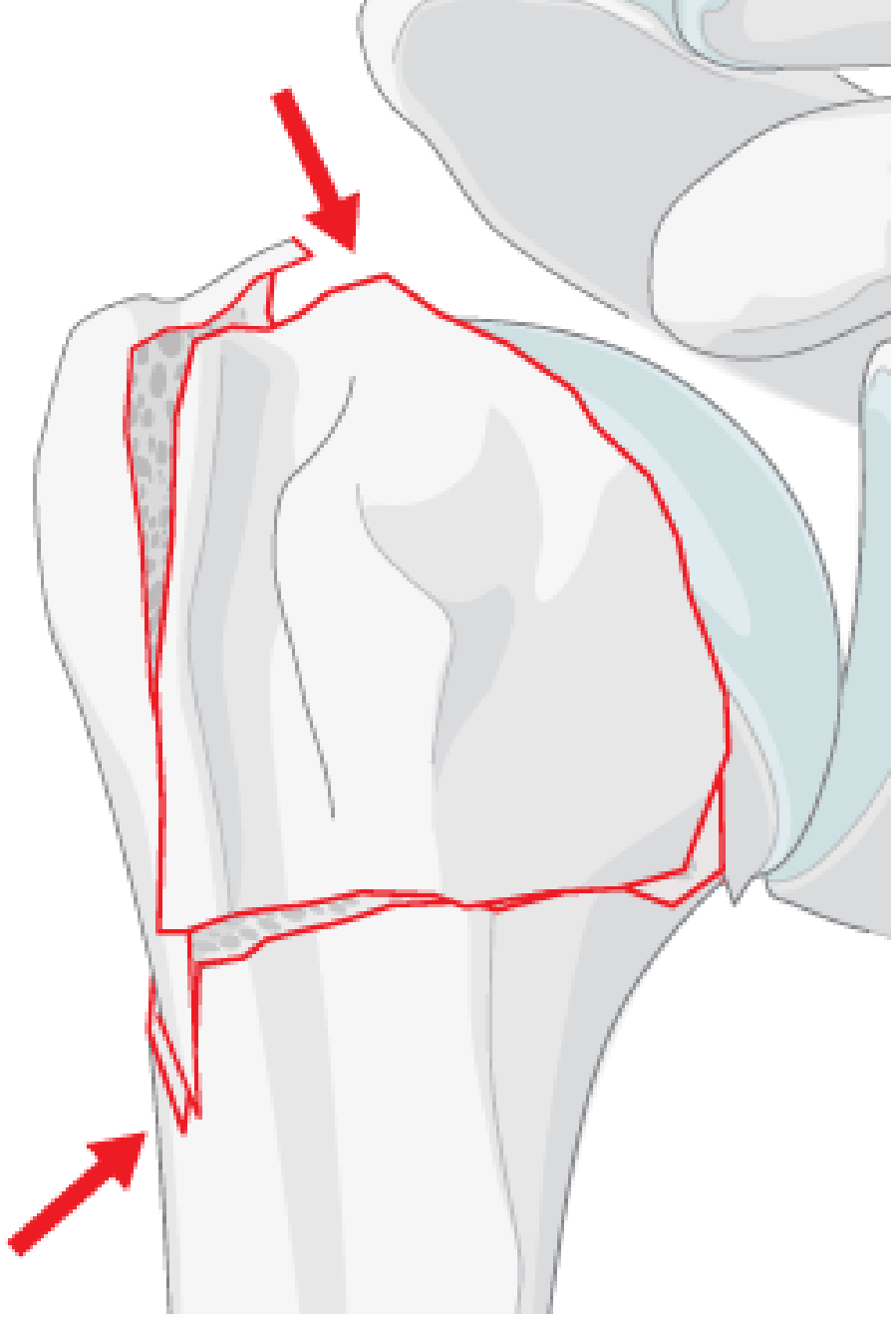


REDUCTION

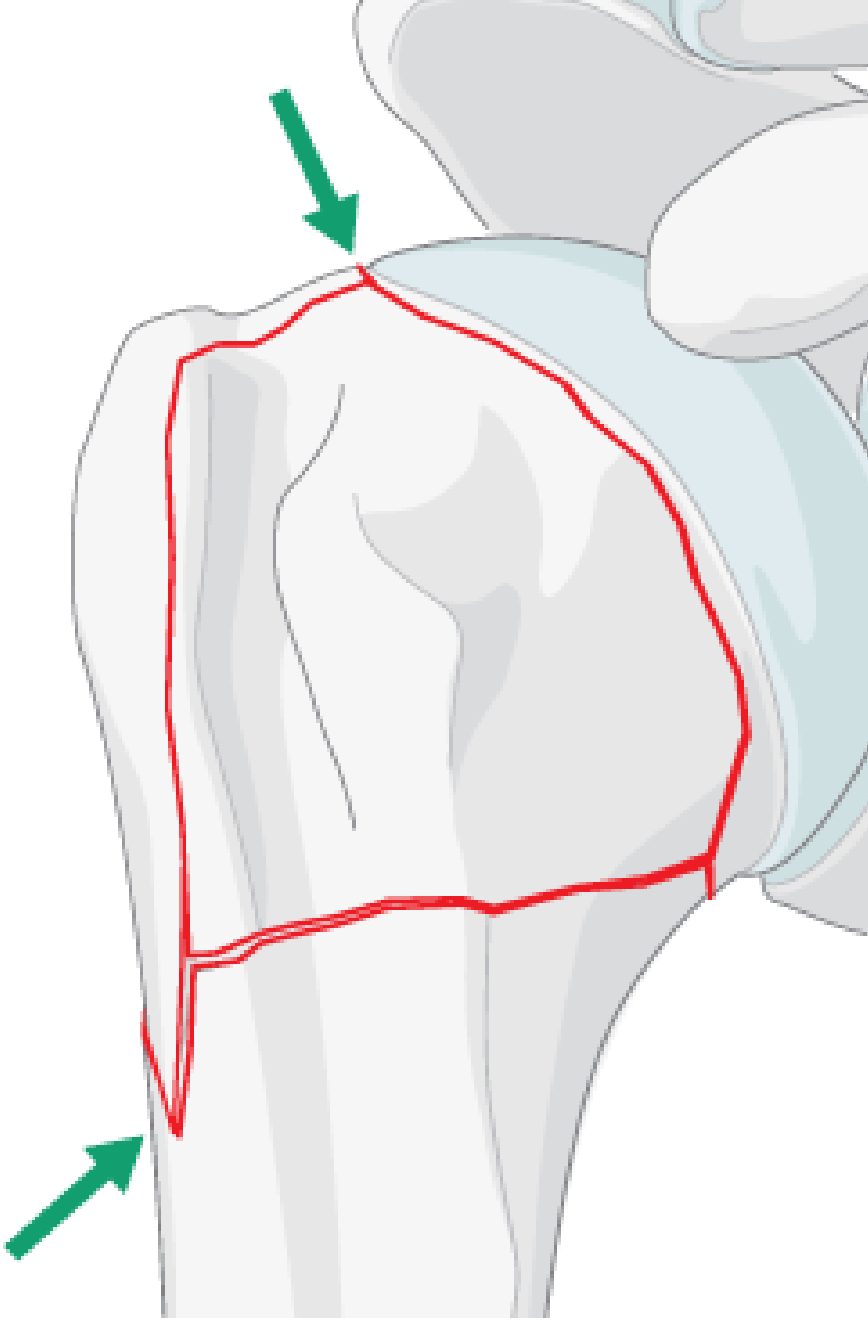
- Tuberosity reduction is critical
- Establish “egg cup” to support head segment



