Shoulder Arthroplasty

Valentin Lance

3/24/16

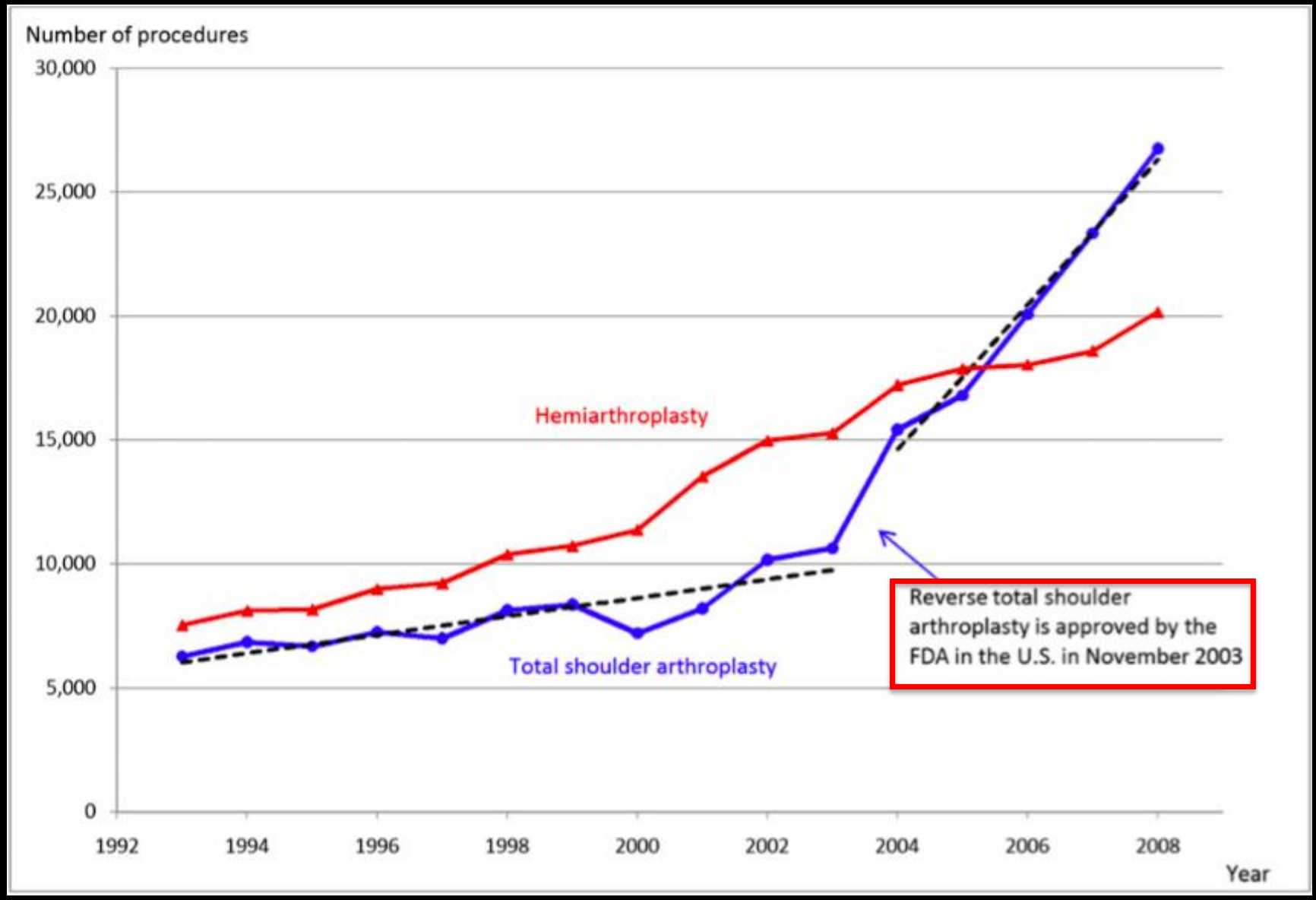
Outline

- Background
- Pre-operative imaging assessment
- Total Shoulder Arthroplasty: Standard and Reverse
- Complications
- Other shoulder hardware
  - Hemiarthroplasty
- Summary

Background

- Increasing incidence of shoulder arthroplasty in the United States
- 2.5 fold increase between 2000 and 2008
- 27,000 total and 20,000 hemiarthroplasties performed in 2008

Kim SH et al. J Bone Joint Surg Am. 2011;93:2249-54



Kim SH et al. J Bone Joint Surg Am. 2011;93:2249-54

Demographics

- Shoulder arthroplasty predominantly performed on patients >65 yrs old
- Indications:
  - Osteoarthrosis (77% of total shoulder and 43% of hemiarthroplasty)
  - Proximal humeral fracture accounted for 33% of hemiarthroplasty indication

Kim SH et al. J Bone Joint Surg Am. 2011;93:2249-54

Preoperative Imaging Assessment

- Radiographs

Acromiohumeral distance ≤7mm associated with rotator cuff tearing

-Full thickness tears of supraspinatus in 90%

-Full thickness tears of infraspinatus in 67%

*also associated with rotator cuff atrophy

Saupe N et al. AJR. 2006;187:376-382

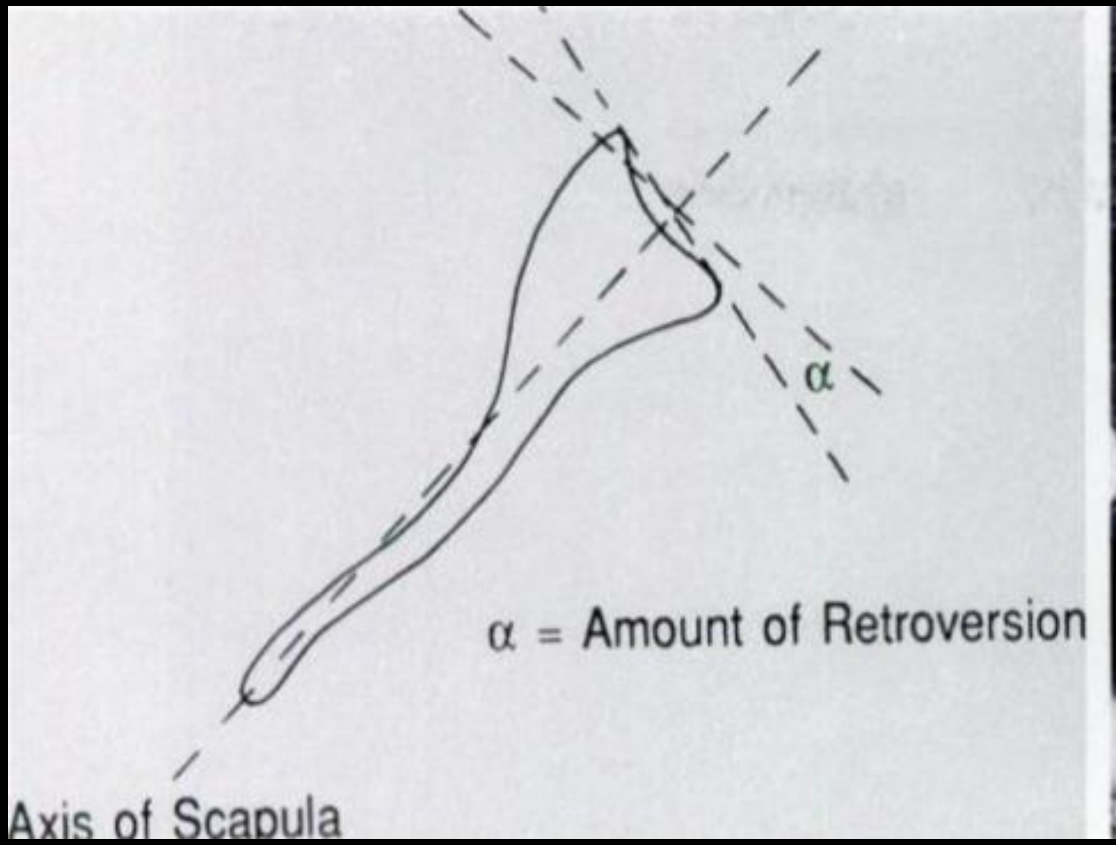
Preoperative Imaging Assessment

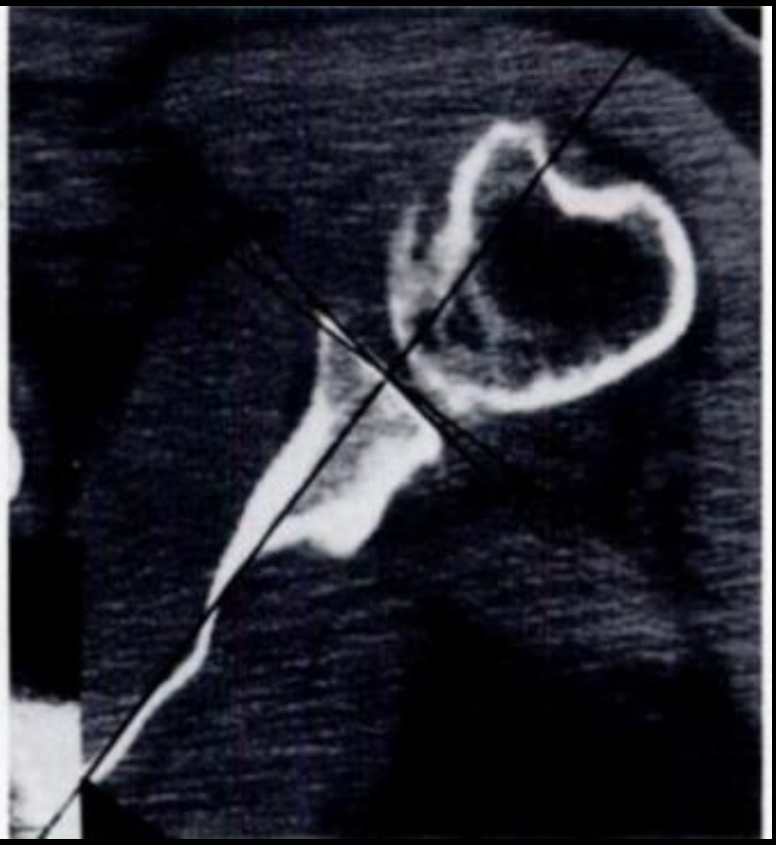
- CT

Glenoid morphology

- Glenoid version differs between normal and osteoarthritic shoulders
- Friedman et al found:
  - 11±8 degrees retroversion in OA vs.
  - 2±5 degrees anteversion in normal controls

Friedman RJ et al. . J Bone Joint Surg. 1992;74A:1032-37





Measure glenoid version inferior to coracoid process

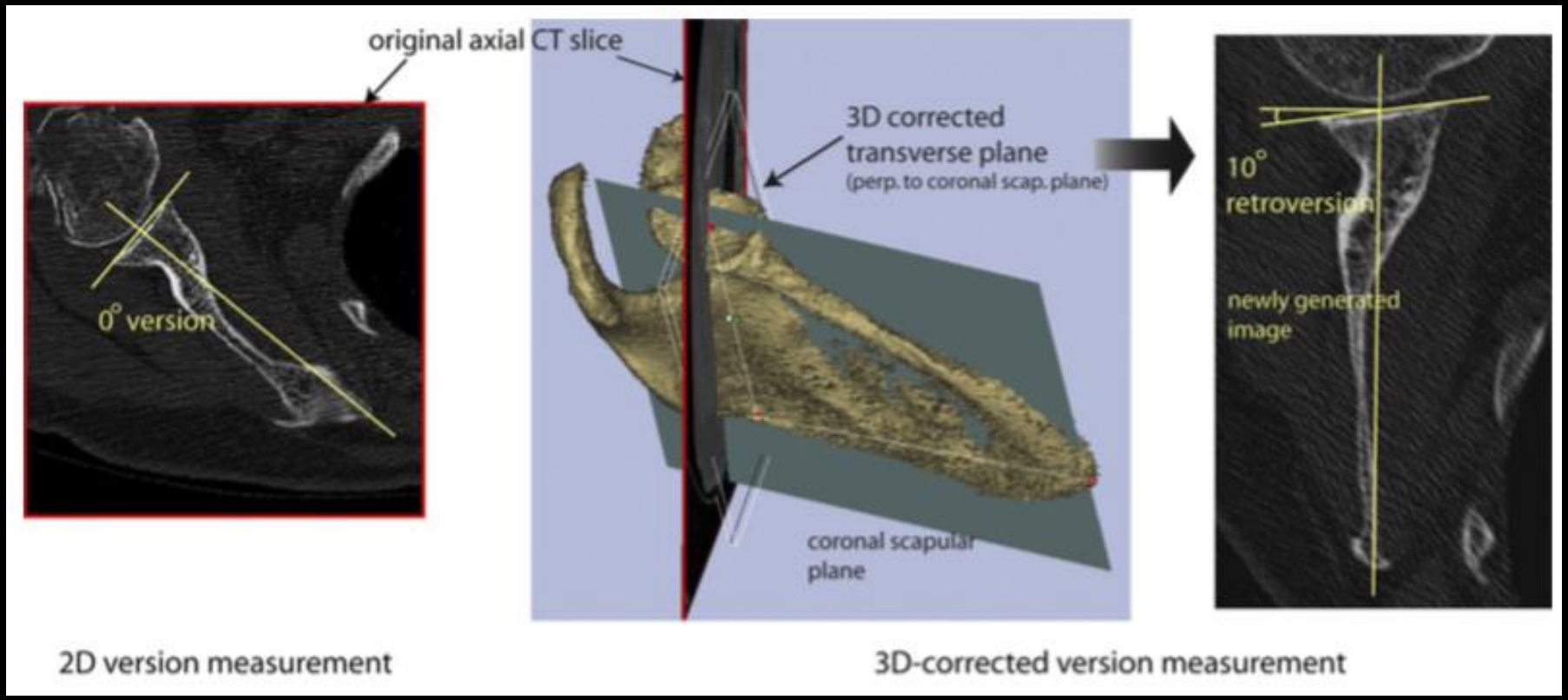
- -line drawn along transverse axis of scapula and line tangent to this
- -α is line along anterior and posterior margin of glenoid , not inclusive of osteophytes
- -measure at mid-glenoid level (within 4 slices below coracoid on 2.5mm cuts)

Friedman RJ et al. . J Bone Joint Surg. 1992;74A:1032-37

3D Reconstruction

- Scapular abduction can alter glenoid version measures on standard 2D CT.
- 3D reconstruction with measurement of the glenoid version perpendicular to the plane of the scapula is more accurate

Budge MD et al. J Shoulder Elbow Surg. 2011;20:577-583



In approximately 50% of patients in this study group, axial 2D images without correction were 5-15 degrees different than their 3D corrected version

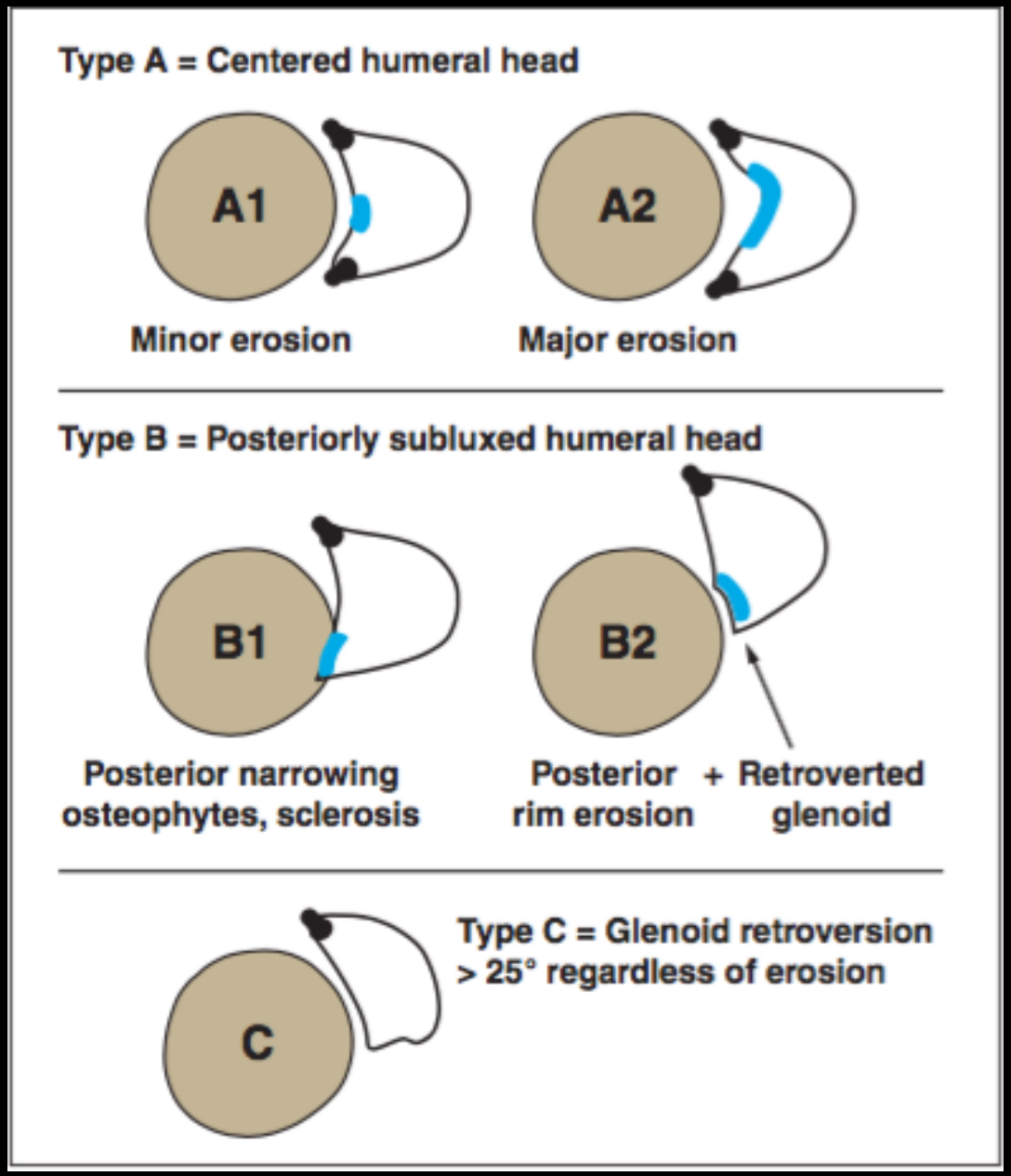
Budge MD et al. J Shoulder Elbow Surg. 2011;20:577-583

Morphologic Study of the Glenoid in Primary Glenohumeral Osteoarthritis

Gilles Walch, MD, Roger Badet, MD, Aziz Boulahia, MD,
and Alfred Khoury, MD

- Classified glenoid morphology based on pattern of erosion and presence of subluxation

Walch G et al. The Journal of Arthroplasty. 1999;14(6):756-760



Walch G et al. The Journal of Arthroplasty. 1999;14(6):756-760
Petscavage JM et al. AJR. 2012;199:757-767

Risks of loosening of a prosthetic glenoid implanted in retroversion

Farron A et al. *J Shoulder Elbow Surg.* July/August 2006: 521-26

- Model of glenohumeral stress upon glenoid implant in varying degrees of retroversion
- With retroversion >10 degrees, significant increases in bone-cement stress and micromotion was observed
- Recommend correction of glenoid retroversion if >10 degrees

Glenoid bone stock

≥25mm from glenoid face to most medial cortex of scapula
(>2cm for a reverse shoulder arthroplasty)

Konin GP. Semin Musculoskelet Radiol. 2015;19:49-59

Preoperative Imaging Assessment

- MRI

Rotator cuff integrity

- MRI can assess for cuff integrity which may dictate reverse versus standard total shoulder arthroplasty
- Incompetent coracoacromial ligament is a contraindication for a standard total shoulder arthroplasty

Konin GP. Semin Musculoskelet Radiol. 2015;19:49-59

Pre-operative Imaging Considerations for Reverse Total Shoulder Arthroplasty

- Deltoid muscle integrity is important for good clinical outcome after reverse total shoulder arthroplasty as the deltoid acts at the primary lever arm
- Teres minor integrity is also important

Konin GP. Semin Musculoskelet Radiol. 2015;19:49-59
Greiner SH et al. Arch Orthop Trauma Surg. 2010;130:177-183

Impact of Fatty Infiltration of the Teres Minor Muscle on the Outcome of Reverse Total Shoulder Arthroplasty

By Ryan W. Simovitch, MD, Naeder Helmy, MD,
Matthias A. Zumstein, MD, and Christian Gerber, MD, FRCSEd

Investigation performed at the Department of Orthopaedics, University of Zurich, Balgrist, Zurich, Switzerland

- Examined 42 patients who underwent reverse total shoulder arthroplasty with preop MRI
- Compared teres minor fat infiltration with clinical outcomes

Simovitch et al. J Bone Joint Surg Am. 2007;89:934-9

TABLE I Grading of Fatty Infiltration of the Rotator Cuff Muscles with the System of Goutallier et al.[10]

Stage	Findings on Magnetic Resonance Imaging
0	No fatty infiltration
1	Some fatty streaks
2	Less fat than muscle
3	Equal muscle and fat
4	More fat than muscle

Grade 4

*Significant difference in functional clinical outcome scores between Grade 0-2 and Grades 3-4.