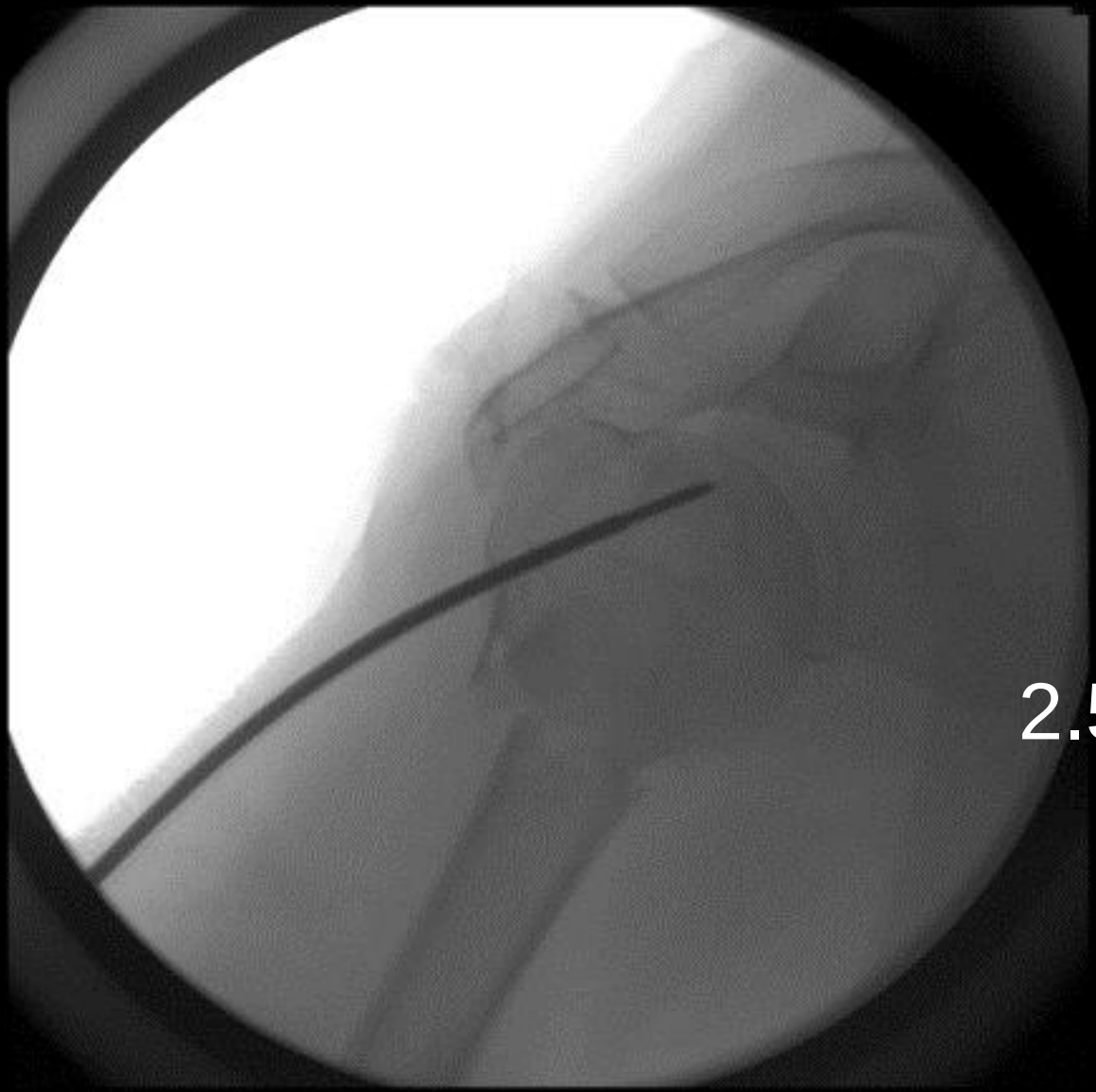
Hertel R, Osteoporosis Int 2005



displaced



reduced



“Joystick”

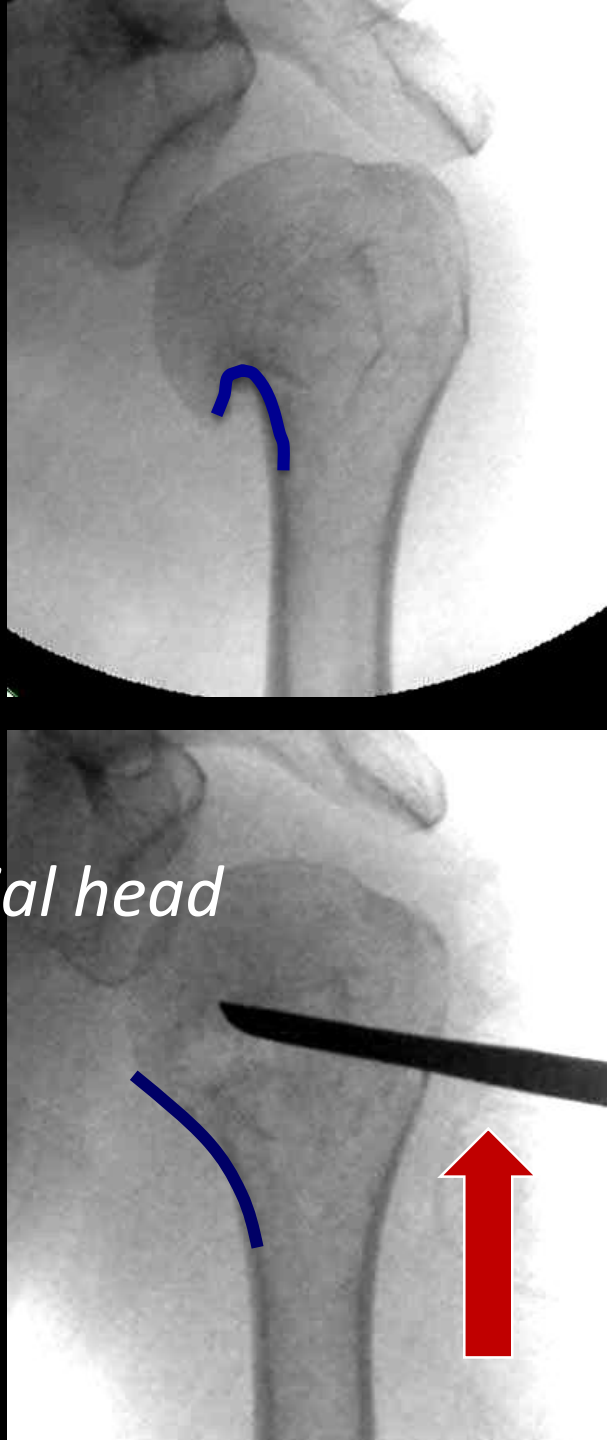
2.5 mm Schanz pin

Elevator to dis-impact the head

DO NOT LEAVE IN VARUS

GREATER TUBEROSITY DISTAL TO HEAD

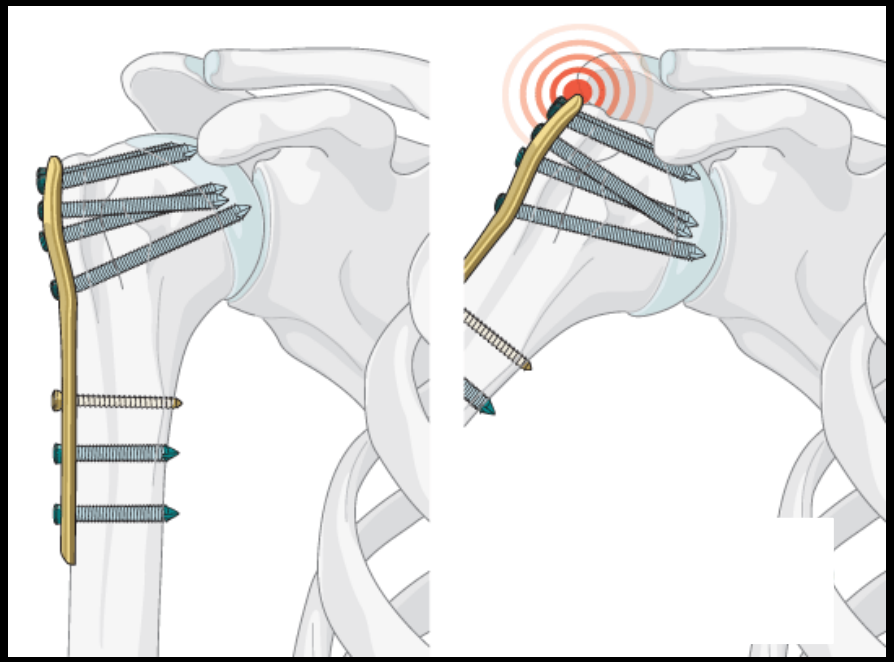
Restore calcar (Shenton) line; support medial head



HOW TO OPTIMIZE FIXATION?

HARDWARE PLACEMENT

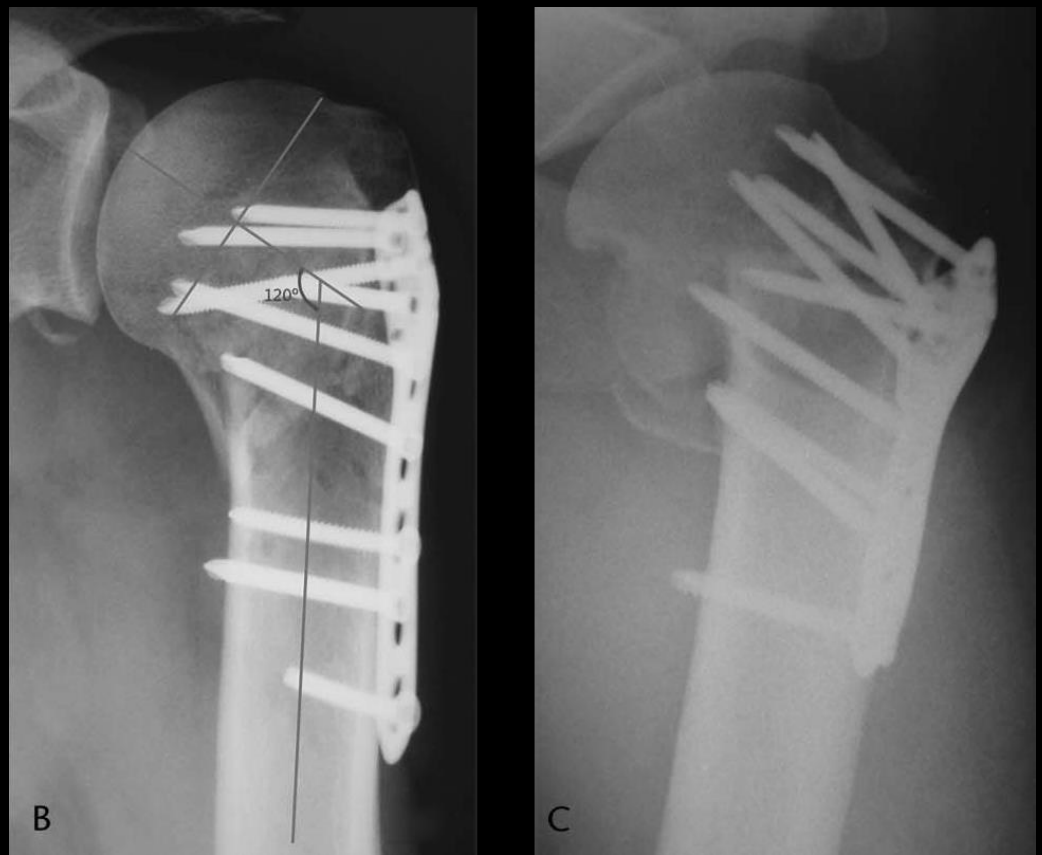
- Plate 5-8 mm distal to greater tuberosity
  - Too proximal – Impingement