*Grade 3-4 preop had net *loss* of external rotation postoperatively

Simovitch et al. J Bone Joint Surg Am. 2007;89:934-9

Quiz

- What is the clinical sign used to assess teres minor muscle strength called?

Quiz

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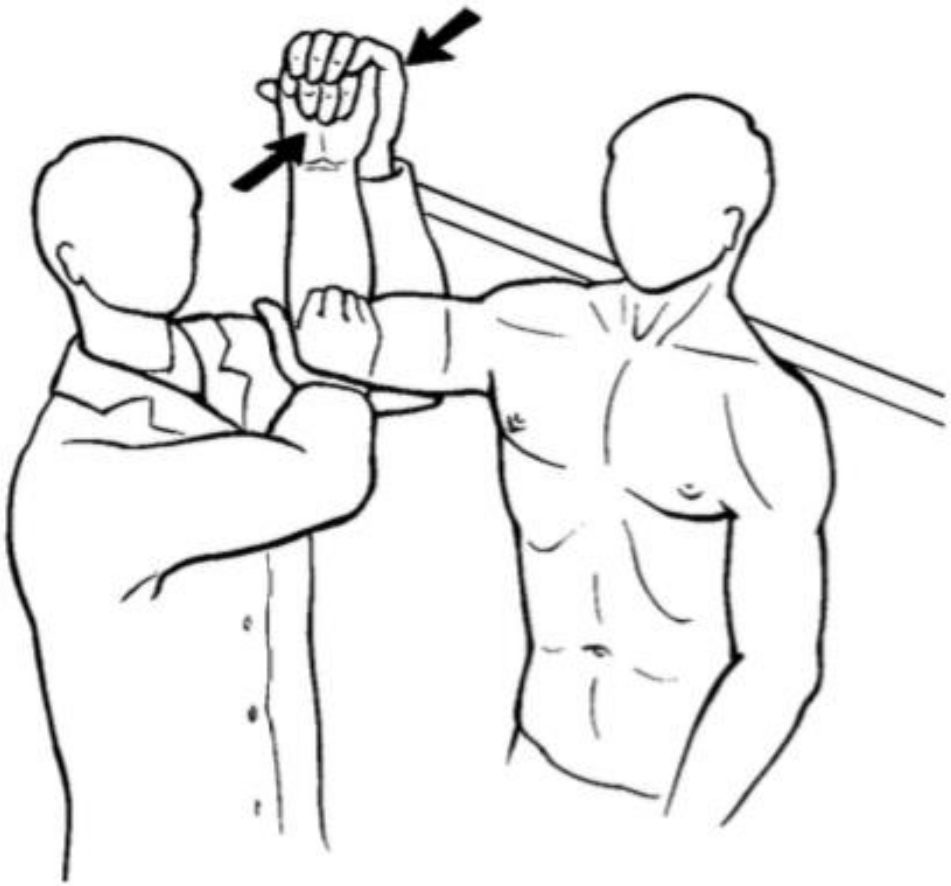
Hornblower's sign

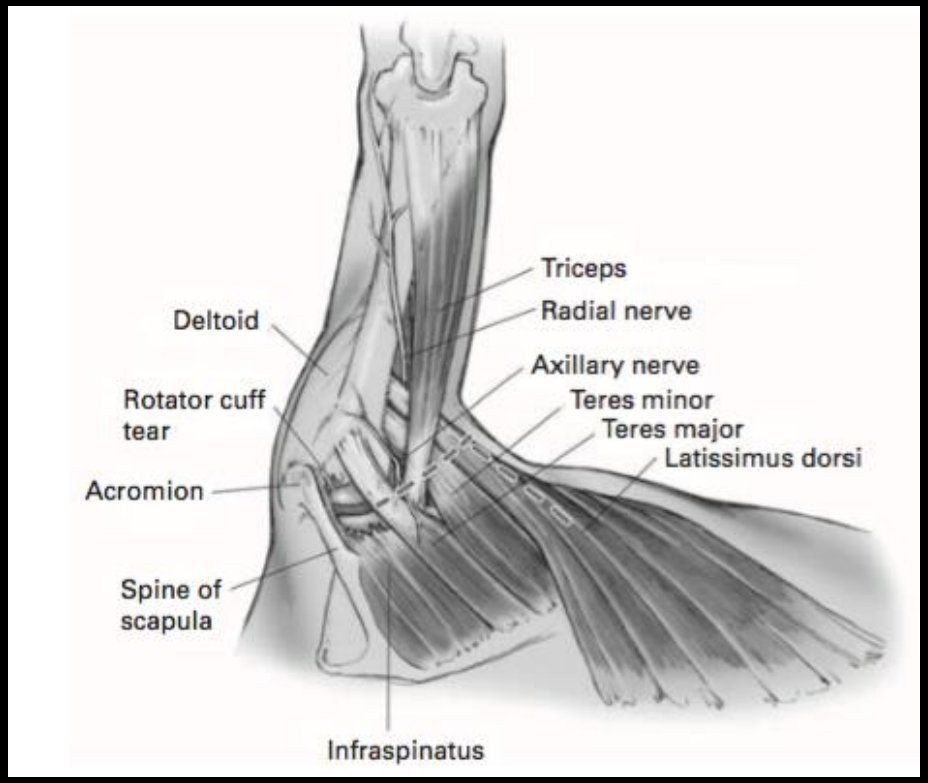
Hornblower's sign

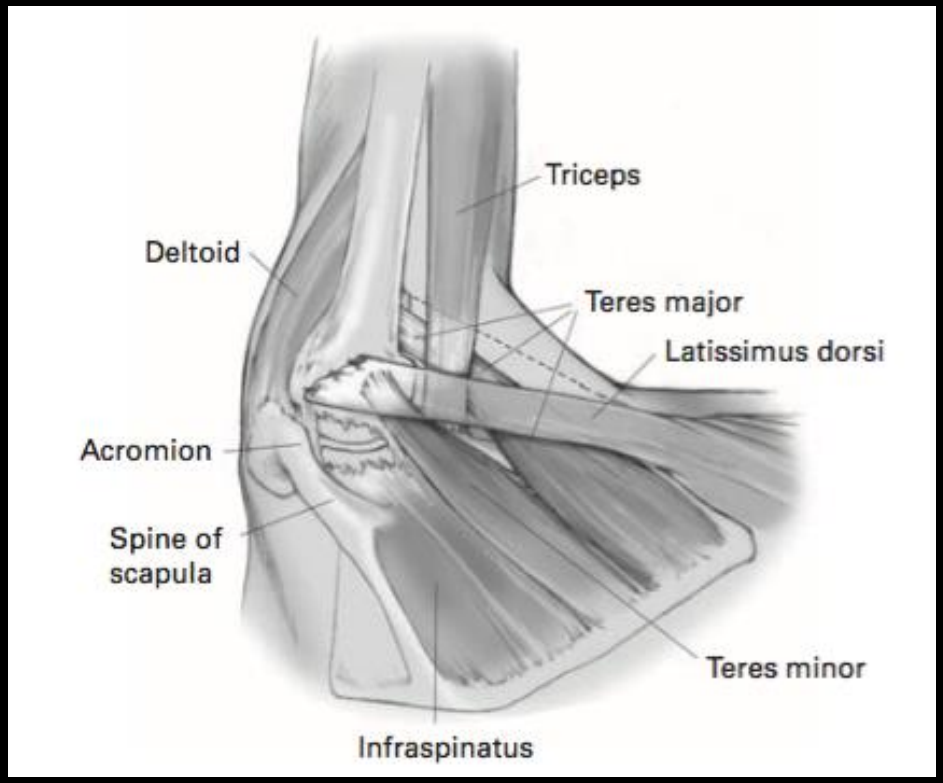


100% sensitivity and 93% specificity for irreparable degeneration of teres minor

Walch G et al. J Bone Joint Surg. 1998;80-B:624-8

Latissimus Dorsi Tendon Transfer





-Reattach latissimus dorsi tendon to near the infraspinatus tendon insertion site on greater tuberosity. *Need intact subscapularis*.
-Results in improvement of external rotation
-Some suggest performing if fatty infiltration of teres minor ≥ Grade 2

Habermeyer P et al. J Bone Joint Surg. 2006;88-B:208-12
Simovitch et al. J Bone Joint Surg Am. 2007;89:934-9

Summary

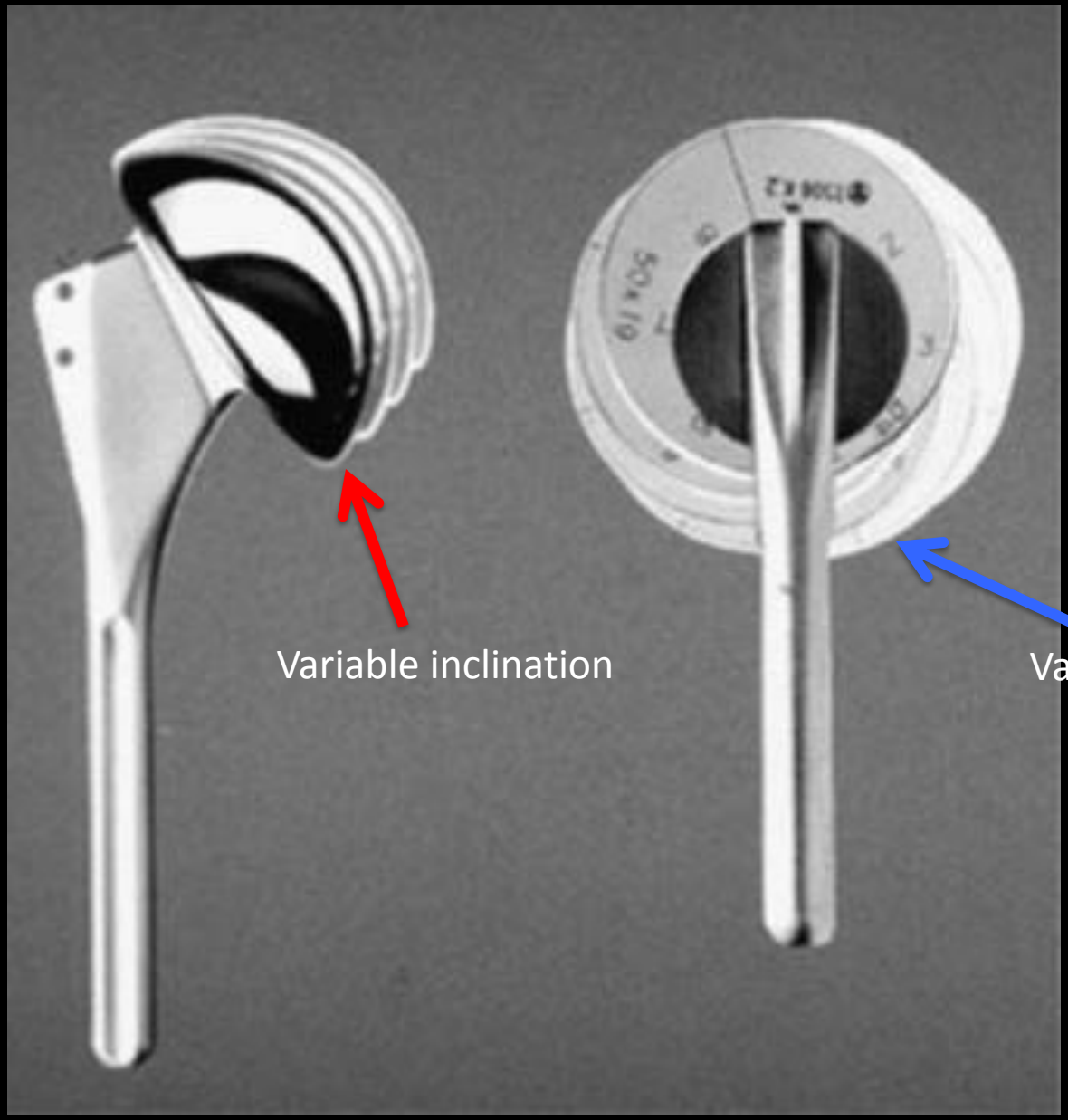
- Preoperative imaging should address:
  - Glenoid version
  - Glenoid bone stock
  - Rotator cuff integrity
  - Coracoacromial arch integrity
- Don't forget to address Deltoid and Teres Minor muscle bulk and degree of fat infiltration, as it may affect clinical outcome and surgical plan

Konin GP. Semin Musculoskelet Radiol. 2015;19:49-59

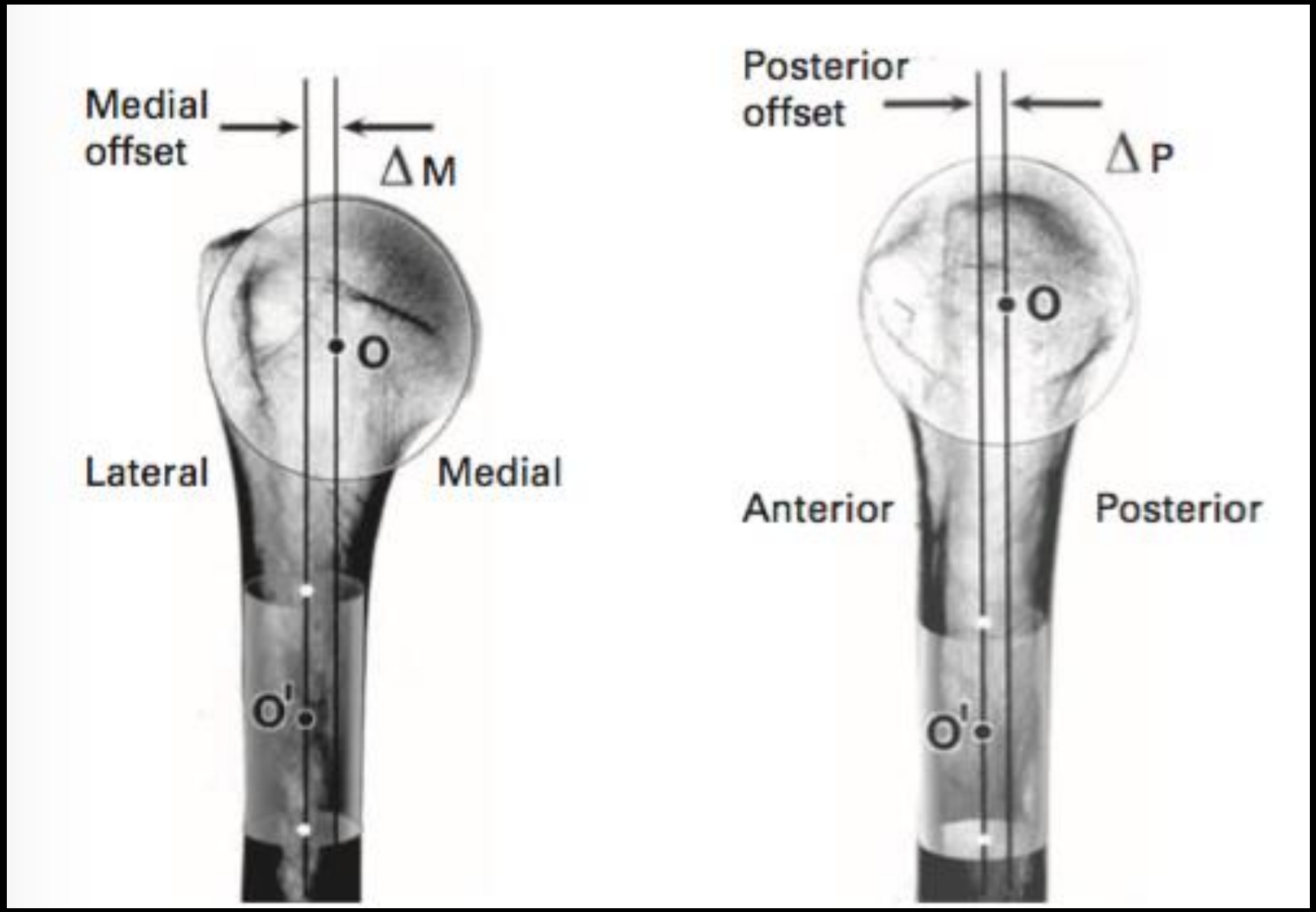
Total Shoulder Arthroplasty

- First arthroplasty performed in 1893
- Procedure was developed and modernized by Neer
- Now in a 3rd generation of design: adaptable or anatomic

Boileau P et al. J Bone Joint Surg. 2006;88-B:562-75
Sanchez-Sotelo J. The Open Orthopedics Journal. 2011; 5:106-114



Boileau P et al. J Bone Joint Surg. 2006;88-B:562-75



Boileau P et al. J Bone Joint Surg. 2006;88-B:562-75

Glenoid component: keeled vs pegged

Lazarus MD et al. J Bone Joint Surg. 2002;84A(7):51174-82

Glenoid component: keeled vs pegged

Keeled

Pegged

Edwards TB et al. J Shoulder Elbow Surg. 2010;19: 251-257

Complications

TABLE I Complications Following Unconstrained Total Shoulder Arthroplasties in Studies Reported from 1996 to 2005*

Complication	No. of Shoulders	Percentage of All Complications	Percentage of All Shoulders
Component loosening	161	39	6.3
Glenoid	134	32	5.3
Humerus	27	6.5	1.1
Instability	124	30	4.9
Superior	77	19	3.0
Posterior	25	6	1.0
Anterior	22	5	0.9
Periprosthetic fracture	46	11	1.8
Intraoperative	27	6.5	1.1
Postoperative	19	4.6	0.7
Rotator cuff tear	32	7.7	1.3
Neural injury	20	4.8	0.8
Infection	19	4.6	0.7
Deltoid detachment	2	0.5	0.08

*Thirty-three series including a total of 2540 shoulders.

Bohsali KI et al. J Bone Joint Surg Am. 2006;88:2279-2292

The Radiographic Evaluation of Keeled and Pegged Glenoid Component Insertion

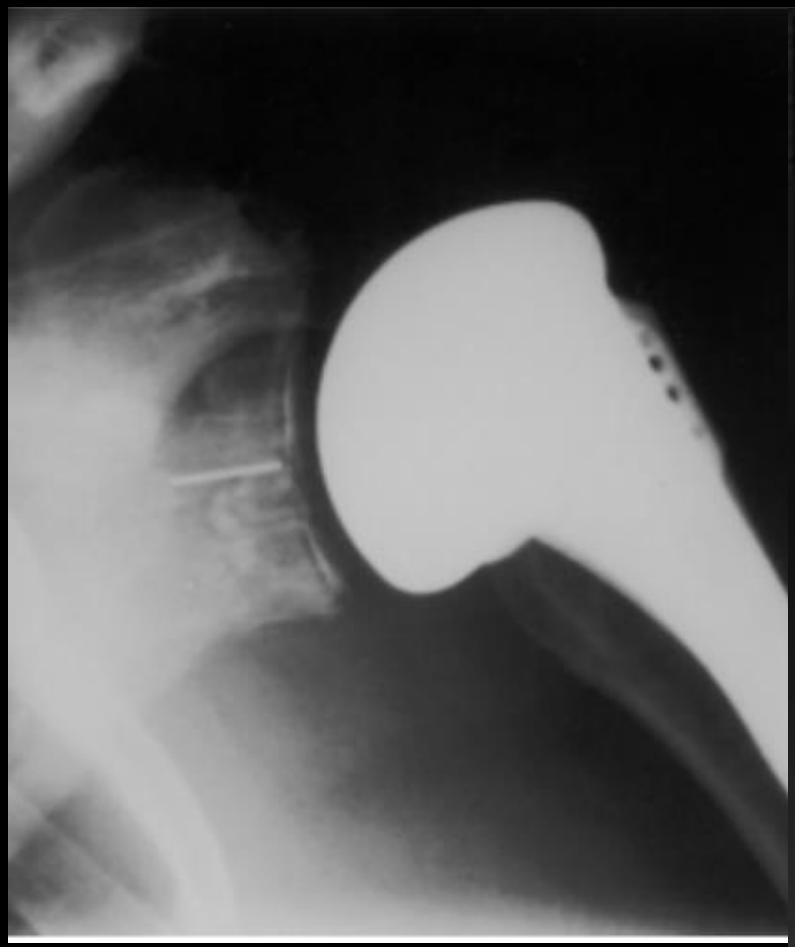
By Mark D. Lazarus, MD, Kirk L. Jensen, MD, Carleton S and Frederick A. Matsen III, MD

Radiographic comparison of pegged and keeled glenoid components using modern cementing techniques: A prospective randomized study

T. Bradley Edwards, MD[a,*], Joanne E. Labriola, MD[a], Rodney J. Stanley, MD[a], Daniel P. O'Connor, PhD[b], Hussein A. Elkousy, MD[a], Gary M. Gartsman, MD[a]

- Radiolucency about the glenoid component very common, even on initial postoperative radiograph
  - At 26 months, 46% of keeled prostheses had lucency vs 15% of pegged prostheses
- Keeled components more likely to have radiolucency and incomplete component seating versus pegged components

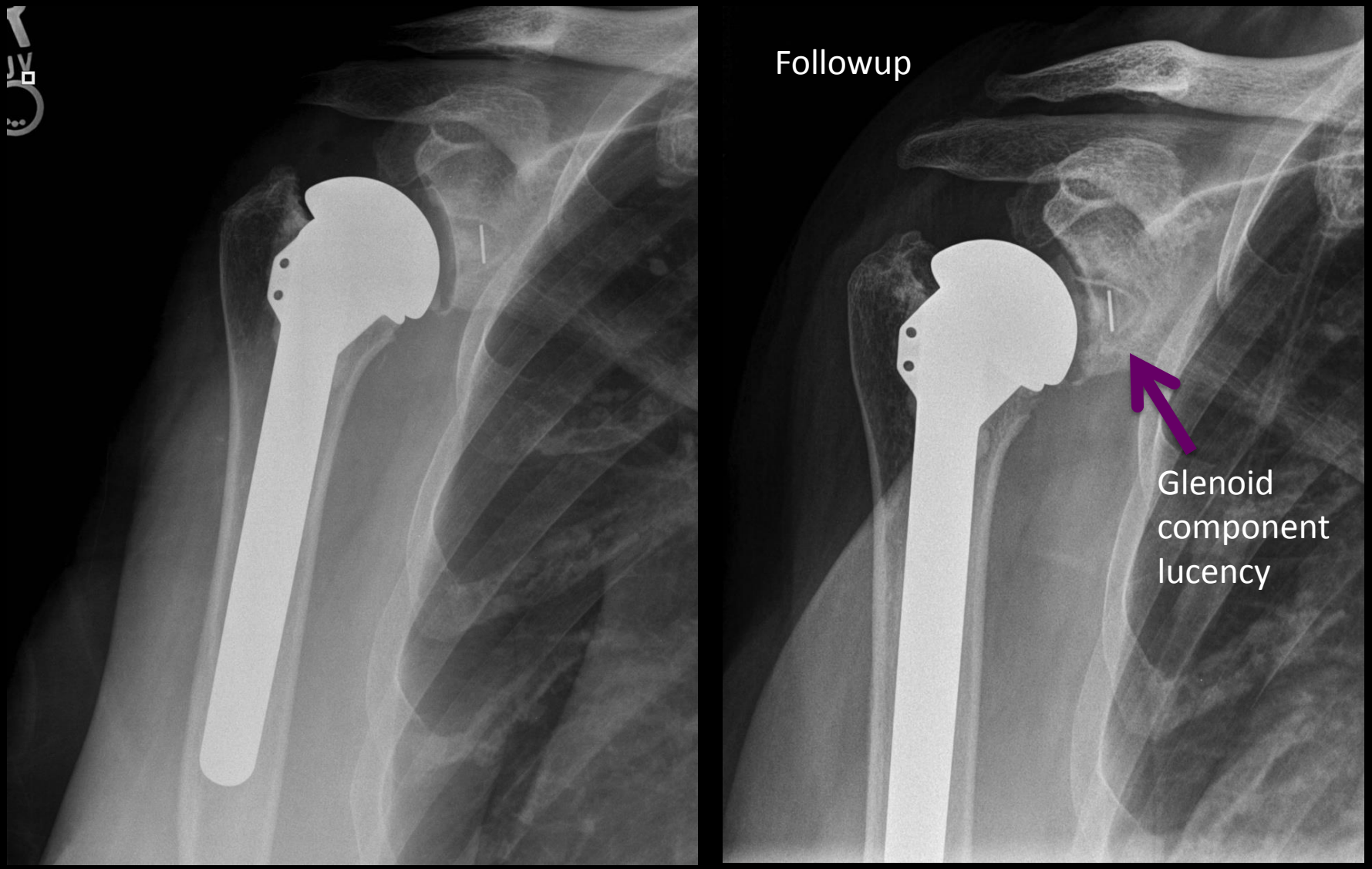
Edwards TB et al. J Shoulder Elbow Surg. 2010;19: 251-257
Lazarus MD et al. J Bone Joint Surg. 2002;84A(7):51174-82

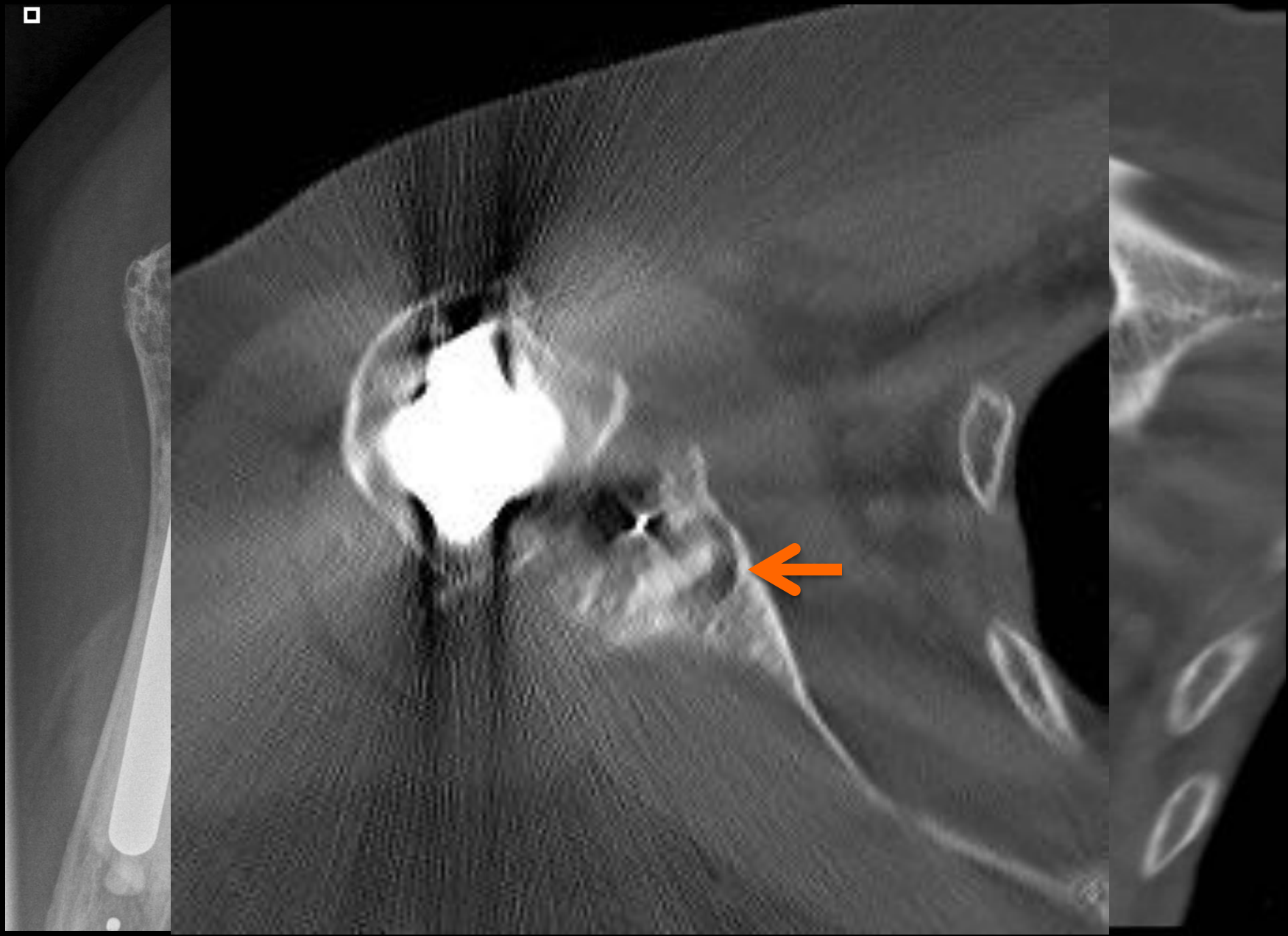


Grade 3 radiolucency

Grade 3 radiolucency

Edwards TB et al. J Shoulder Elbow Surg. 2010;19: 251-257
Lazarus MD et al. J Bone Joint Surg. 2002;84A(7):51174-82

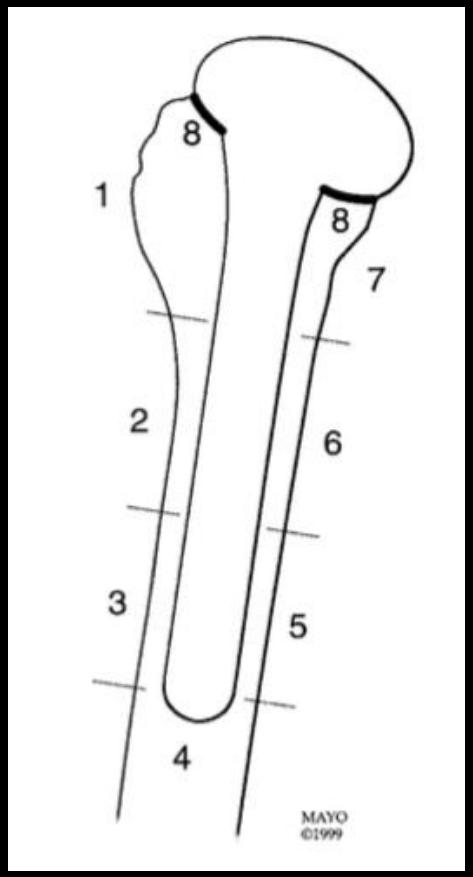

Followup
Glenoid component lucency

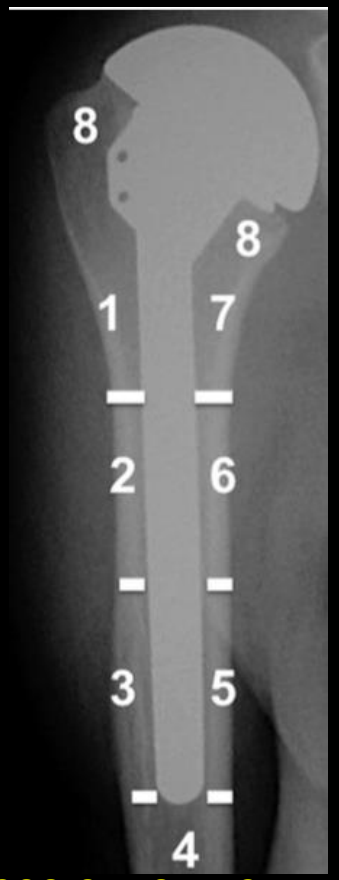


Humeral component loosening

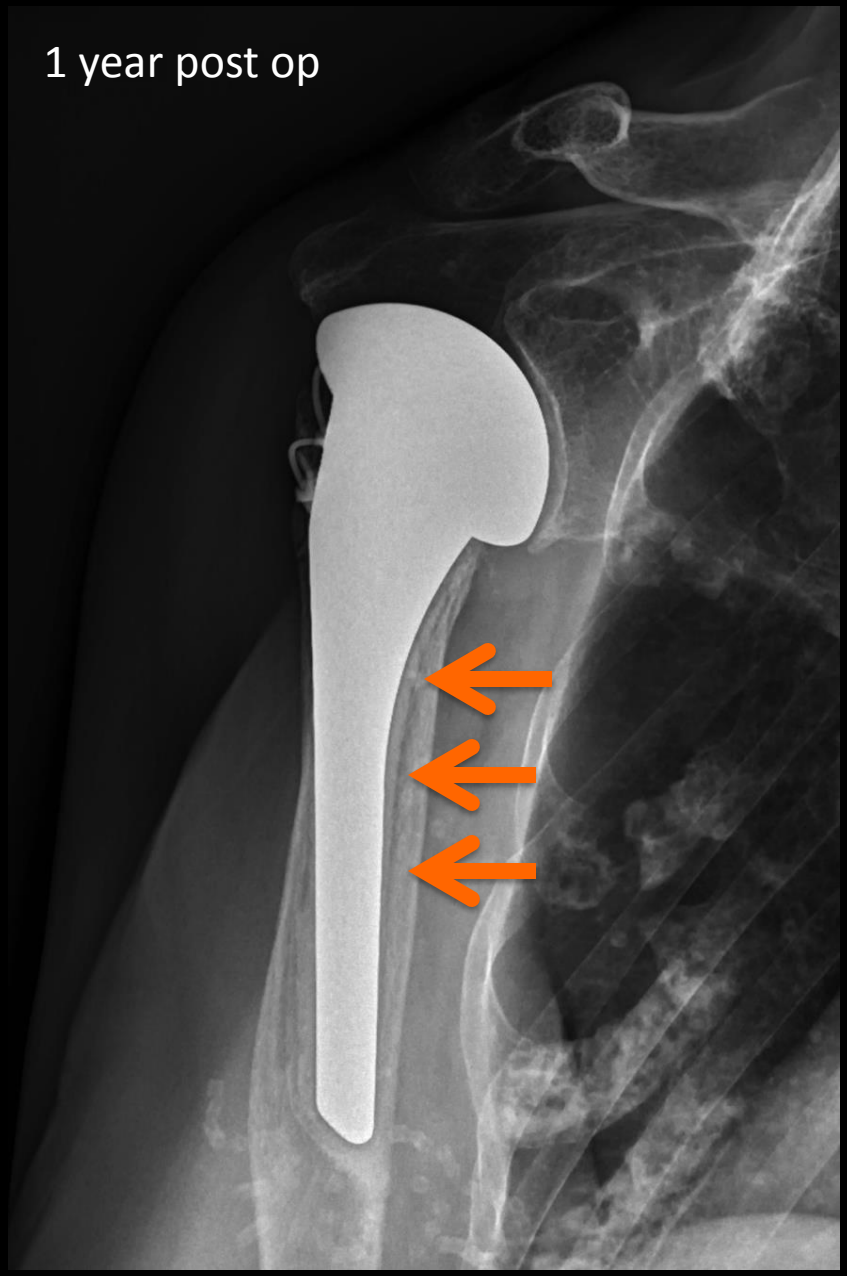
- Lucency surrounding the humeral component divided into zones

*Humeral component considered “at risk” for loosening if 3 or more zones have a lucent line ≥2mm





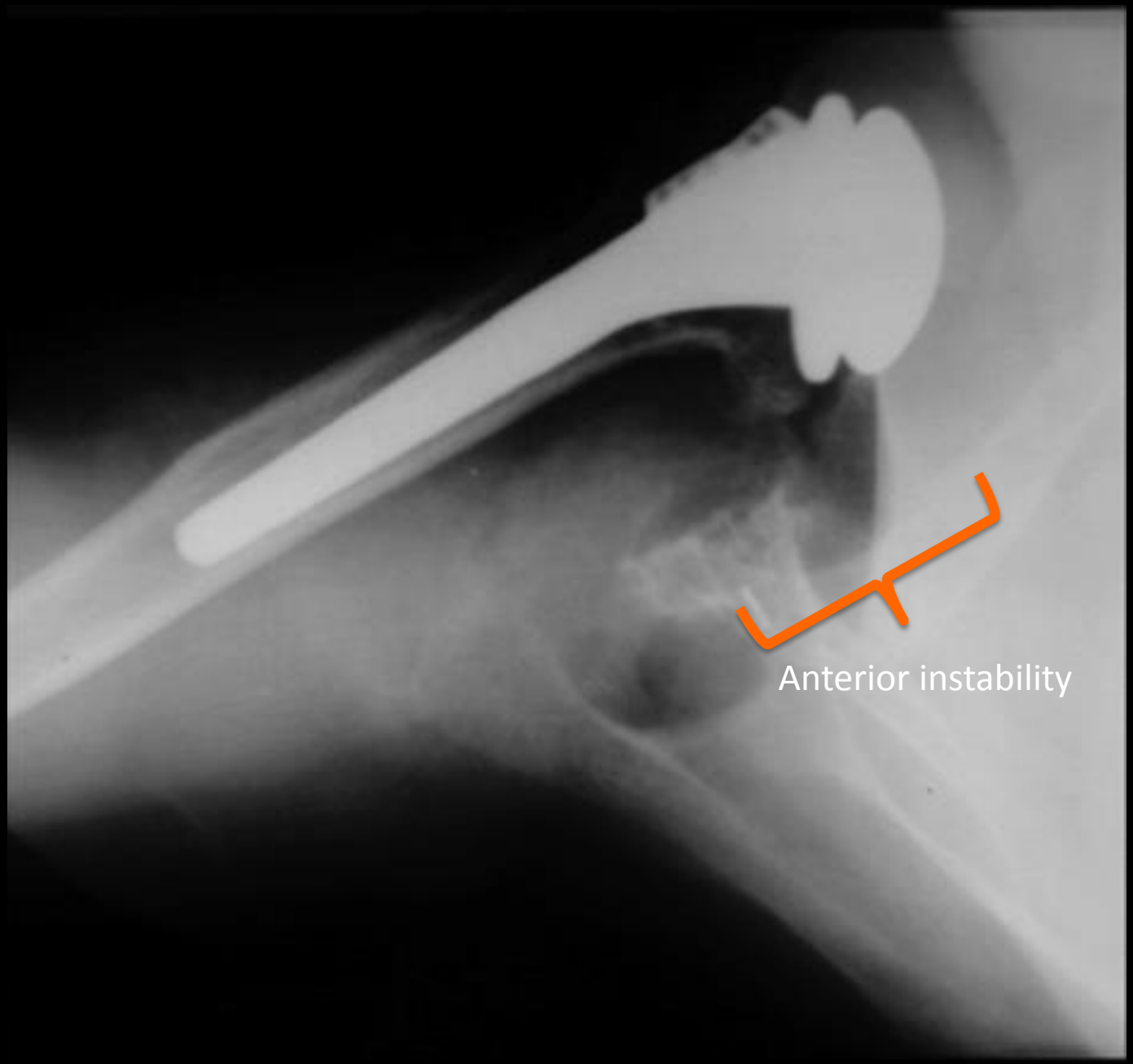
Sperling JW et al. J Shoulder Elbow Surg. 2000;9: 507-13
Wiater BP et al. J Shoulder Elbow Surg. 2014;23: 745-758