Aofoundation.com

HARDWARE PLACEMENT

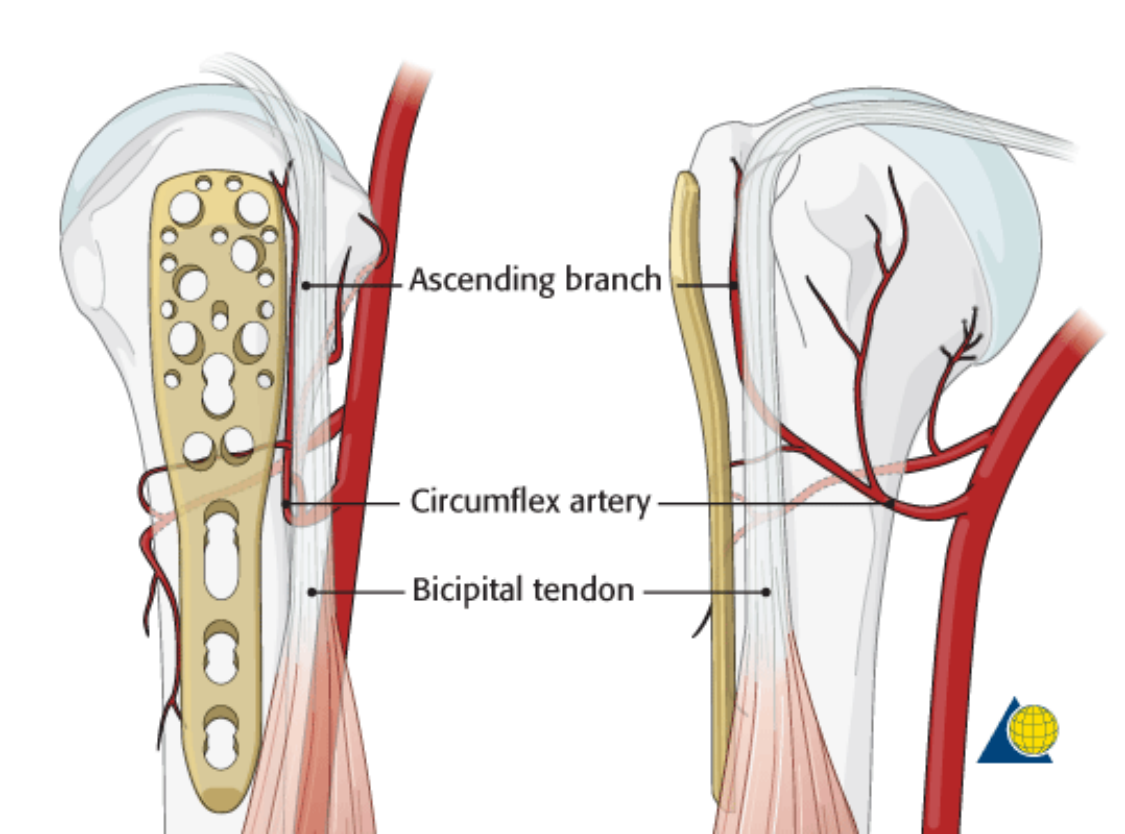
– Too distal – inadequate fixation



Agudelo et al *JOT* 2007

HARDWARE PLACEMENT

- 2-4 mm posterior to bicipital groove
  - Too anterior – ascending branch/ biceps tendon