1 year post op

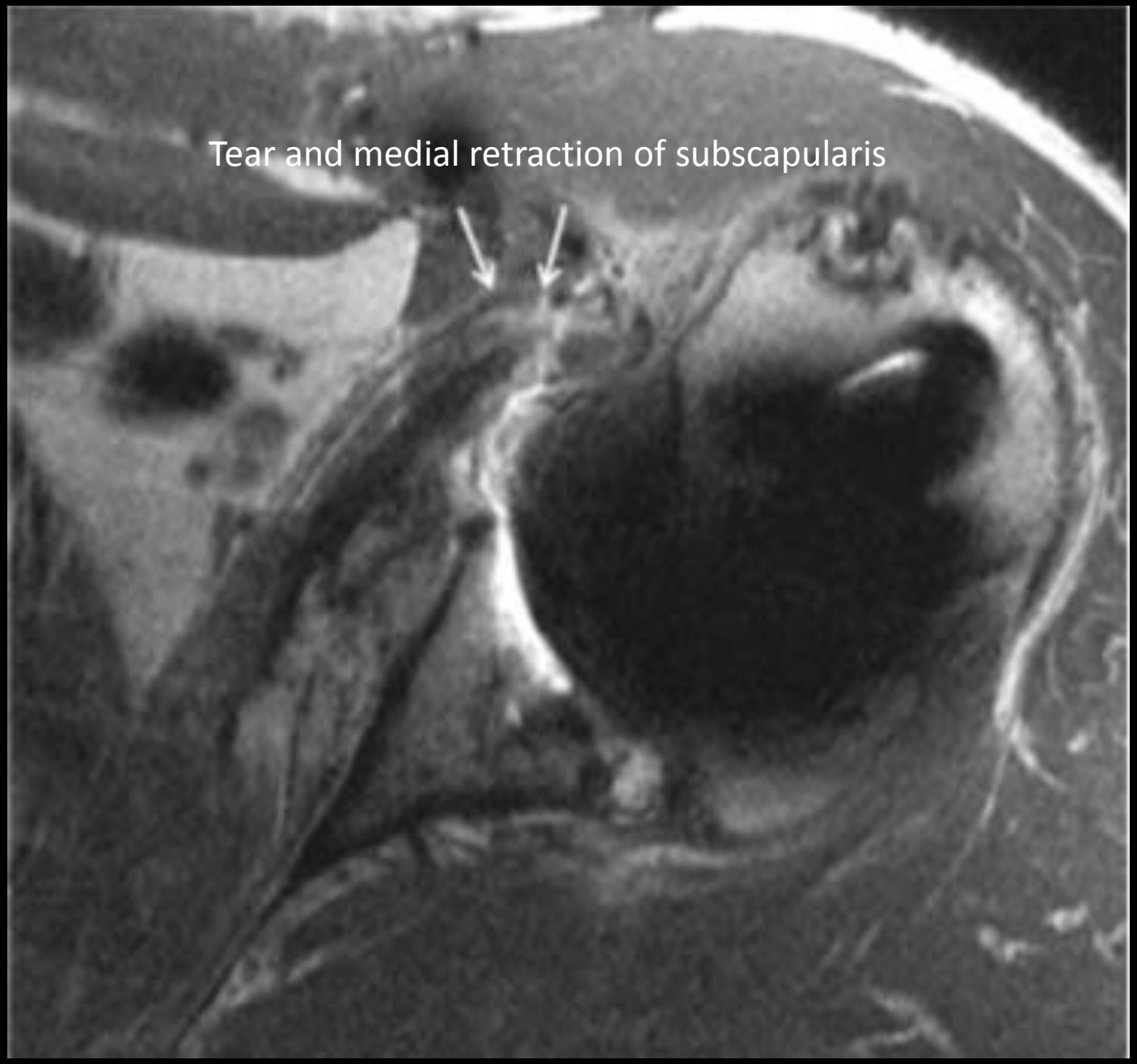
Complications: Instability

- Can have anterior, posterior or superior instability
  - Anterior and superior instability most common (80% of instability)
  - Most instability associated with component malposition and soft tissue imbalance
- Anterior subluxation often associated with tear of the subscapularis tendon

Bohsali KI et al. J Bone Joint Surg Am. 2006;88:2279-2292



Wiater BP et al. J Shoulder Elbow Surg. 2014;23: 745-758



Nwawka OK et al. HSSJ. 2014;10:213-224

Utility of MRI

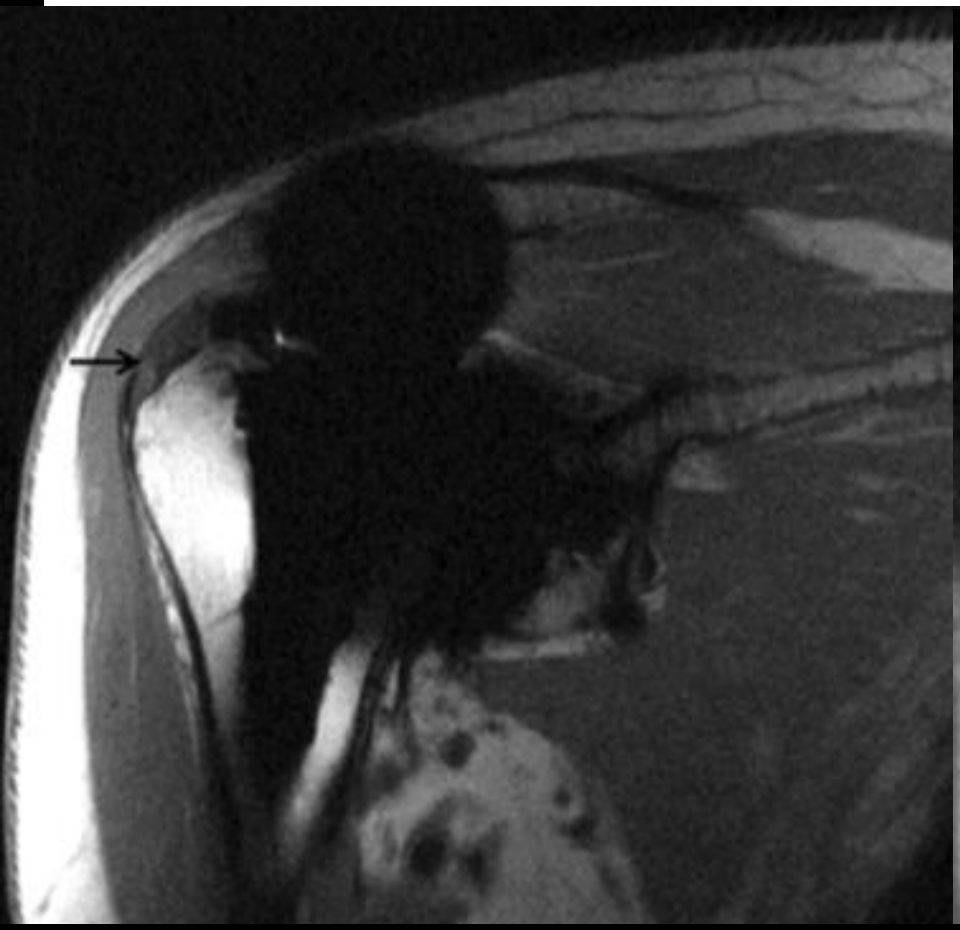
- With the use of metal suppression techniques, it is a useful adjunct for assessment of failed shoulder arthroplasty
- In particular, rotator cuff integrity and rotator cuff muscle bulk may be assessed and influence clinical management
- Useful for evaluating deltoid attachment

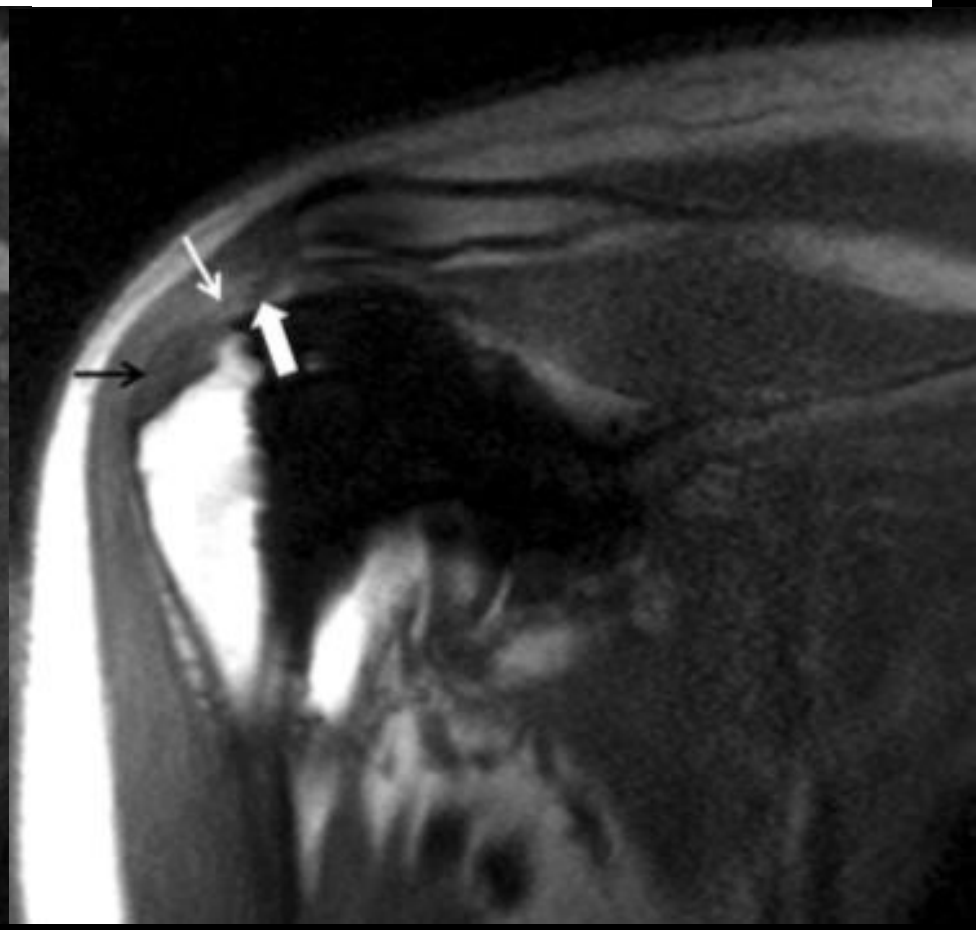
Nwawka OK et al. HSSJ. 2014;10:213-224

Magnetic Resonance Imaging of Shoulder Arthroplasty

Review Article

O. Kenechi Nwawka, MD · Gabrielle P. Konin, MD · Darryl B. Sneag, MD
Lawrence V. Gulotta, MD · Hollis G. Potter, MD



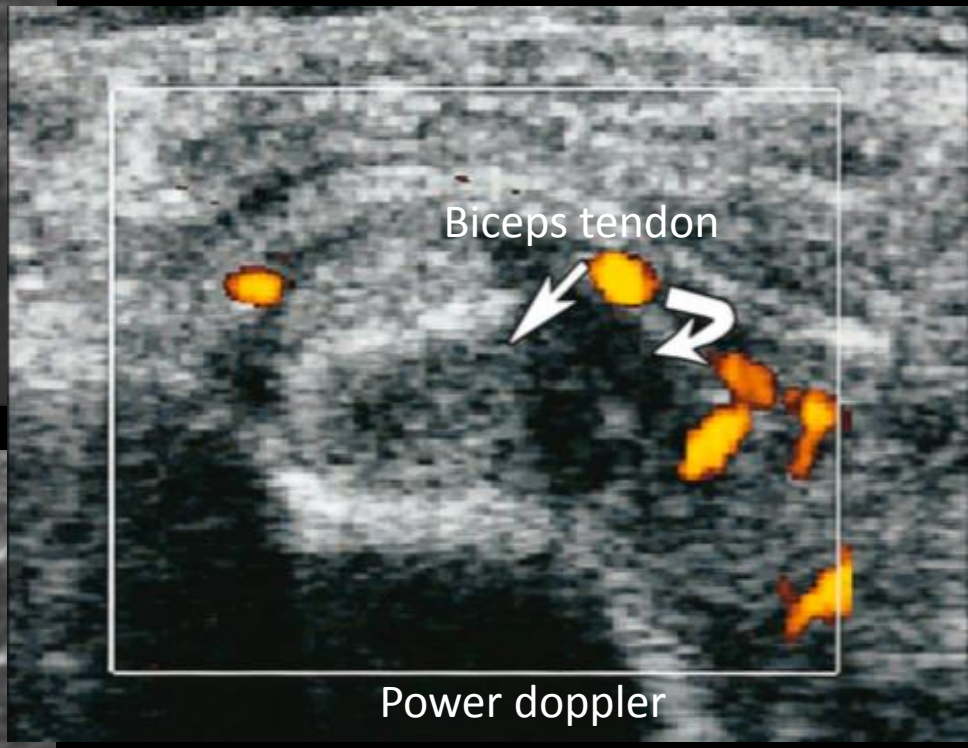


Nwawka OK et al. HSSJ. 2014;10:213-224

Role of Ultrasound

- Useful for assessment of rotator cuff integrity
- Harmonic imaging and extended field of view may be helpful

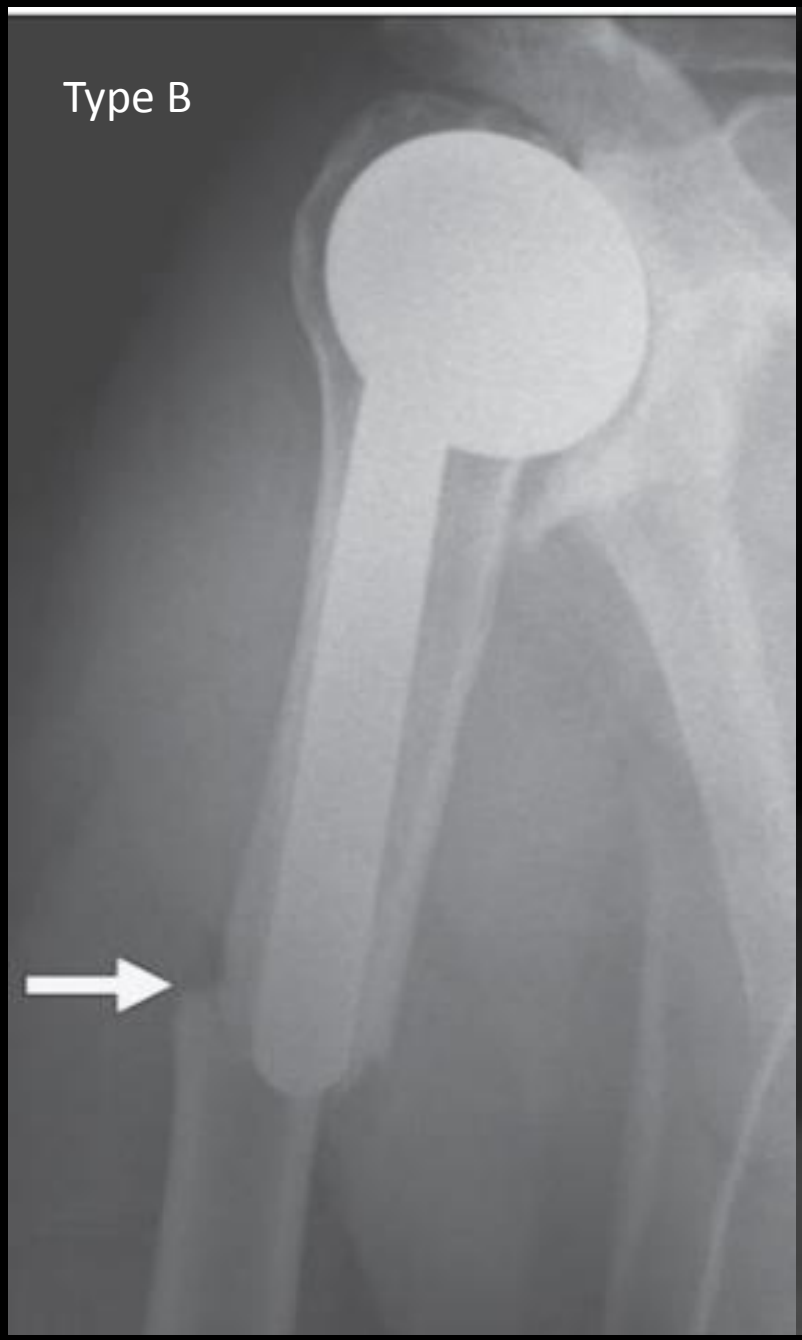
Sofka CM et al. AJR. 2003;180:1117-1120



Sofka CM et al. AJR. 2003;180:1117-1120

Complications: Periprosthetic fracture

- Wright and Cofield classification
- Divide periprosthetic fractures in relation to humeral component



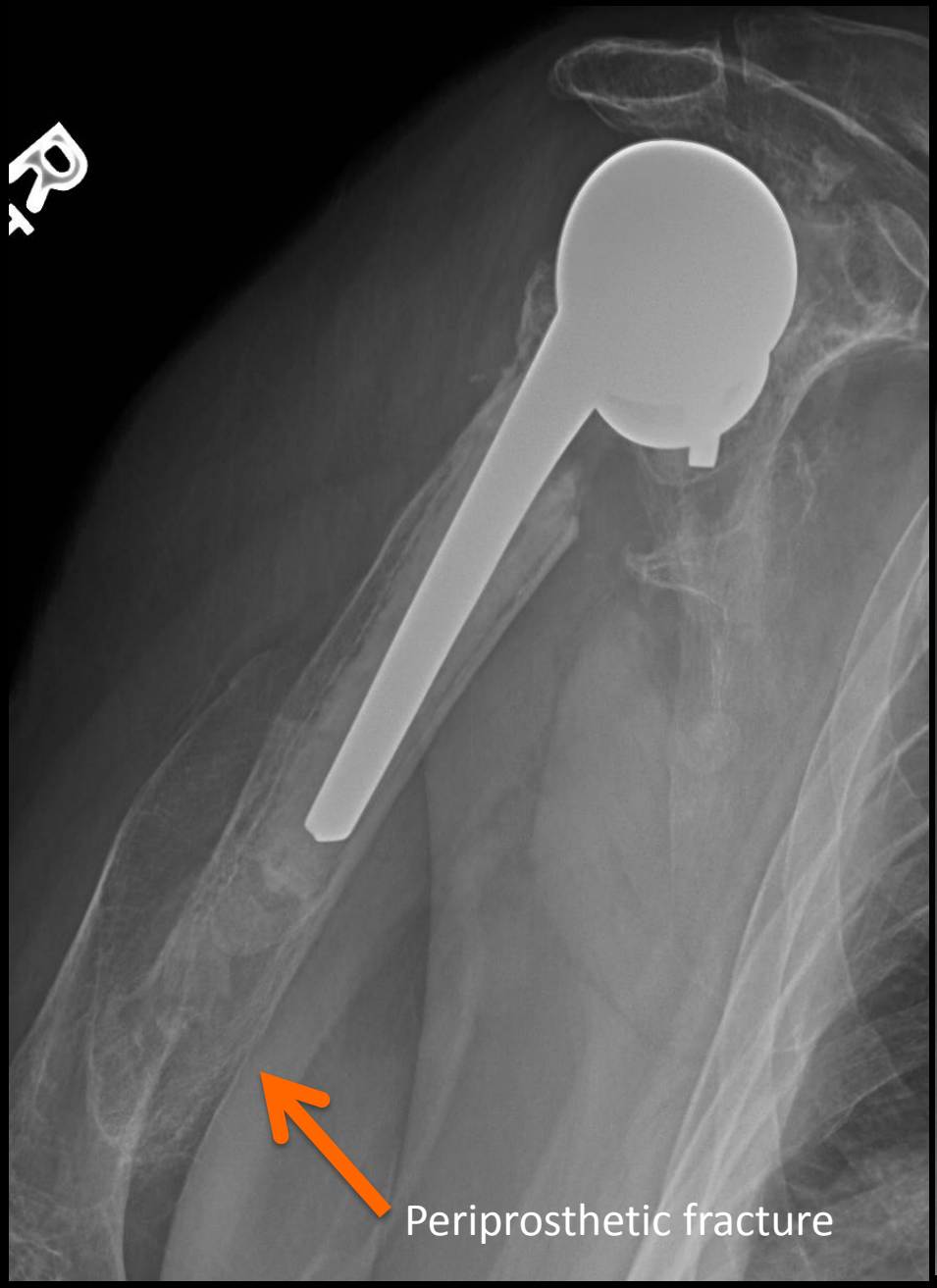
Petscavage JM et al. AJR. 2012;199:757-767