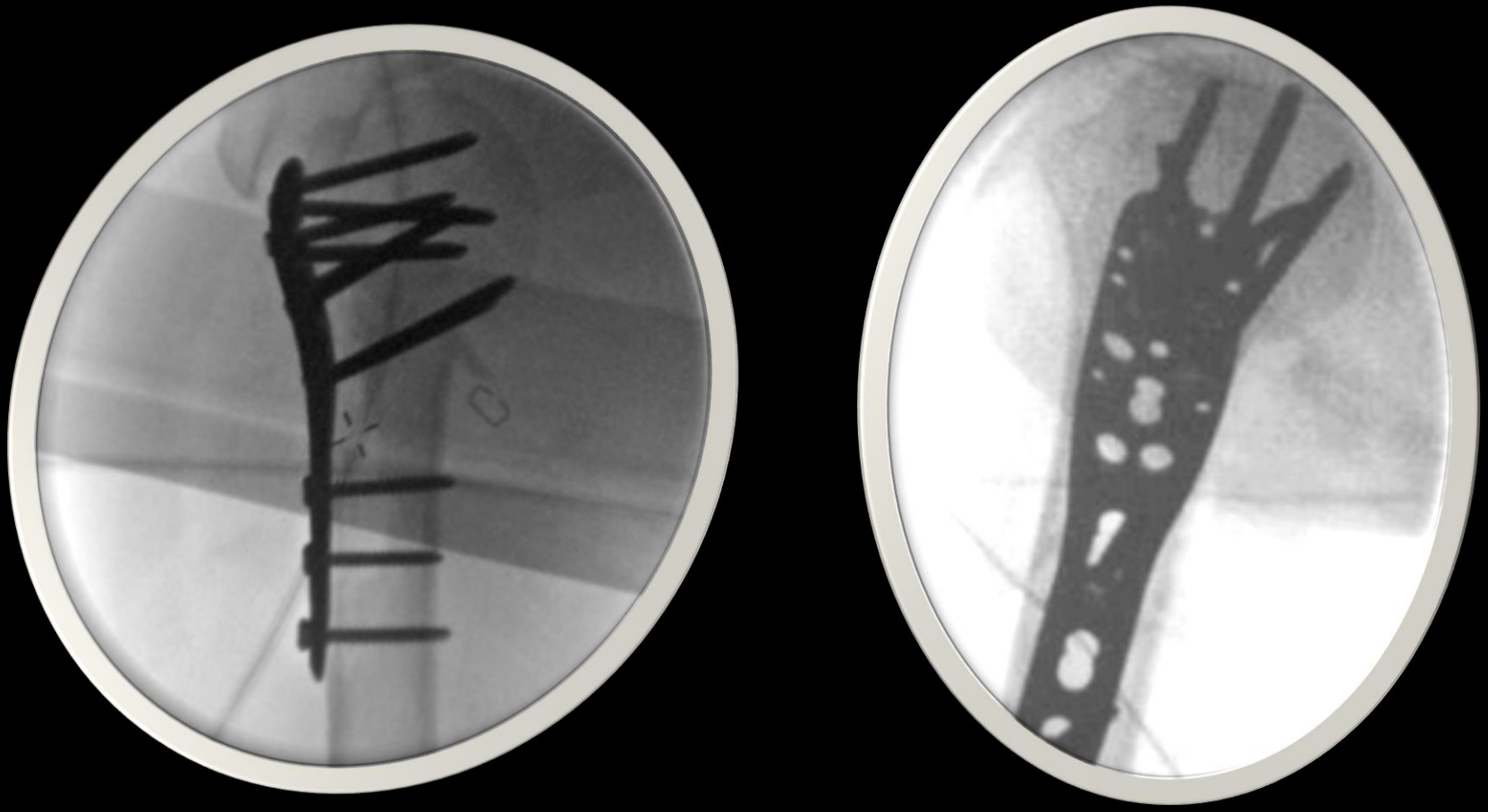
Aofoundation.com

SCREW INSERTION

- Screw may not follow drill path
- Penetration of articular surface increases risk of screw cut out
- Use fluoro
  - Move image of drill/ depth gauge to contralateral screen
  - Confirm correct screw trajectory

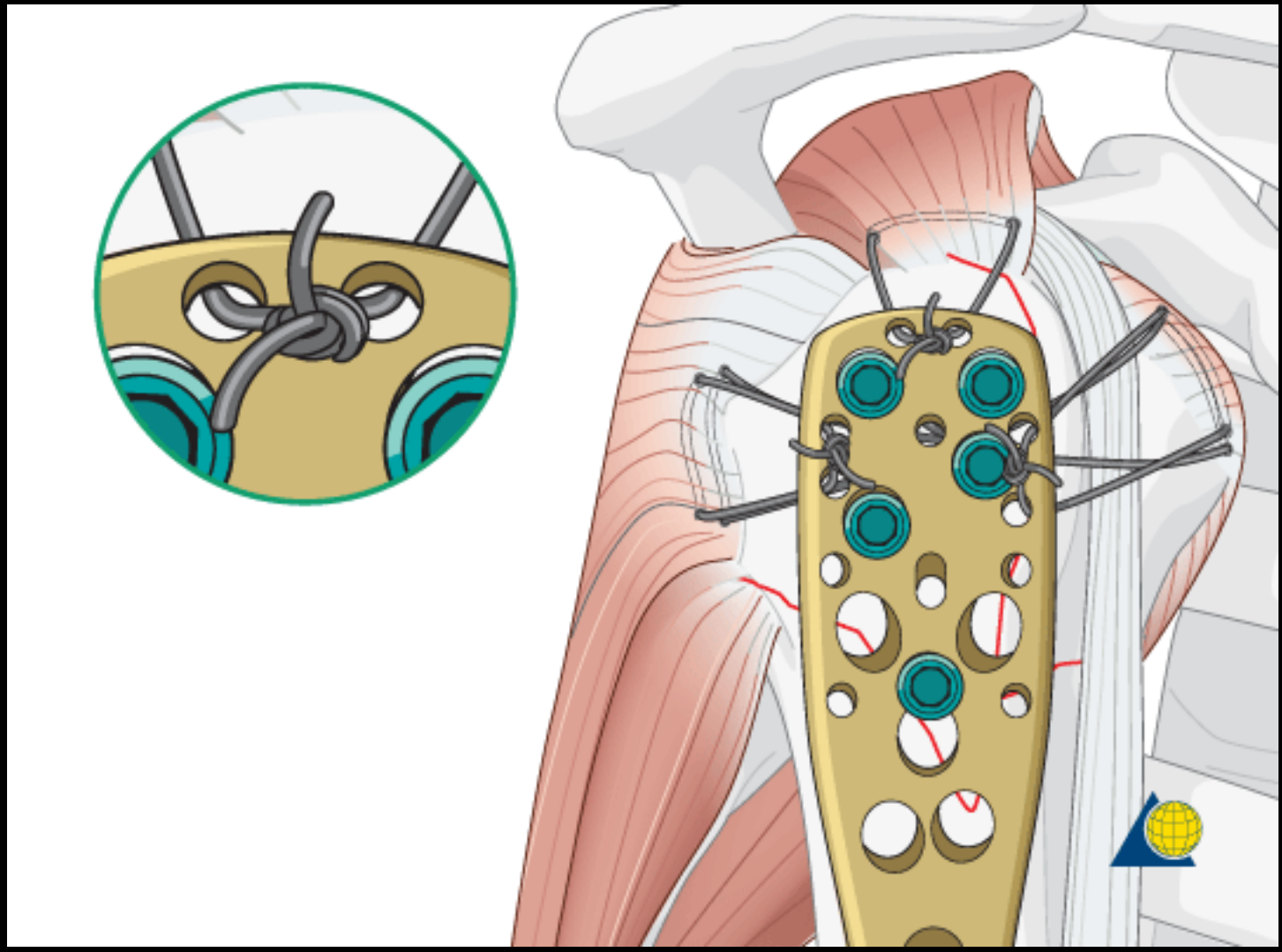
SCREW LENGTH

Screws should be within 5-10 mm subchondral bone



Confirm all screws are contained on numerous views

Secure sutures through holes in plate



$CaPO_4$ AUGMENTATION

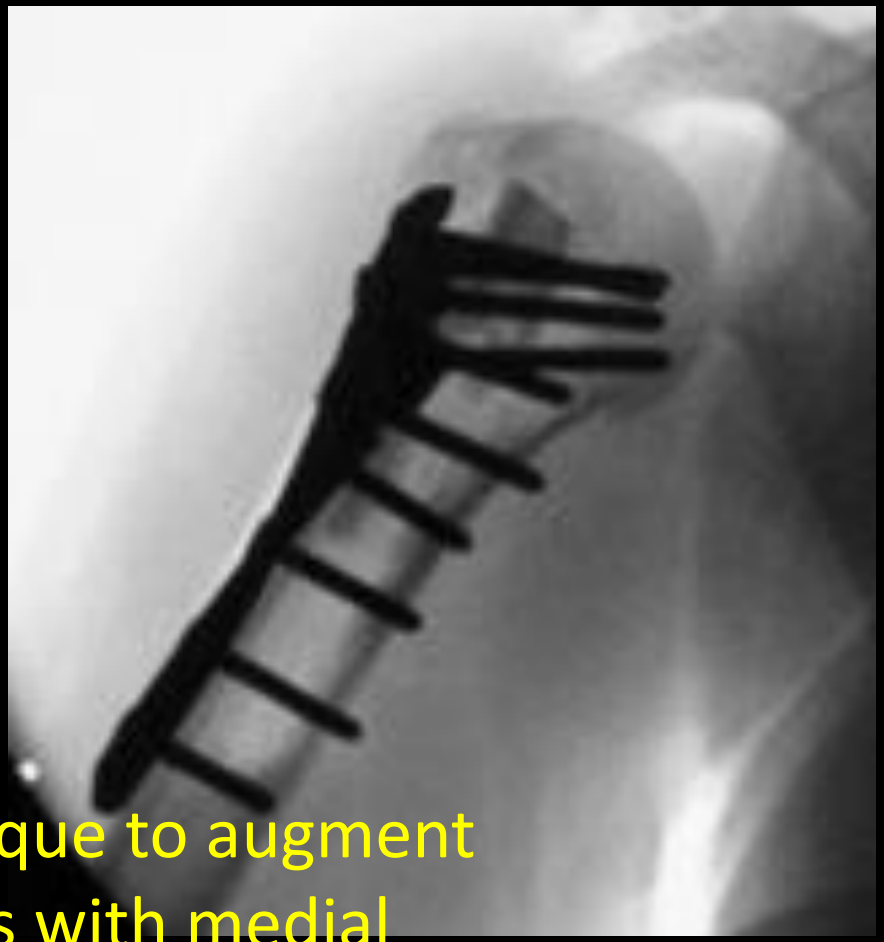
- Kwon et al *JBJS* 2002
  - 18 paired cadaveric limbs
  - Surgical neck and GT osteotomy
  - Manual impaction cancellous bone recreate medullary void
  - Half with $CaPO_4$
  - + $CaPO_4$
    - decreased interfragmentary motion
    - increase in torque to failure
    - increase torsional stiffness

$CaPO_4$ AUGMENTATION

Egol et al *J Shoulder Elbow Surg* 2011

- Retrospective study 92 patients > 1 year f/u
- 29 (32%) augmentation with allograft chips
- 27 (29%) augmentation w $CaPO_4$
- 36 (39%) no augmentation
- "Augmentation with $CaPO_4$ decreased fracture settling and significantly decreased the incidence of intra-articular screw penetration"

ALLOGRAFT STRUT AUGMENTATION



- Matasi et al *Injury* 2012
  - No collapse > 2 mm
  - No AVN
  - No screw penetration
  - "Safe and promising technique to augment proximal humerus fractures with medial comminution"

HOW TO AVOID COMPLICATIONS?

COMPLICATIONS

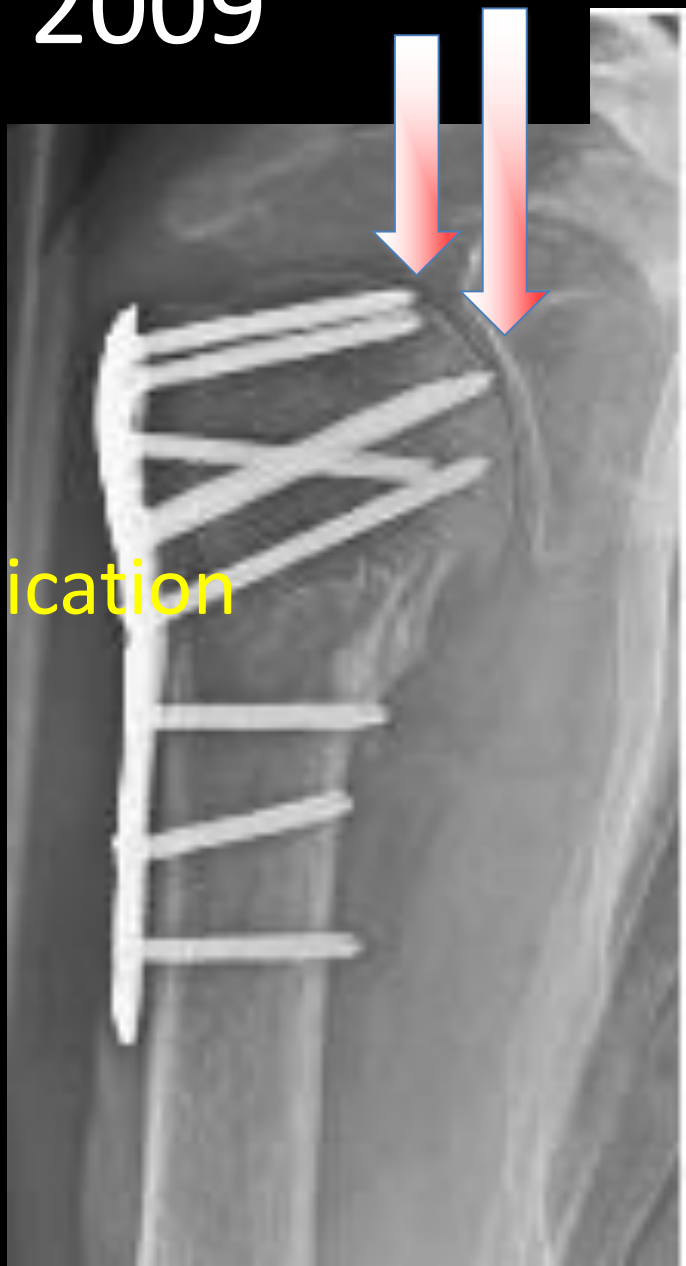
- Screw penetration (13-23%)
- Varus malalignment
- Hardware failure
- AVN (3-16%)
- Nonunion

SCREW PENETRATION

- Intraoperative error
  - Avoidable by not drilling through subchondral bone and confirming placement on numerous views
- Post operative collapse
  - Minimize risk by avoiding varus and achieving stable reduction and fixation