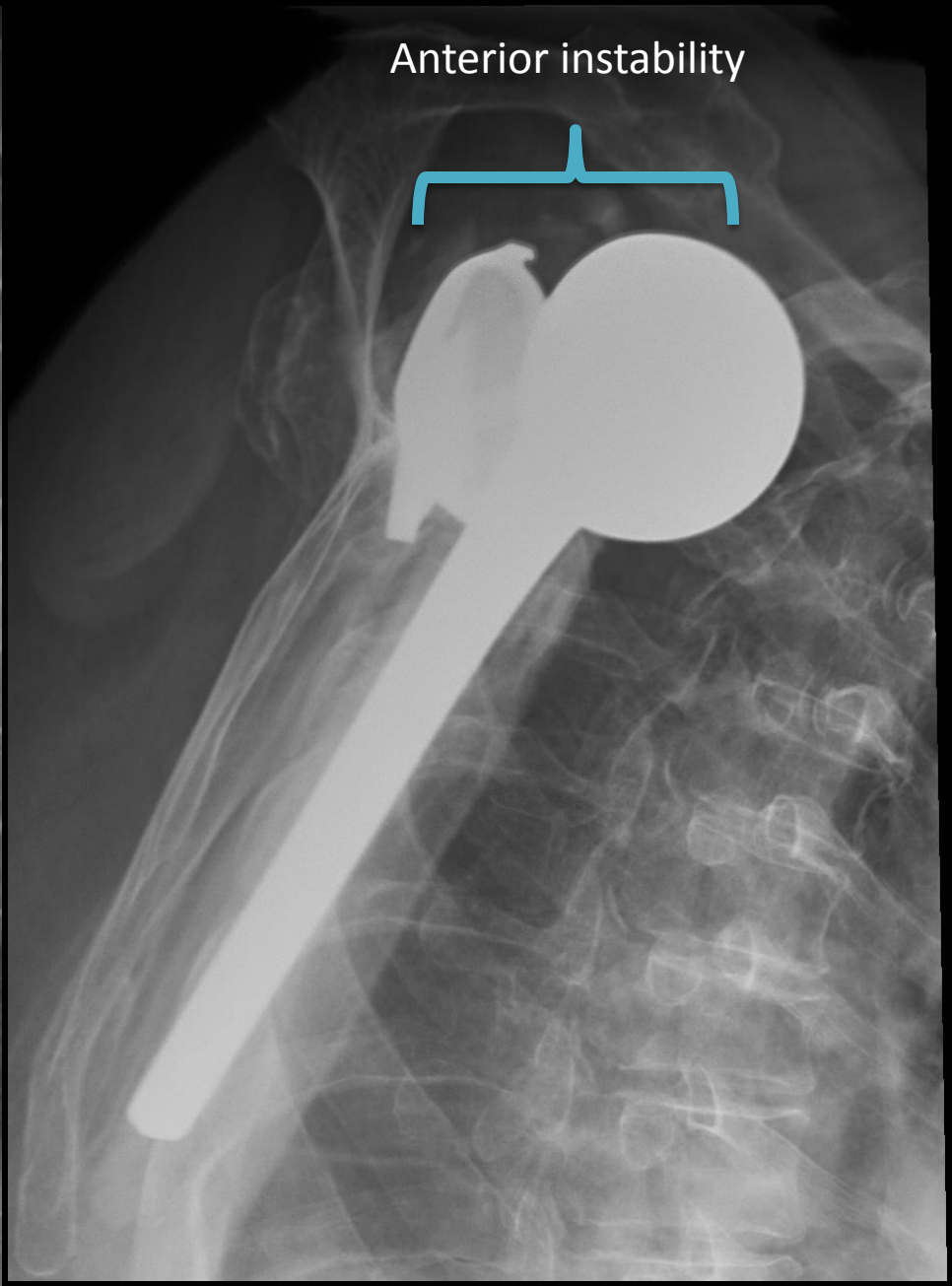
Timeline of complications

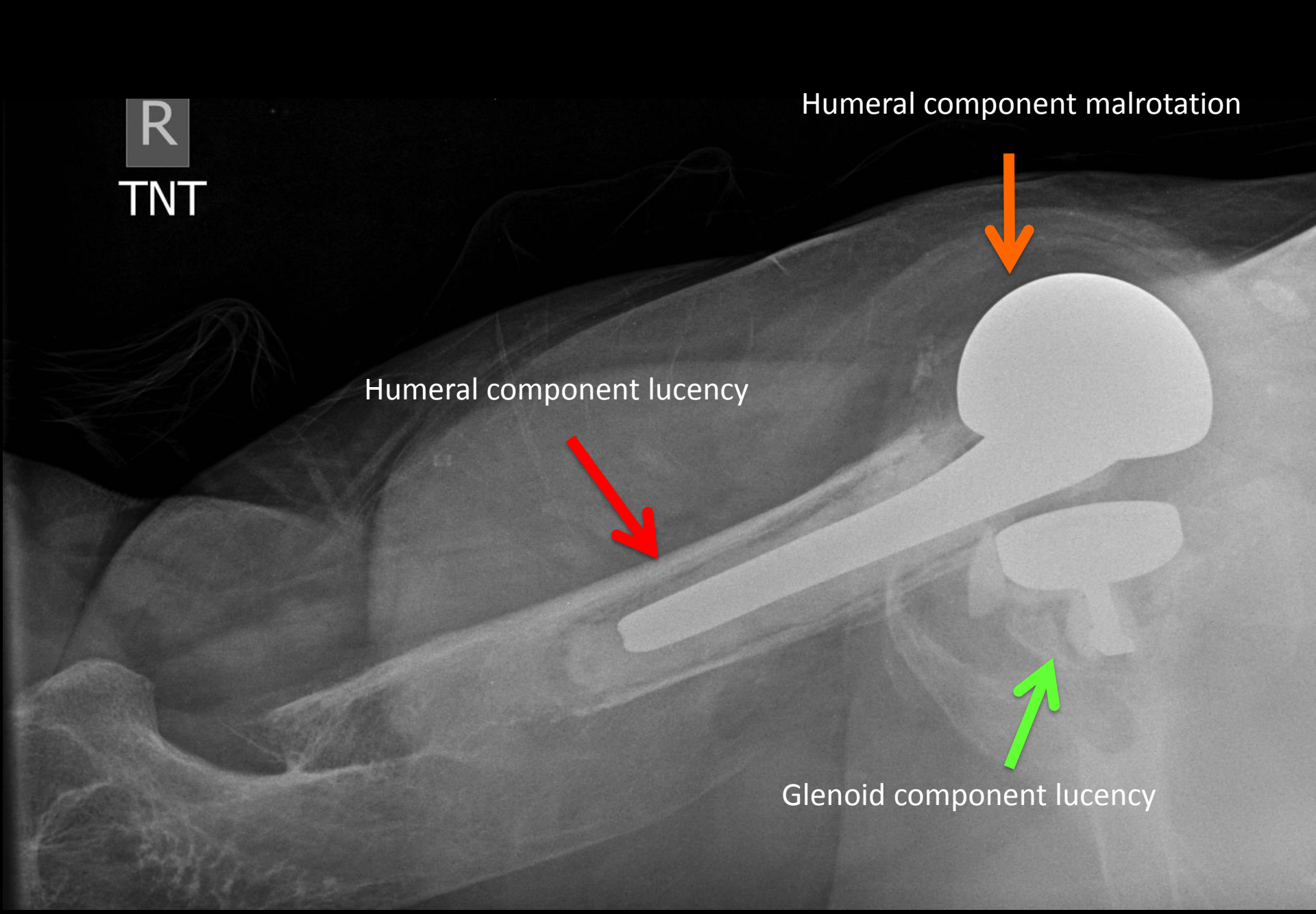
- Onset of hardware complications often comes years after surgery:
  - Component loosening: 7.7±4.8 years
  - Infection: 12.1±2.9 years
  - Dislocations: 2.1±3.6 years
  - Periprosthetic fractures: 5.8±4.7 years
- Emphasizes importance of long term followup

Deshmukh AV et al. J Shoulder Elbow Surg. 2005;14(5):471-79

Case


Periprosthetic fracture

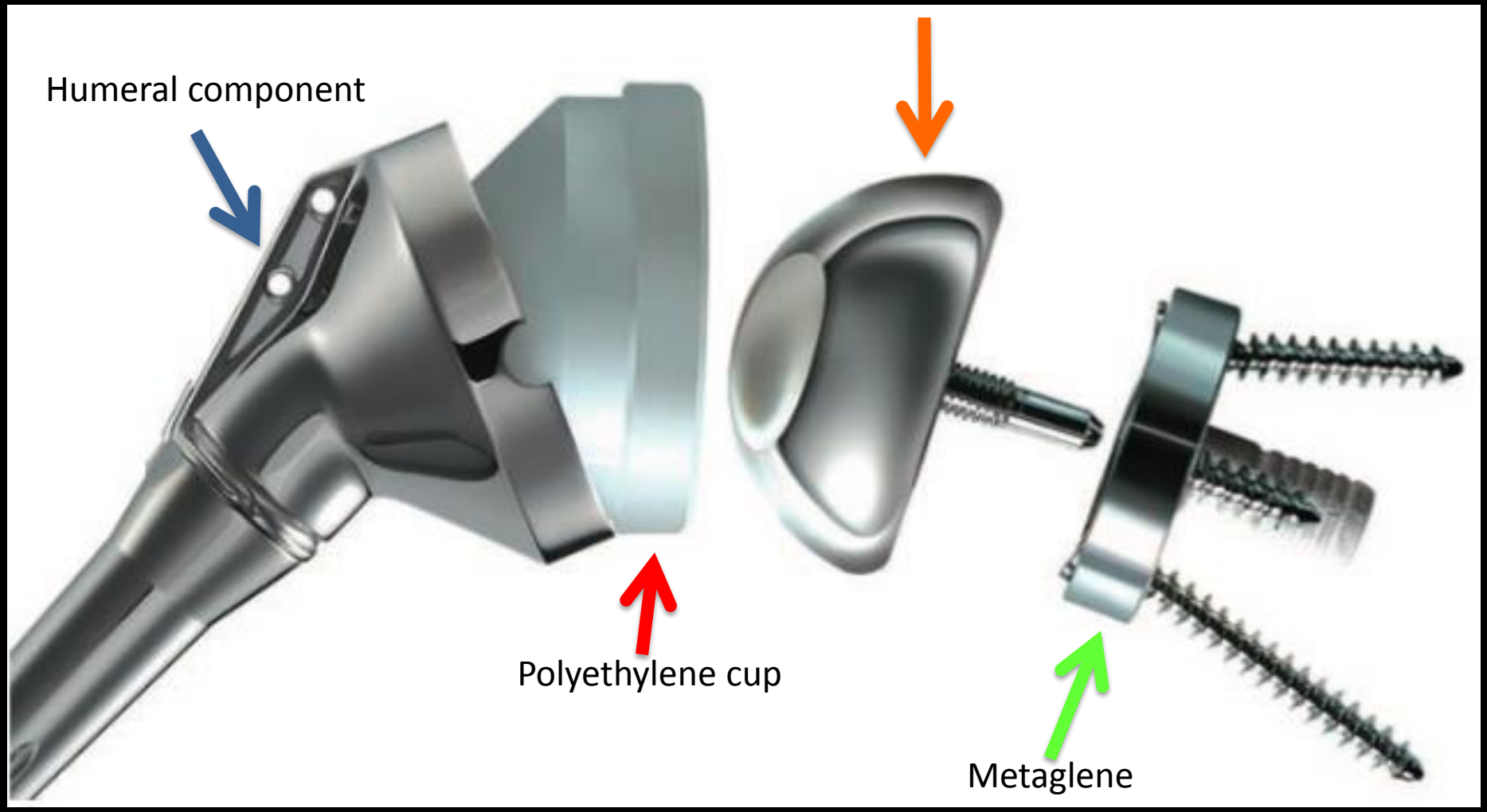

Anterior instability


R
TNT
Humeral component malrotation
Humeral component lucency
Glenoid component lucency

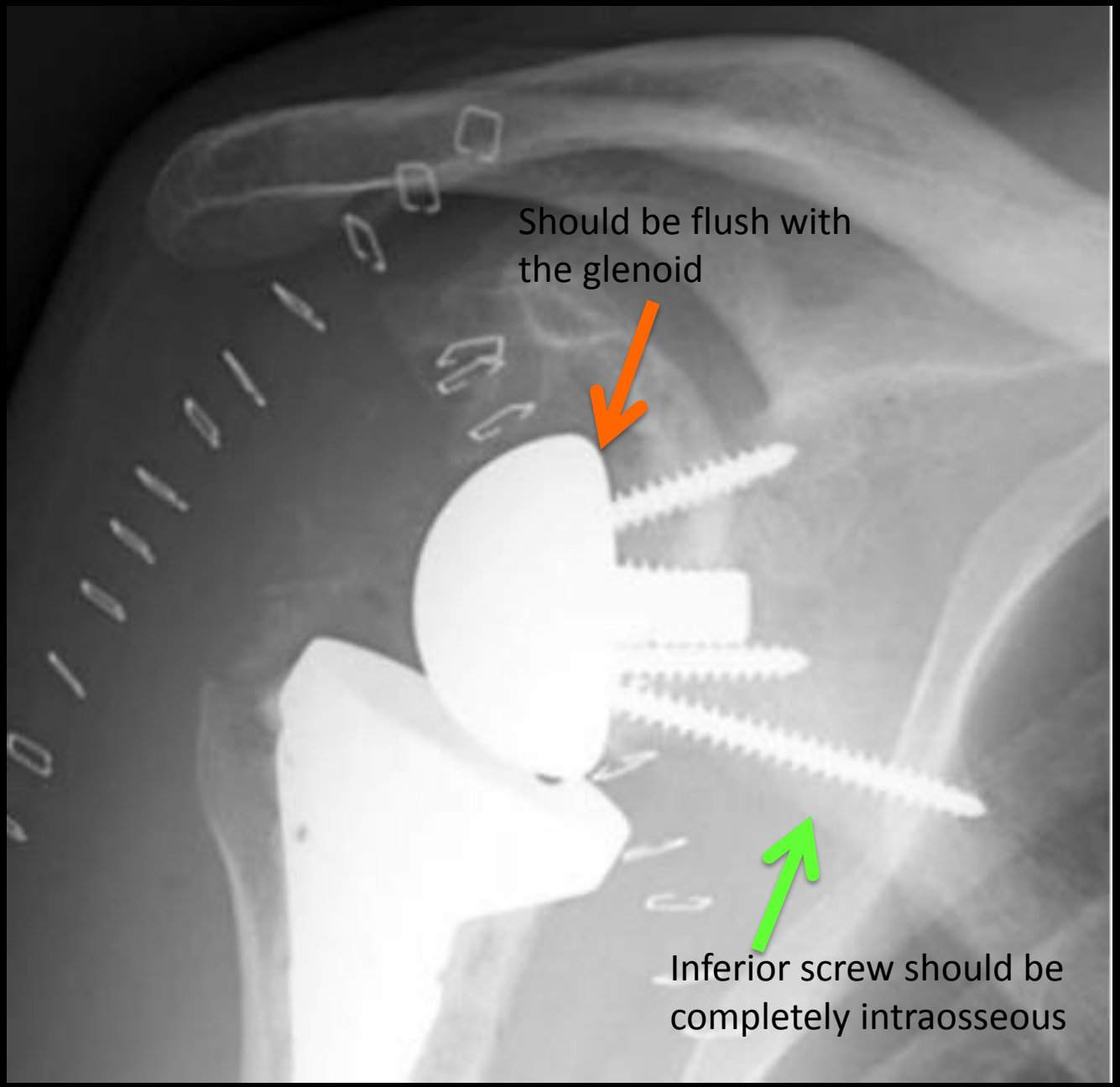
Reverse Shoulder Arthroplasty

- Designed in 1980s by Grammont
- Given FDA approval in 2003
- Indications:
  - Rotator cuff arthropathy
  - Failed conventional shoulder arthroplasty
  - Proximal humeral tumors
  - Proximal humeral fractures with anterosuperior escape

Nam D et al. J Bone Joint Surg. 2010;92:23-35

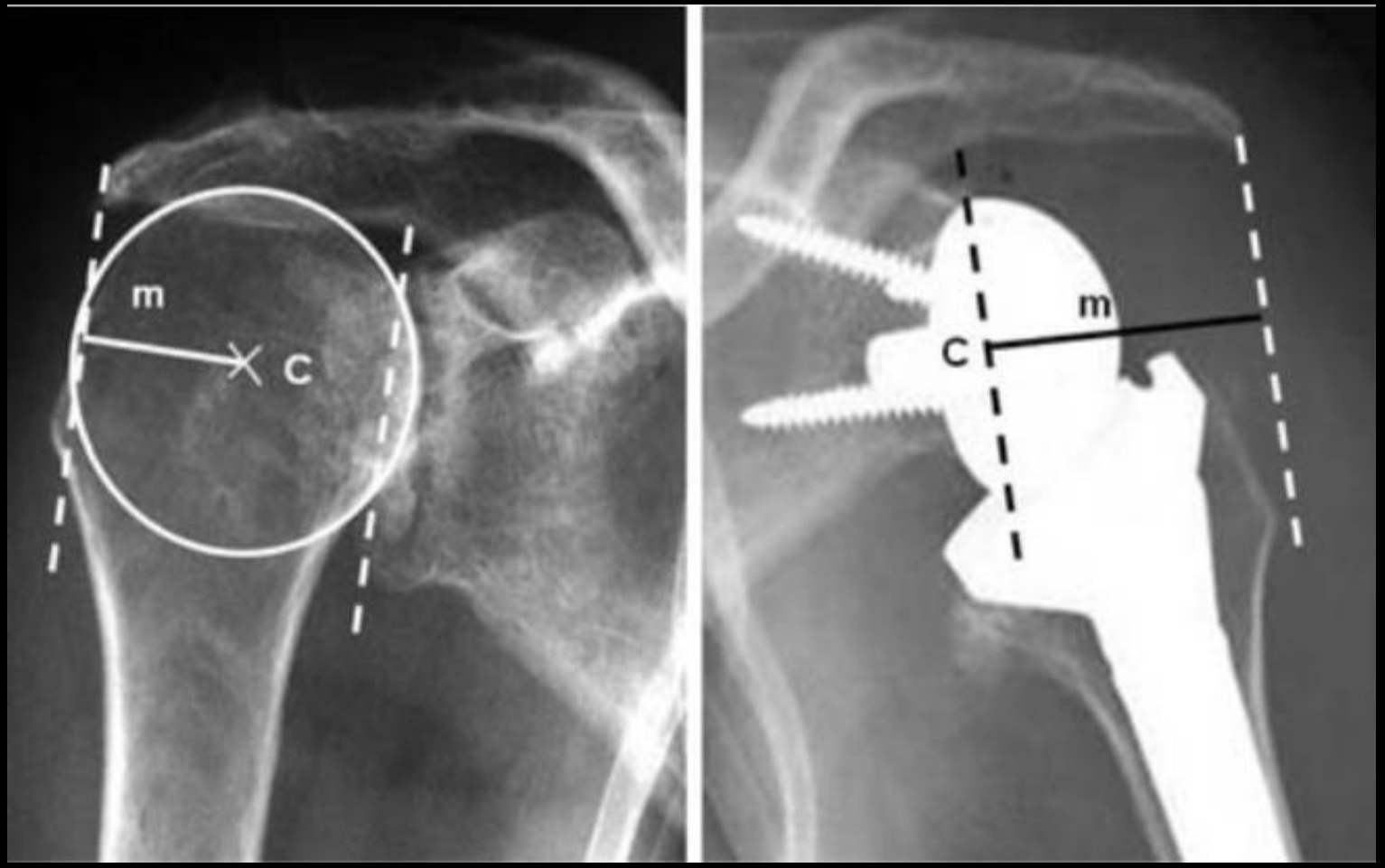


Matsen FA et al. J Bone Joint Surg. 2006;88-A:659-667

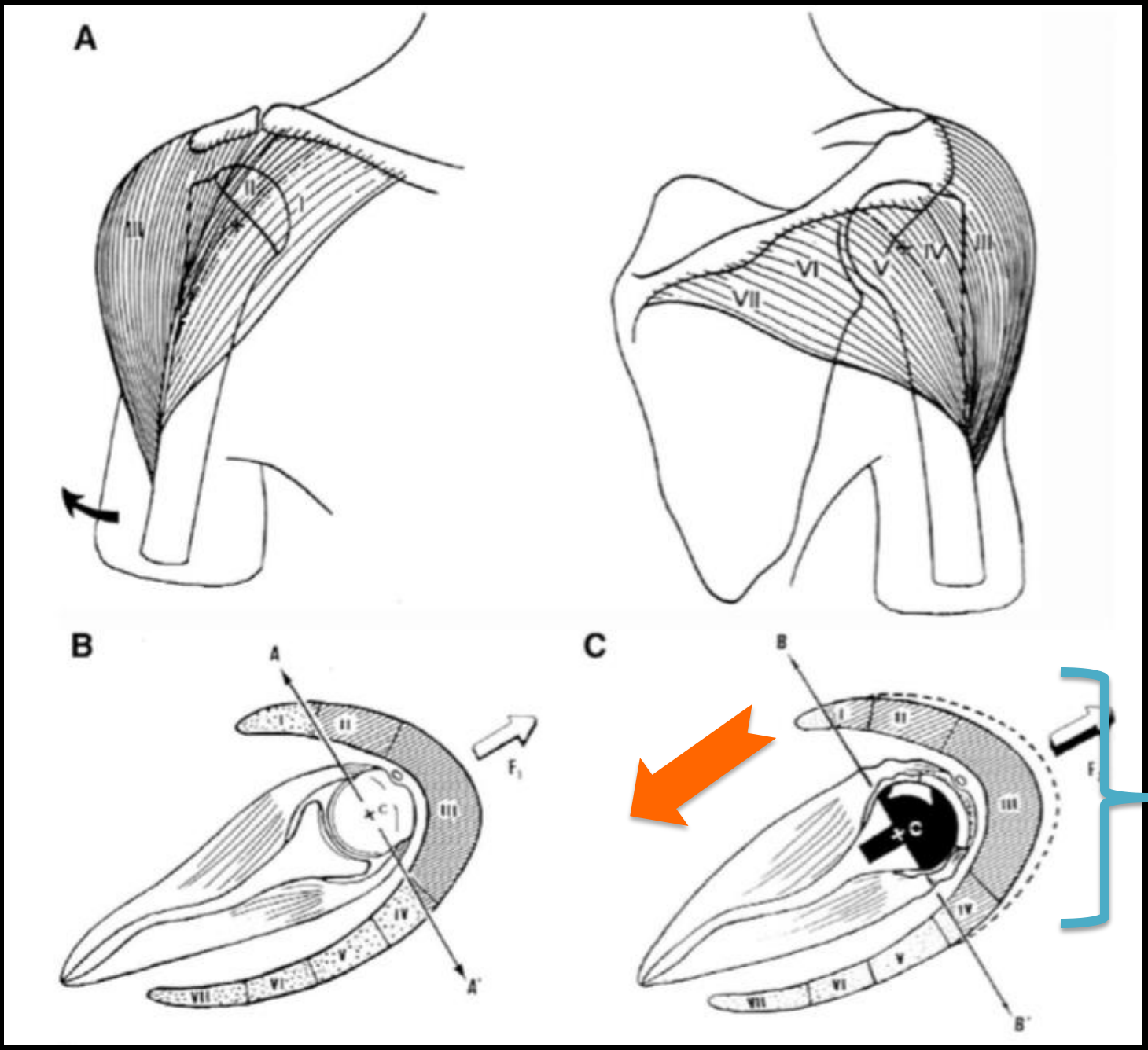


Matsen FA et al. J Bone Joint Surg. 2006;88-A:659-667

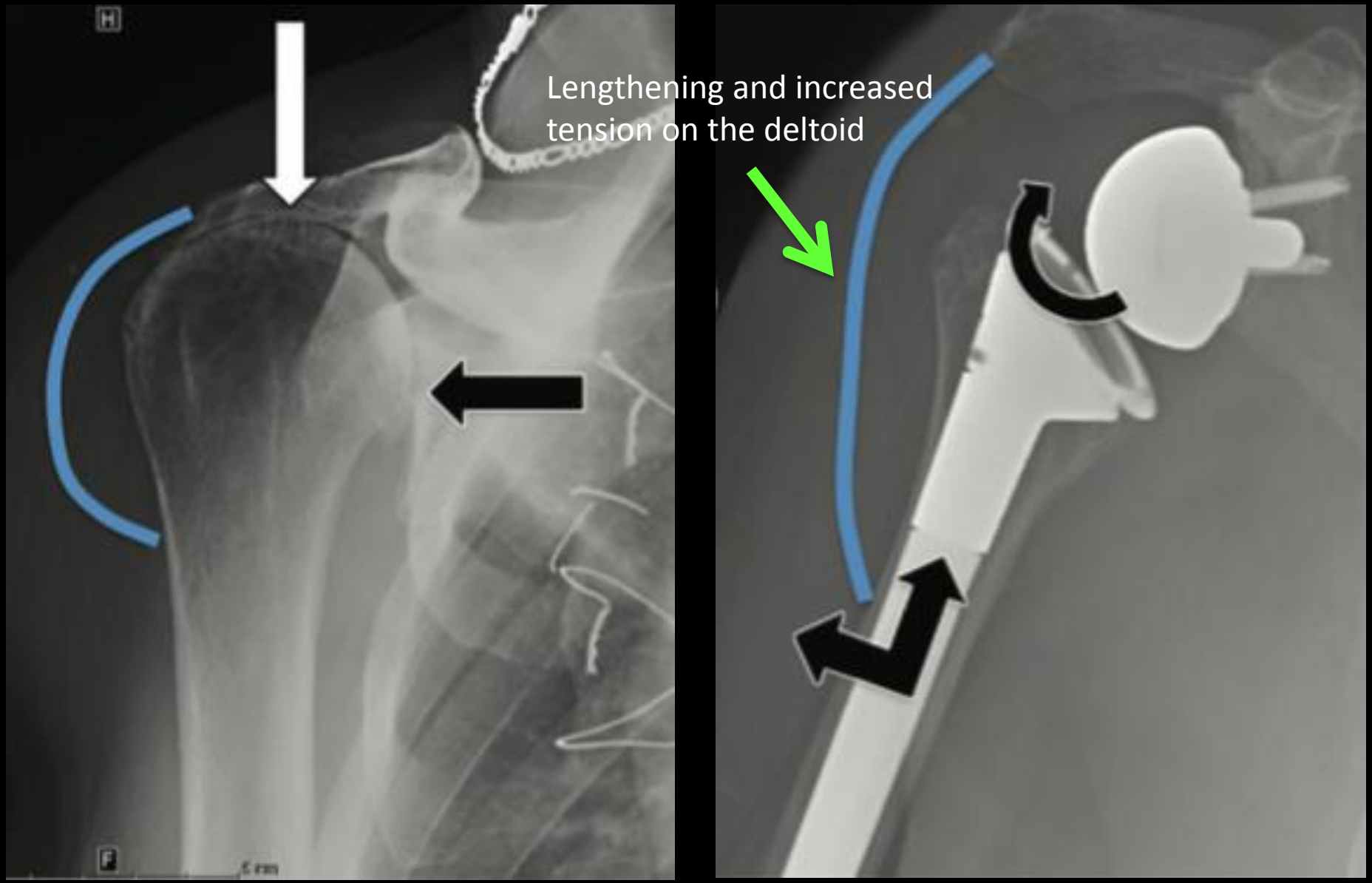
Medialization of center of rotation



Greiner SH et al. Arch Orthop Trauma Surg.2010;130:177-183



Nam D et al. J Bone Joint Surg. 2010;92:23-35



Lin DJ et al. Radiographics. 2016;36:192-208

Unique complications to RTSA

- Scapular notching
- Anterosuperior dislocation
- Acromial fractures

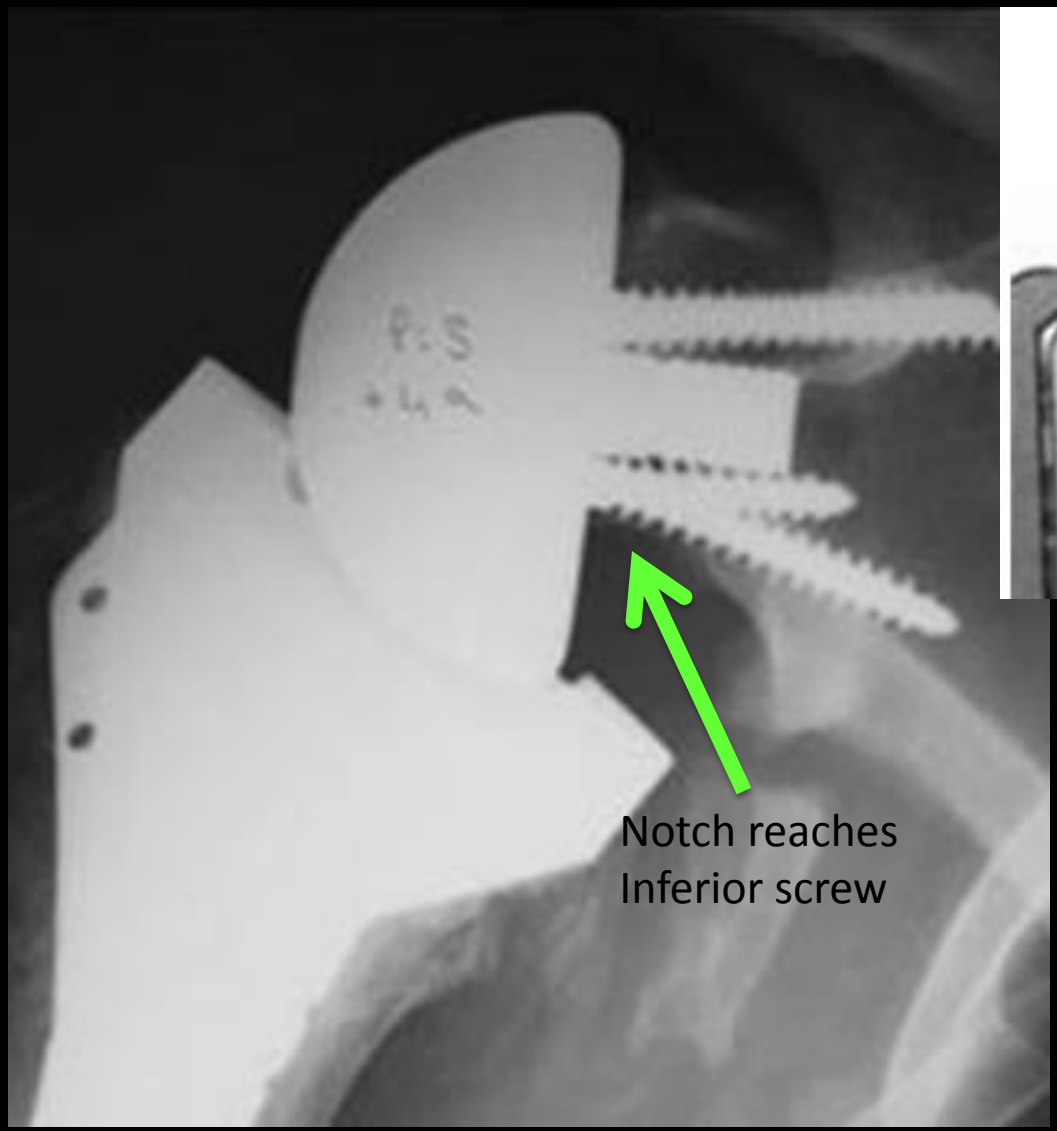
*Decreasing order of frequency

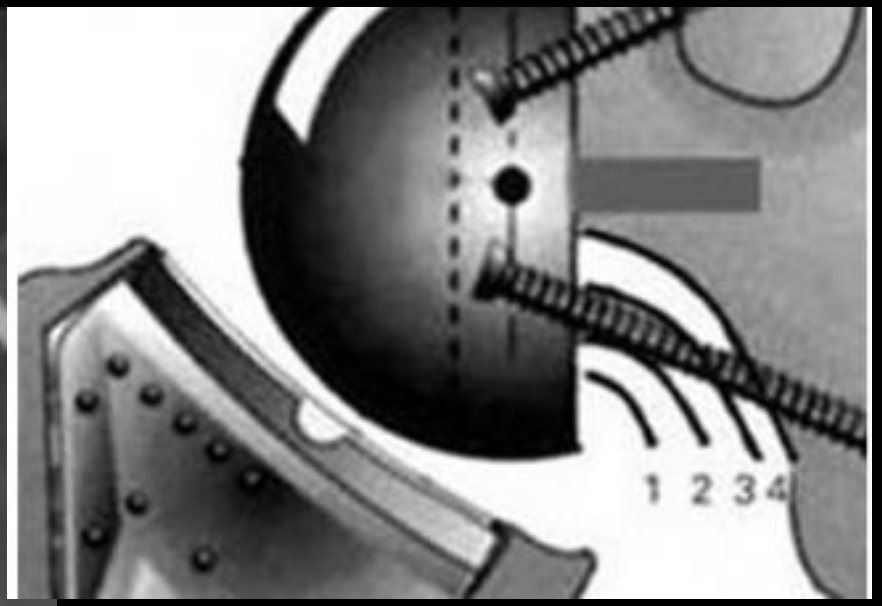
Bohsali KI et al. J Bone Joint Surg Am. 2006;88:2279-2292

Scapular Notching

- Likely due to impingement of the medial rim of the humeral cup during adduction
- *Most common complication

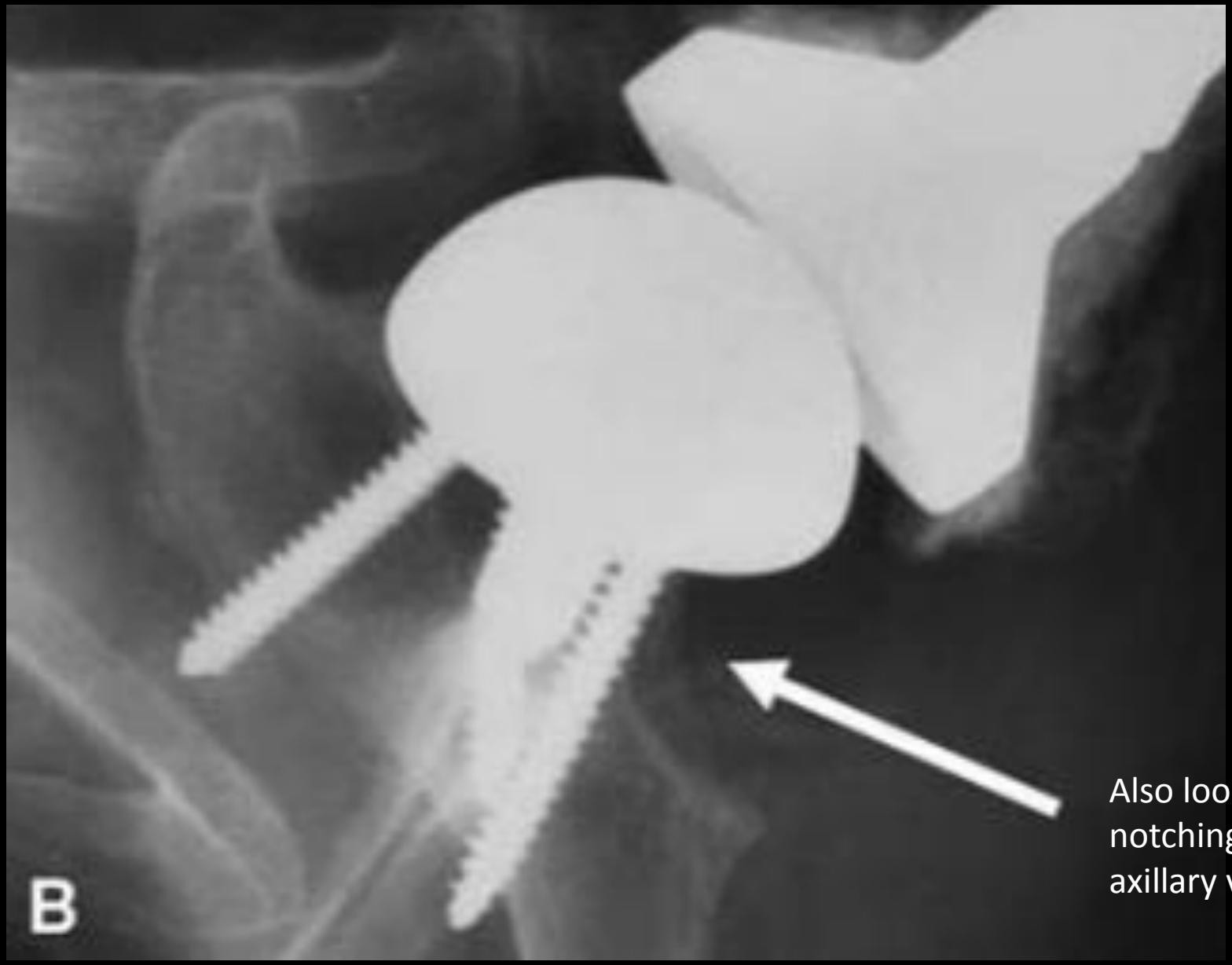
Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520
Bohsali KI et al. J Bone Joint Surg Am. 2006;88:2279-2292





Describe degree of notching in relation to the inferior screw and central peg of the baseplate

Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520



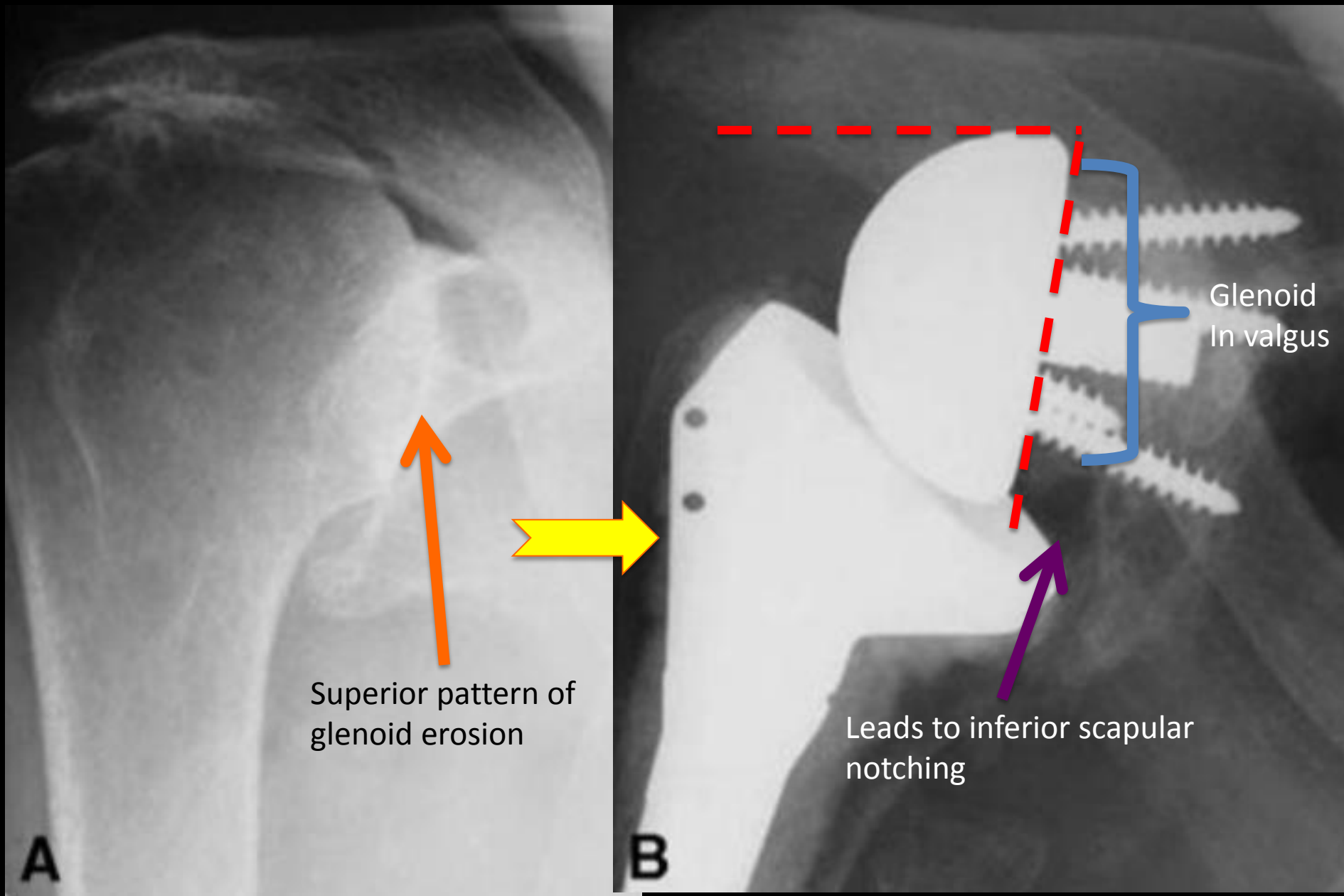
Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520

Scapular Notching in Reverse Shoulder Arthroplasty: Is It Important to Avoid It and How?