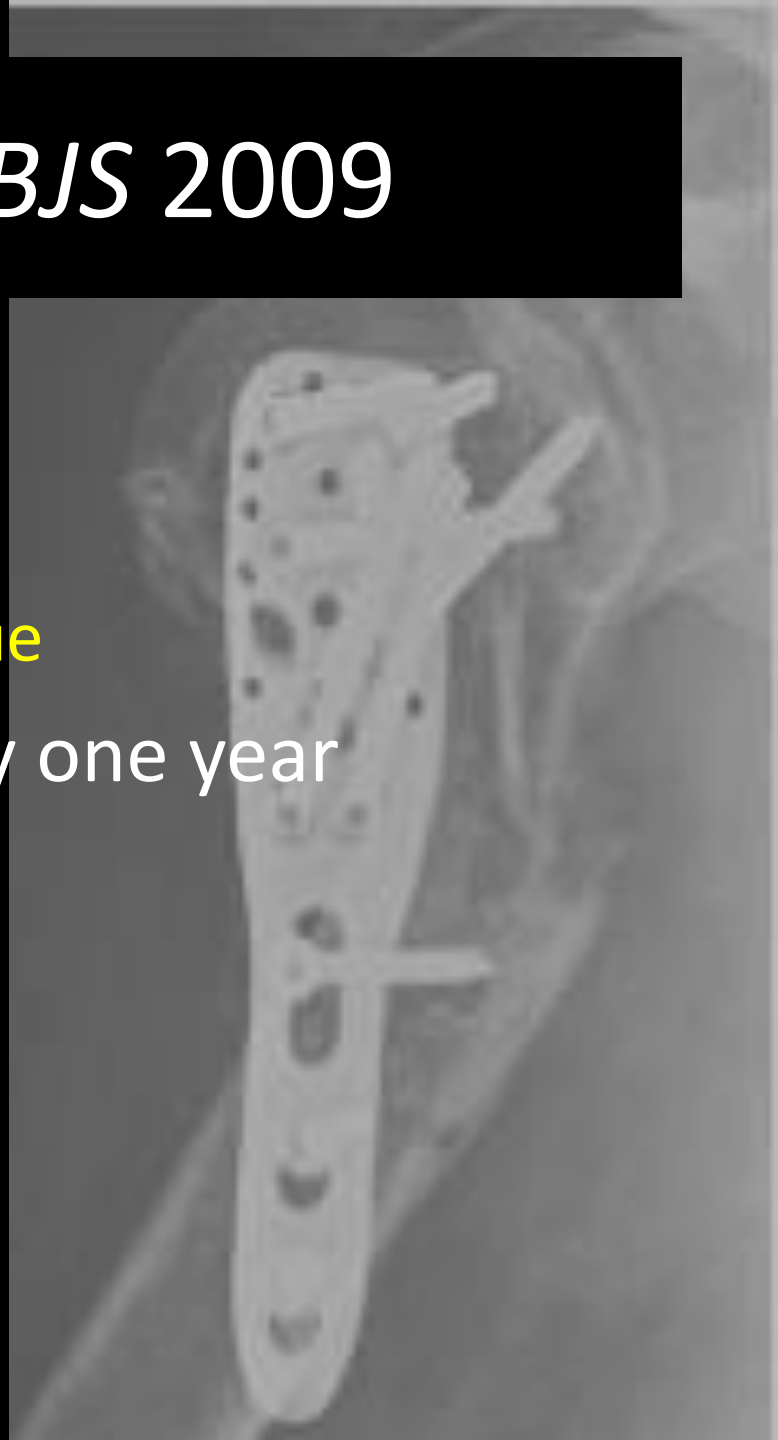
Brunner et al *JOT* 2009

- Prospective case series
- 158 fractures
- Mean age 65
- 46% patients at least one complication
- 25% unplanned surgeries
- *22% screw penetration*



Sudkamp et al *JBJS* 2009

- 178 patients mean age 63
- 34% complications at 1 yr
  - 48% incorrect surgical technique
- 19% unplanned 2nd surgery by one year
- 14% screw penetration



Owsley et al *JBJS* 2008

- 53 patients mean age 52
- 36% complication rate
  - 23% cut out
  - 25% varus (>10˚)
  - 4% AVN
  - Radiographic complications 57% people > age 60 vs 22% < 60

The Importance of Medial Support in Locked Plating of Proximal Humerus Fractures

Michael J. Gardner, MD, Yoram Weil, MD, Joseph U. Barker, MD, Bryan T. Kelly, MD, David L. Helfet, MD, and Dean G. Lorich, MD

JOT 2007

- 35 patients treated with PHLP
- Average age 62
- Xrays analyzed
- Adequate medial support if
  - Medial cortex anatomically reduced
  - Shaft medialized and impacted into head
  - Screws within 5 mm inferomedial cortex