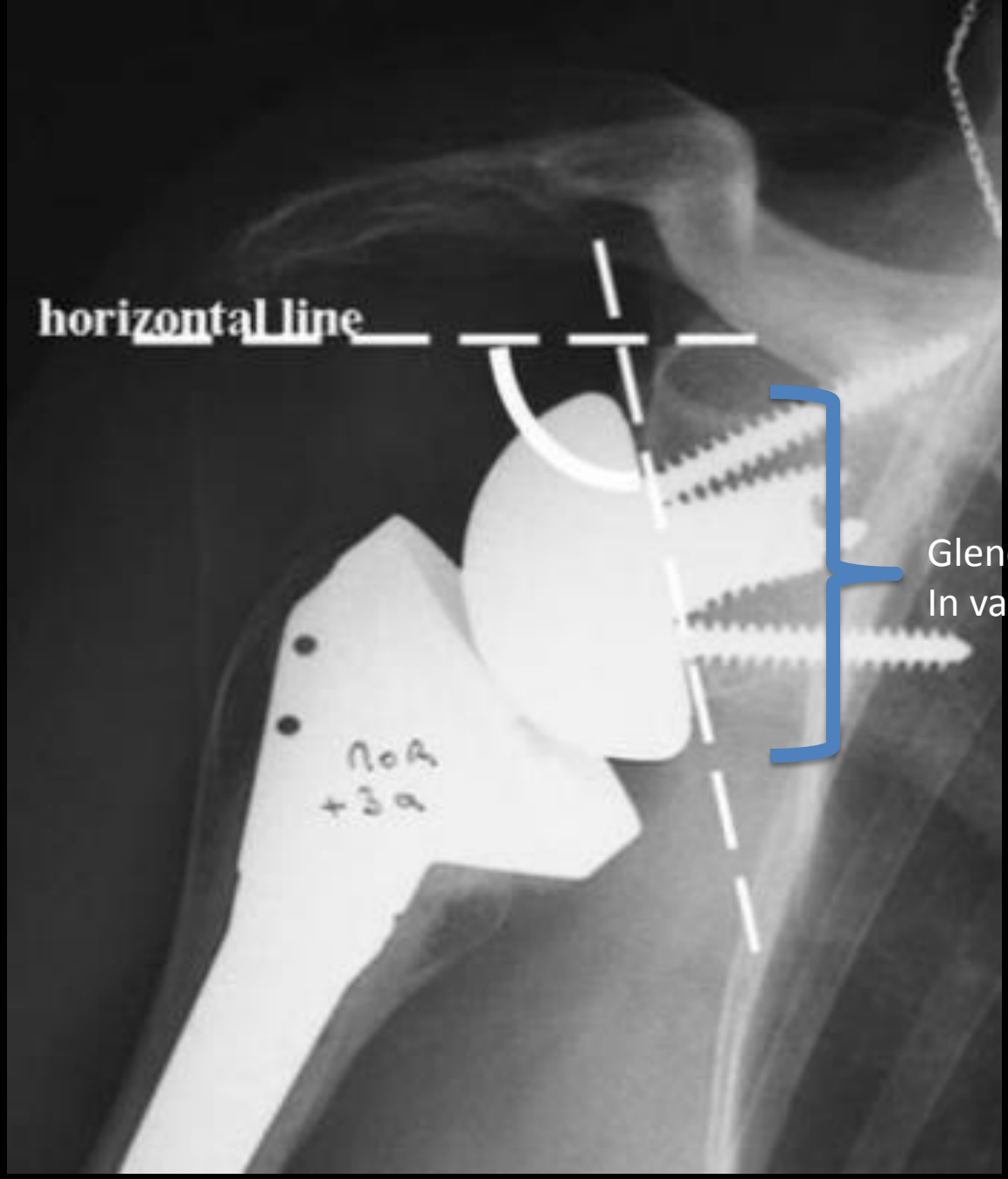
Christophe Lévigne MD, Jérome Garret MD, Pascal Boileau MD, Ghassan Alami MD, Luc Favard MD, Gilles Walch MD

- Retrospective look at 448 patients who underwent reverse TSA
- Notching occurred in 68% of cases (48% within 1 year)
- Glenoid radiolucent lines more frequent with notching
- Pattern of glenoid erosion affects notching incidence

Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520



Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520



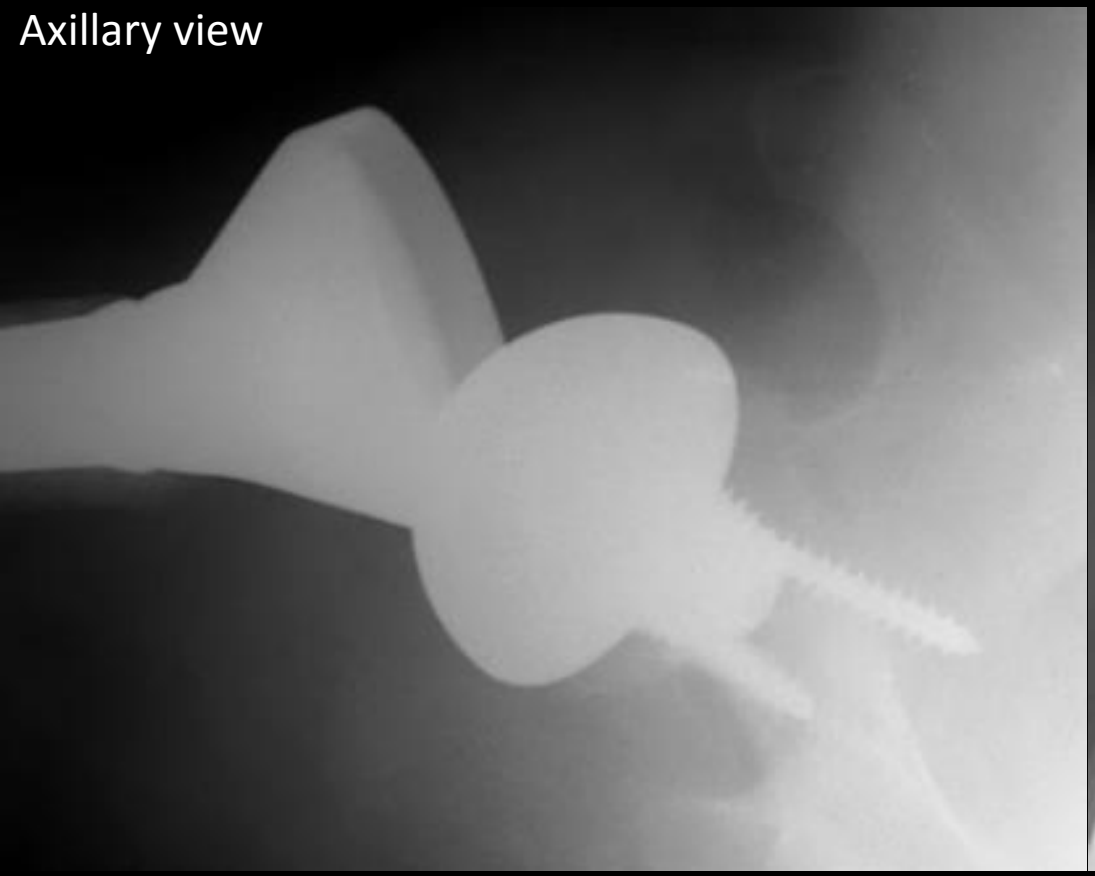
Levigne et al. Clin Orthop Relat Res. 2011;469:2512-2520

Anterosuperior Dislocation

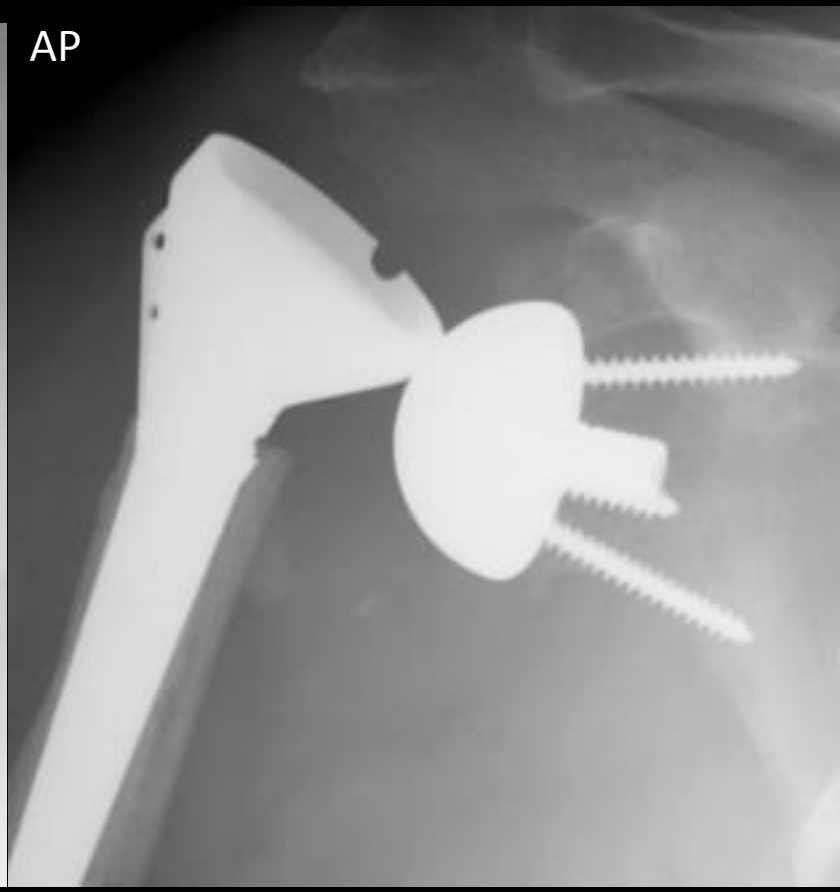
- Occurs in up to 20% of patients
- Pull of the deltoid muscle allows for superior positioning of the anteriorly dislocated shoulder

Roberts CC et al. Radiographics. 2007;27:223-235

Axillary view



AP



Roberts CC et al. Radiographics. 2007;27:223-235

Ha AS et al. *AJR*. 2012;199:768-776

Acromial fracture

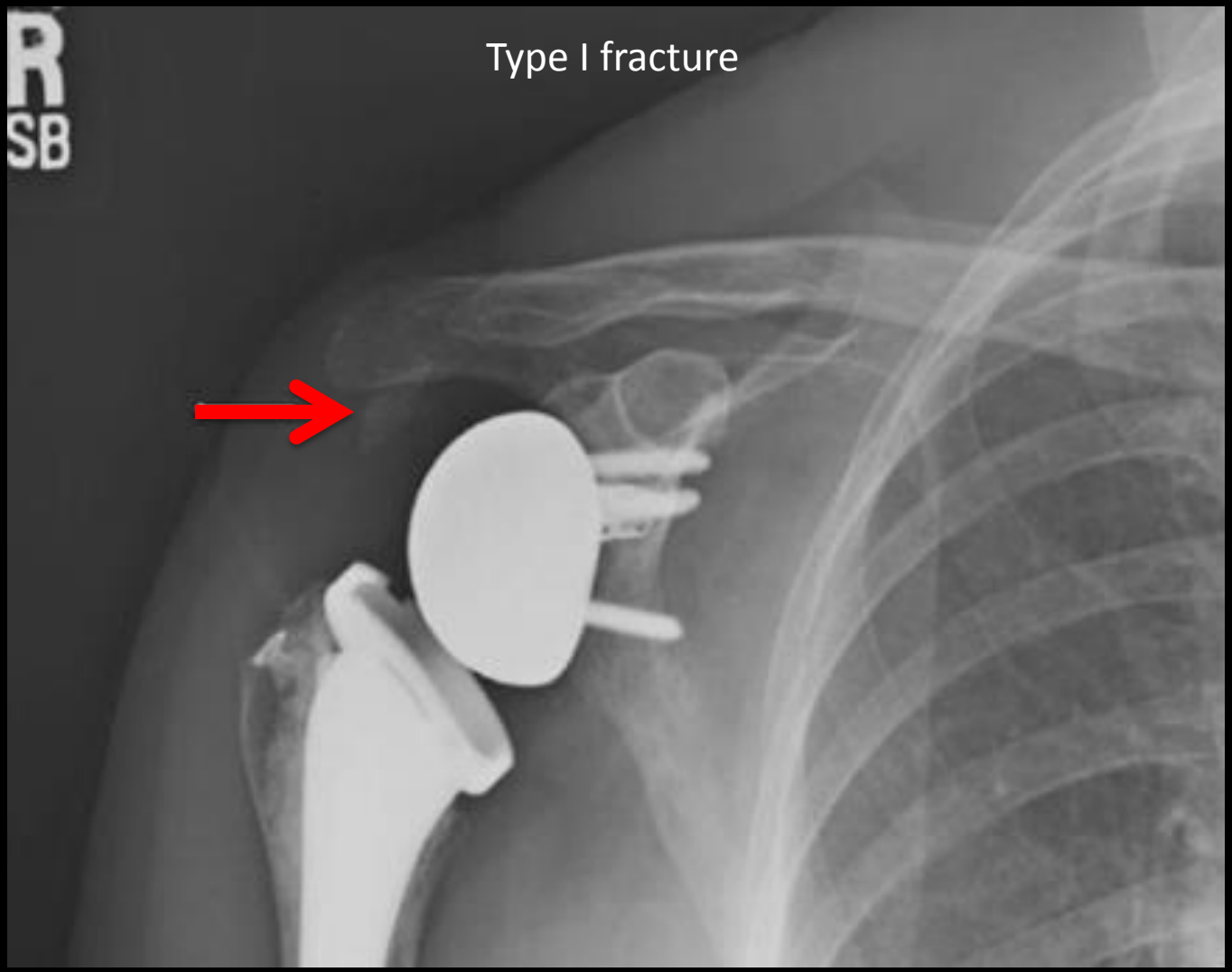
- Altered deltoid biomechanics place stress upon the acromion
- Various classifications of fracture types

Scapula Fractures After Reverse Total Shoulder Arthroplasty: Classification and Treatment

Lynn A. Crosby MD, Adam Hamilton MD,
Todd Twiss MD

- 3 types of acromial fracture:
  - Type I: avulsion fracture of anterior acromion
  - Type II: fracture posterior to the AC joint
  - Type III: fracture of the scapular spine
- Overall incidence of fracture 5.8%

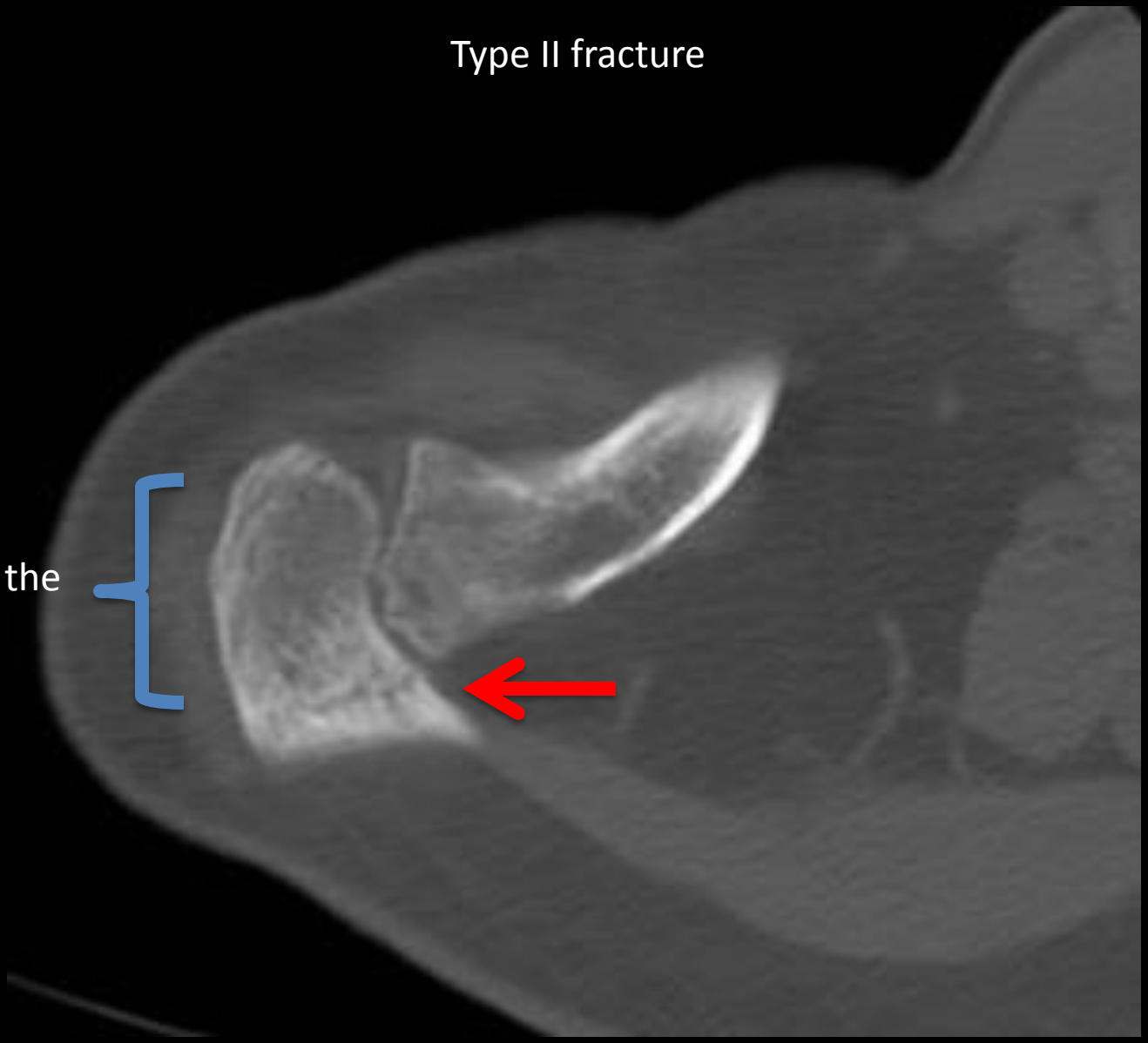
Crosby LA et al. Clin Orthop Relat Res. 2011;469:2544-2549



-Majority iatrogenic
-Generally treated conservatively

Crosby LA et al. Clin Orthop Relat Res. 2011;469:2544-2549

Type II fracture

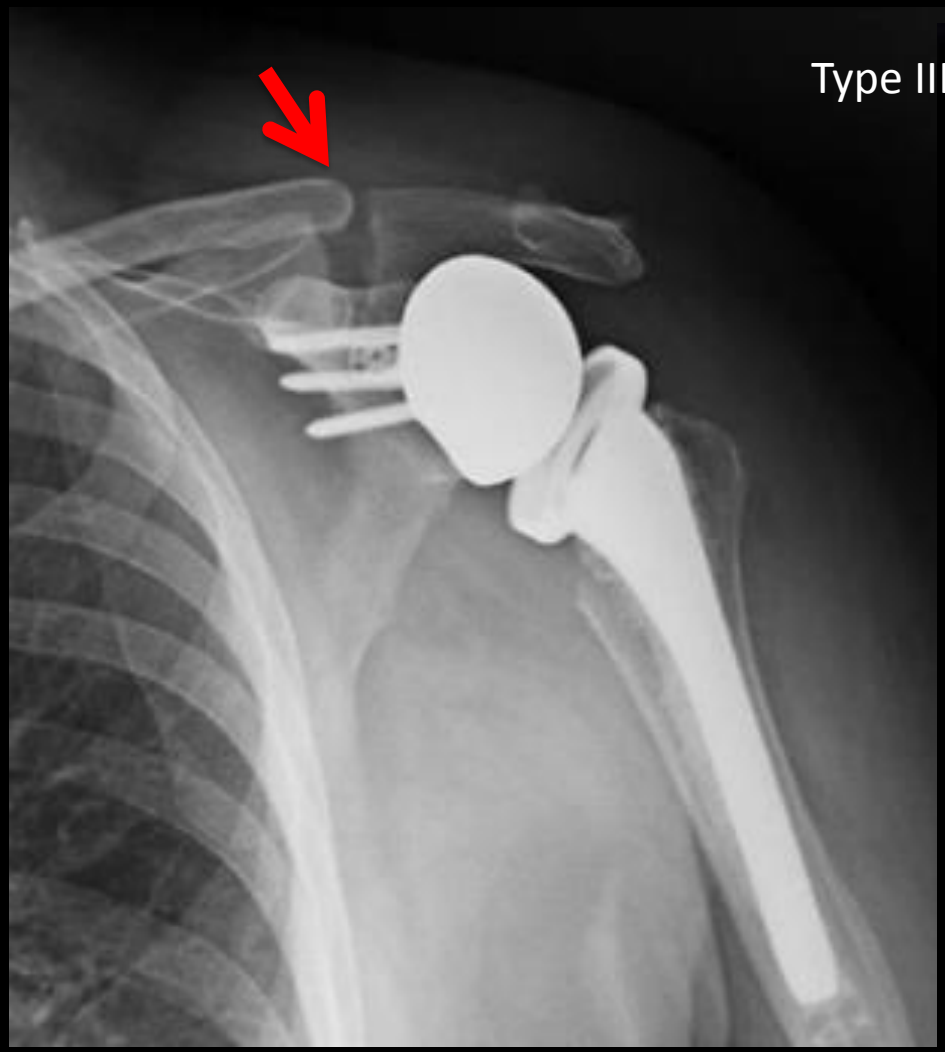


Posterior to the AC joint

May need AC joint resection or ORIF

Crosby LA et al. Clin Orthop Relat Res. 2011;469:2544-2549

Type III fracture



-May be secondary to stress from superior metaglene screw
-All treated with ORIF

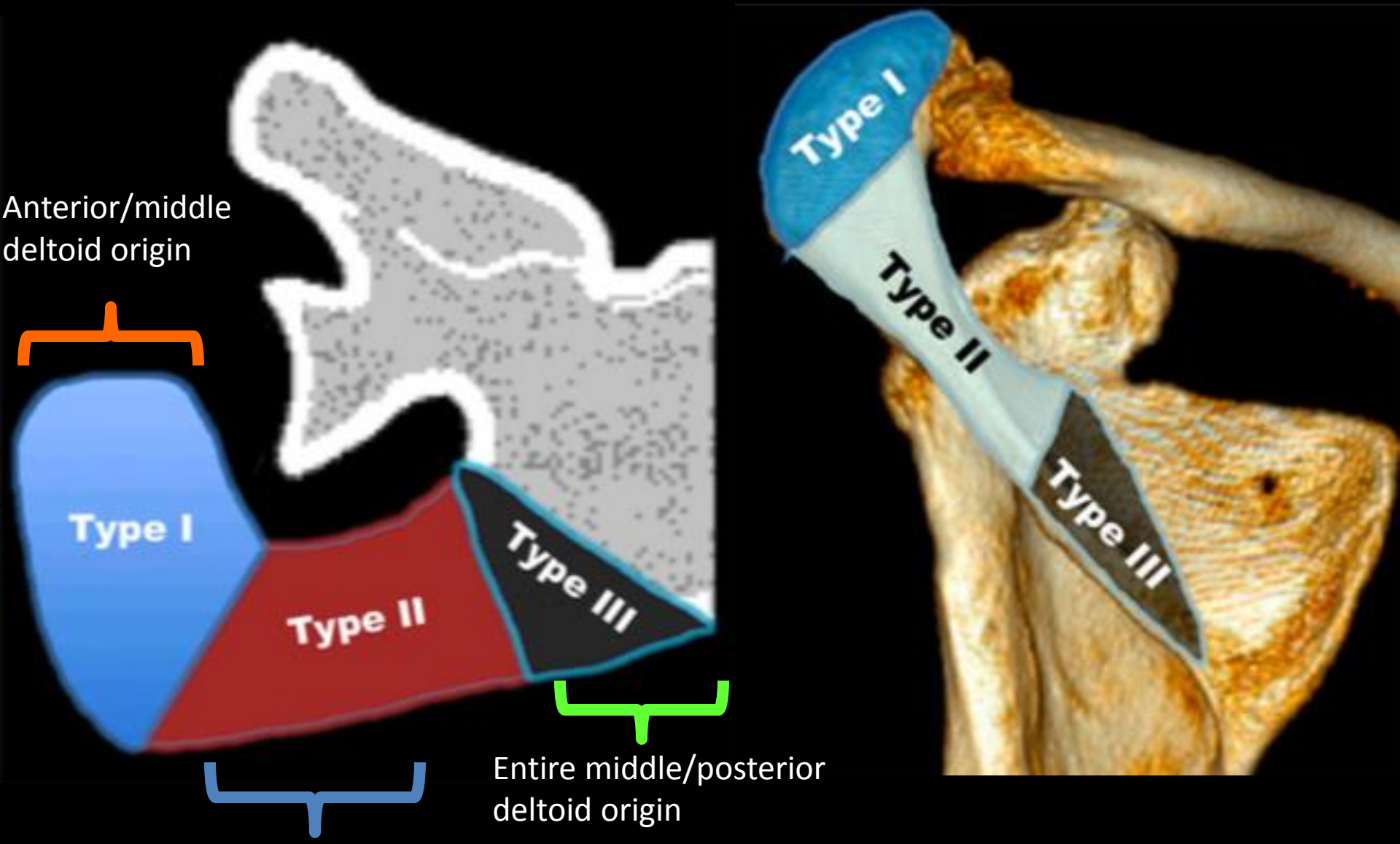
Crosby LA et al. Clin Orthop Relat Res. 2011;469:2544-2549

Classification of Postoperative Acromial Fractures Following Reverse Shoulder Arthroplasty

Jonathan C. Levy, MD, Christopher Anderson, MS, CCRP, and Anil Samson, MBBS

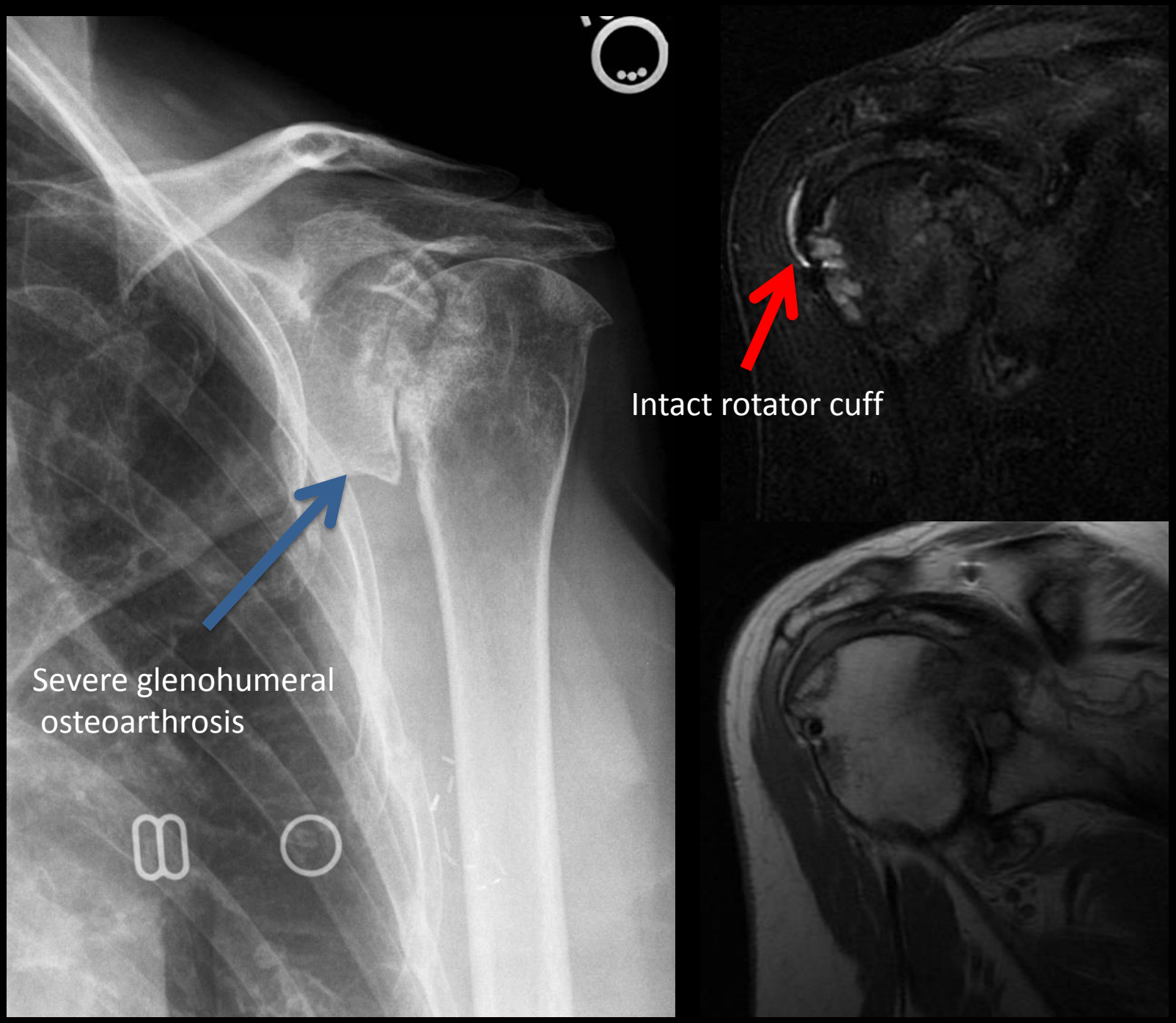
- Classified acromial fracture on the basis of deltoid muscle origin
- No patients treated operatively, so necessity for surgery not determined based on subtype

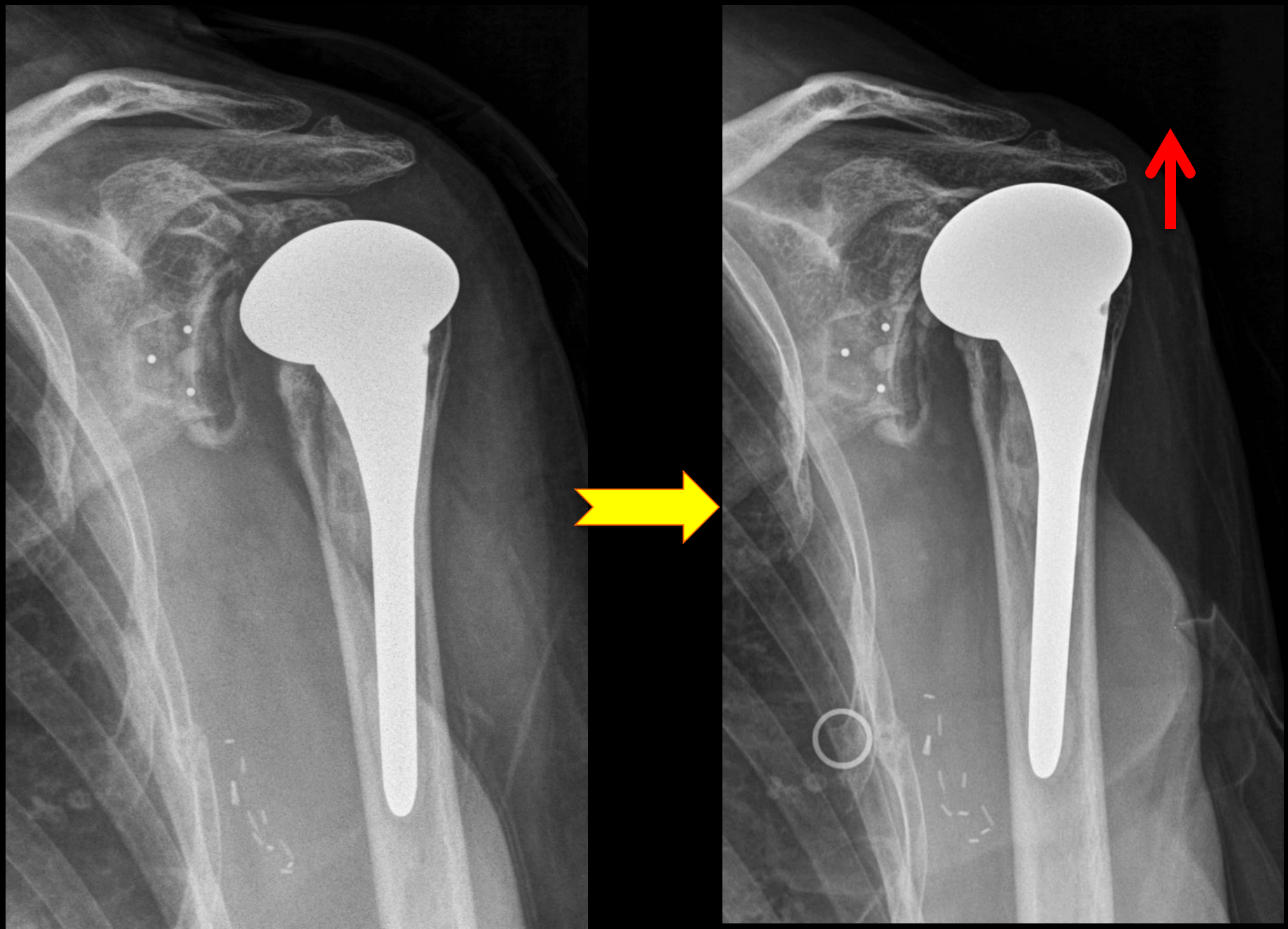
Levy JC et al. J Bone Joint Surg Am. 2013;95(e104):1-7

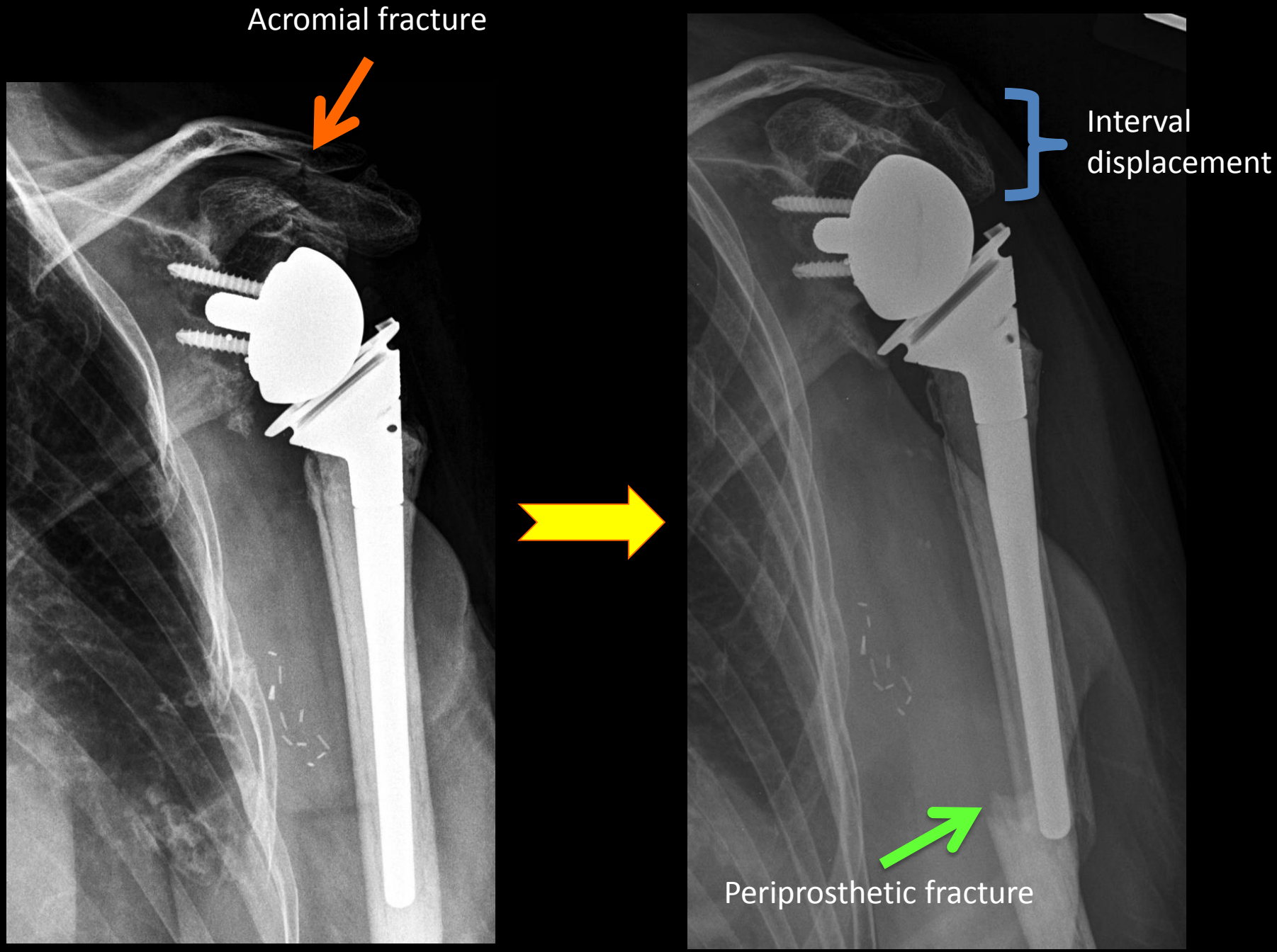


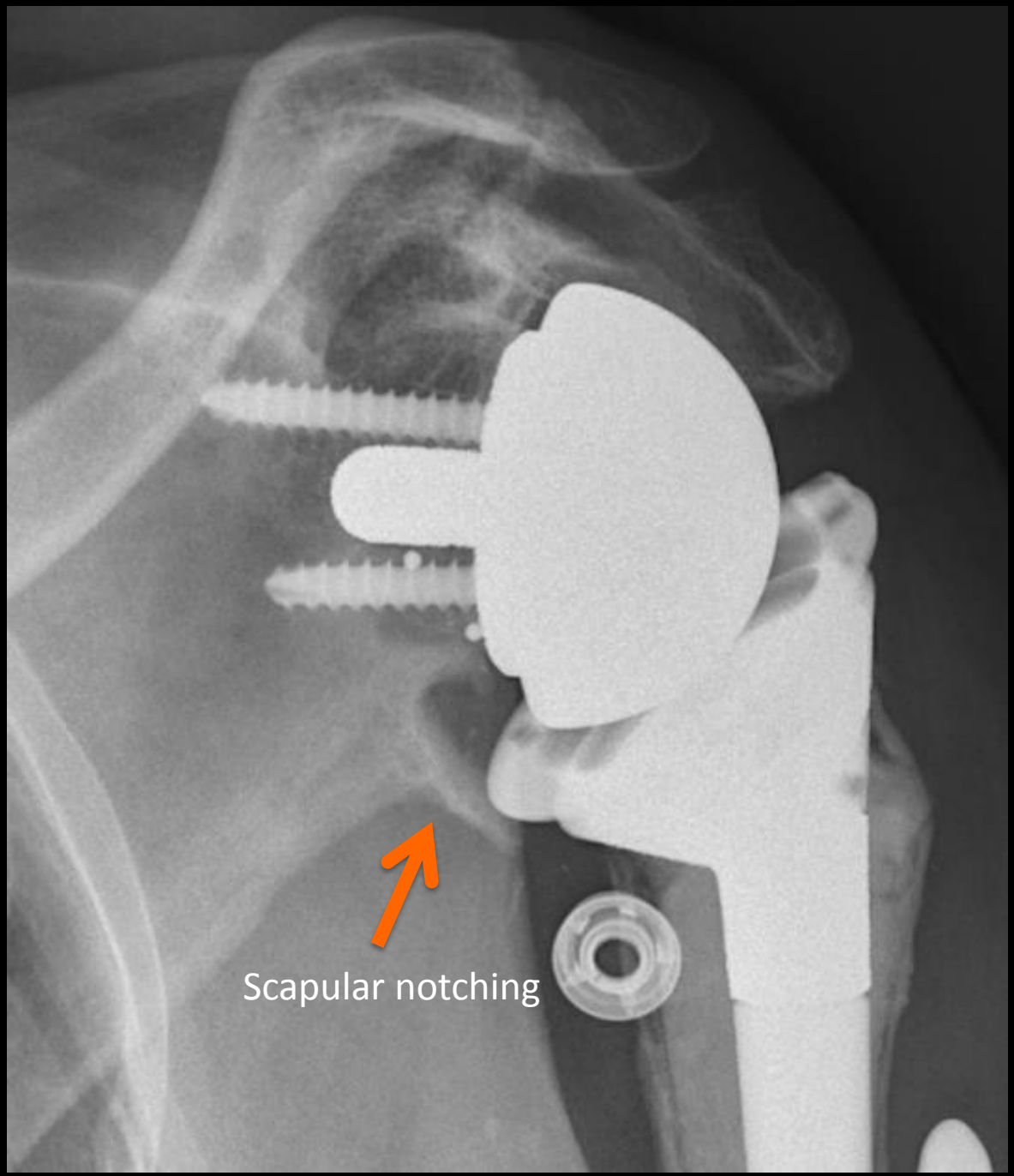
Levy JC et al. J Bone Joint Surg Am. 2013;95(e104):1-7

Case


Intact rotator cuff
Severe glenohumeral
osteoarthrosis




Acromial fracture
Interval displacement
Periprosthetic fracture


Scapular notching

Hemiarthroplasty

- Indications:
  - Severe proximal humerus fractures (3 and 4 part)
  - Arthritis with inadequate glenoid bone stock
  - Osteonecrosis or osteoarthrosis with sparing of the glenoid

Petscavage JM et al. AJR. 2012;199:757-767

Ideally should have the top of the humeral component 2-5mm above a line drawn perpendicular to the greater tuberosity.

Petscavage JM et al. AJR. 2012;199:757-767

Subsidence

Clinically signficant if change >5mm

Petscavage JM et al. AJR. 2012;199:757-767

Variations on design

Extended coverage design covers more of the humeral head, preventing contact between the greater tuberosity and the acromion

Petscavage JM et al. AJR. 2012;199:757-767

Conclusions

- A continued increase in incidence of shoulder arthroplasty is likely
- Knowledge of the indications for both total standard and reverse shoulder arthroplasty is important and should dicatate preoperative imaging assessment
- Familiarity with common complications is important, as they are frequent, and may occur many years following surgery

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