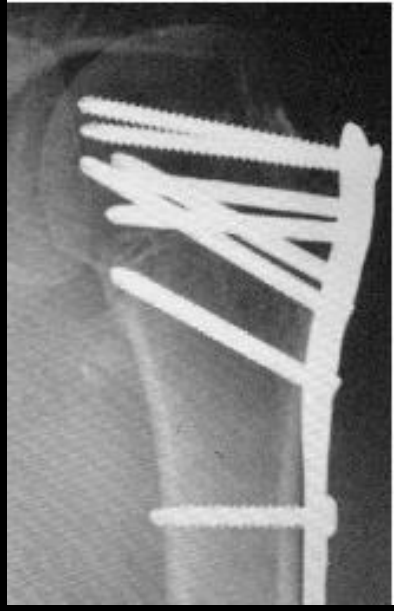
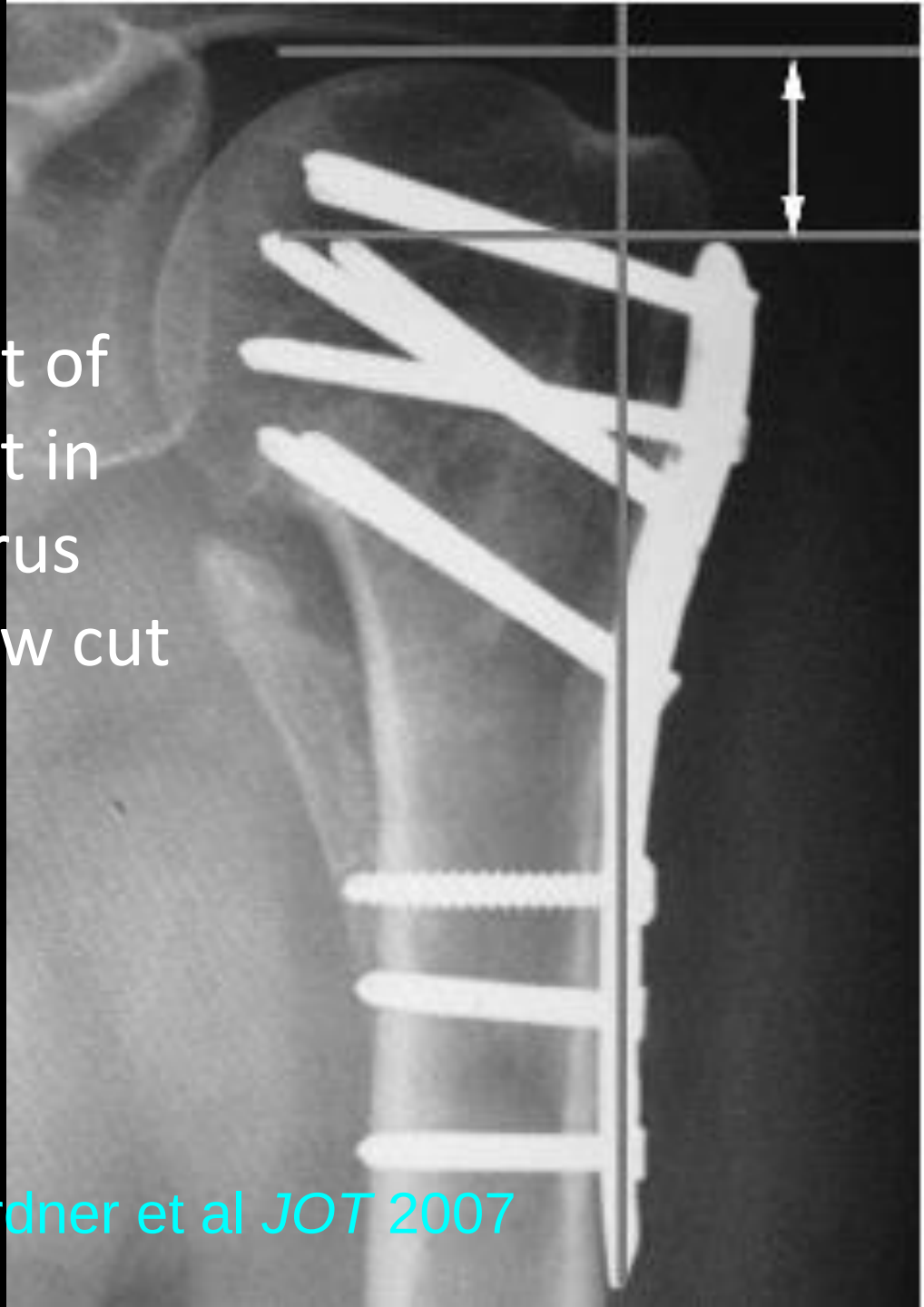


TABLE 1. Patient Data for the +MS (Medial Support) and −MS (No Medial Support Group)

		Group		
		+MS	−MS	*P* Value
N		18	17	
Sex	Females	14	10	0.15
	Males	4	7	
Average age (yr)		55	69	0.004
Fracture	2 Part	4	2	
distribution	3 Part	8	7	0.68
(Neer)	4 Part	6	8	
CaP cement augmentation		3	6	0.12
Change in	Mean	1.2	5.8	
humeral head	SD	1.4	3.9	<0.001
height (mm)	Max	4.1	13.6	
>5 mm Loss of	N	0	9	<0.001
reduction	%	0	53	
Screw penetration		1	5	0.02
Screw loosening		0	2	<0.001

- Restoration and support of medial cortex important in preventing collapse, varus malalignment, and screw cut out



Gardner et al *JOT* 2007

ARTHROPLASTY

- Role of arthroplasty also evolving
- Indications:
  - unreconstructable humeral head
  - shell-like head
  - avascular humeral head
  - delayed presentation or salvage after failed ORIF

- Function in elderly worse than expected
- Relies on tuberosity healing for good outcome
- 35% of patient FF > 90 degrees

Pijls *J Orthop Trauma* 2011

- < 50% satisfactory outcome at 10 years

Antuña *J Shoulder Elbow Surg* 2008

- Optimal treatment for displaced fractures in elderly remains unclear

HEMI vs NON-OP

- RCT hemi vs nonop 4 part fractures
- 55 patients mean age 77
- Hemi:
  - Less pain
  - Better QOL
  - Same ROM

Olerud et al *J Shoulder Elbow Surg* 2011

ORIF vs NON-OP

- RCT ORIF vs nonop 3 part fractures
- 60 patients mean age 74
- ORIF:
  - Better ROM
  - Better function
  - Better QOL
  - 30% reoperation

Olerud et al *J Shoulder Elbow Surg* 2011

ORIF vs HEMI

- Retrospective review
- 57 patients mean age 56.9 years
- 3 and 4 part fractures
- ORIF:
  - Better functional outcome
  - Better UCLA shoulder score
  - Better Constant score
  - Better patient satisfaction
  - Better ROM

Wild et al *Orthopedics* 2011

ORIF vs HEMI

- Retrospective review
- 122 patients > 55 years old
- 38 locked plate, 48 hemi
- ORIF:
  - Better Constant score (3 pt > 4 pt)
  - More complications
- Initial varus displacement worse outcomes

Solberg et al *JBJS* 2009

82 year old female hx afib, hypothyroid. Lives independently

12 days post injury

3 weeks post injury

3 months post injury


9 months post op
FF 150
RXC

SUMMARY

- Who needs surgery (ORIF)?
- How to achieve reduction?
- How to optimize fixation?
- How to avoid complications?
- When is a hemiarthroplasty indicated?

SUMMARY

- Who needs surgery (ORIF)?

Patient specific
Greater tuberosity >3-5 mm
20° variation varus/ valgus
> 50% shaft translation

SUMMARY

- How to achieve reduction?

Sutures bone/tendon interface
Use plate to help achieve reduction
Adjuncts: sutures, kwires, joy sticks
Tuberosities critical
NO VARUS

SUMMARY

- How to optimize fixation?

Plate not too high or too low
Plate posterior to bicepital groove
Screws within 5-10 mm subchondral bone
Sutures through plate
Adjunts: CaPO4, fibular strut

SUMMARY

- How to avoid complications?

Avoid intra-articular screws
No varus
Restore medial buttress
Screw within 5 mm medial buttress

SUMMARY

- When is a hemiarthroplasty indicated?

Unreconstructable or shell-like head
Avascular head
Salvage
Relies on tuberosity healing
Less-than ideal function

Thank you!