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Shoulder Prosthesis
Postoperative Imaging

Florian M. Buck, MD

University of
Zurich[UZH]

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Shoulder Prosthesis

Surgical Approach Findings

Imaging Modalities

Postoperative Problems

Shoulder Prosthesis

What are we talking about

Anatomical Prostheses

- Conventional prosthesis
- Fracture prosthesis

Inversed prosthesis

Glenoid components

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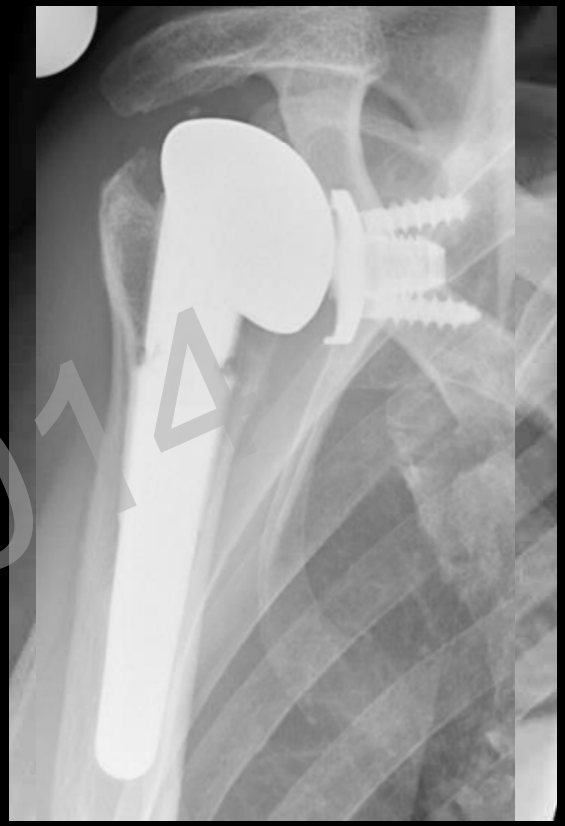
Shoulder Prosthesis

Different Types

Anatomical Total Shoulder Prosthesis

+ Glenoid Allograft



Shoulder Prosthesis

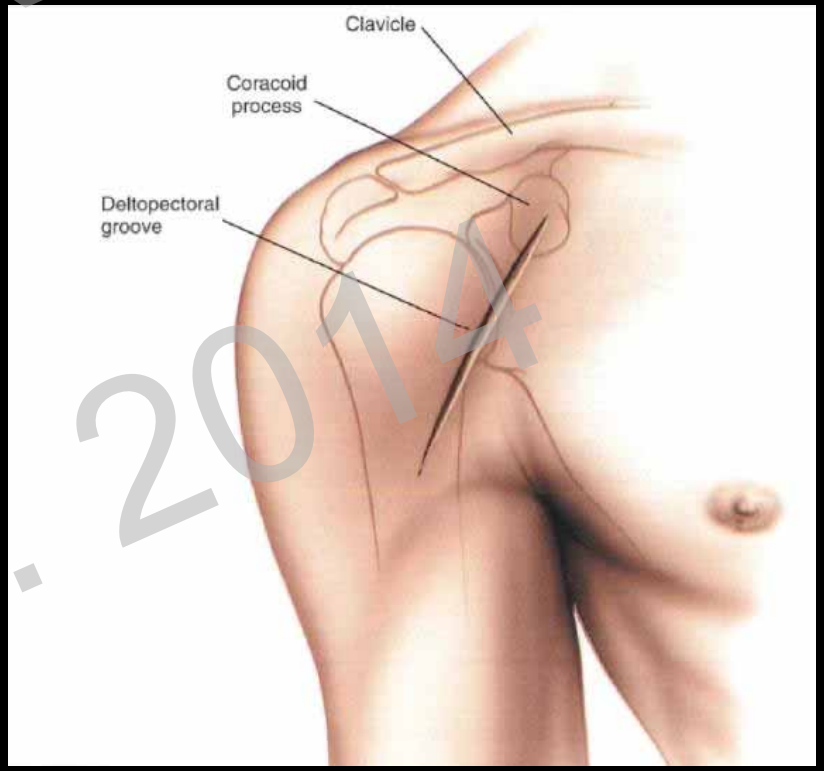
Different Types

Inversed Total Shoulder Prosthesis

Surgical Approach Findings

Deltopectoral approach

- Between deltoid and pectoralis major muscle
- Same approach as for instability surgery



Surgical Approach Findings

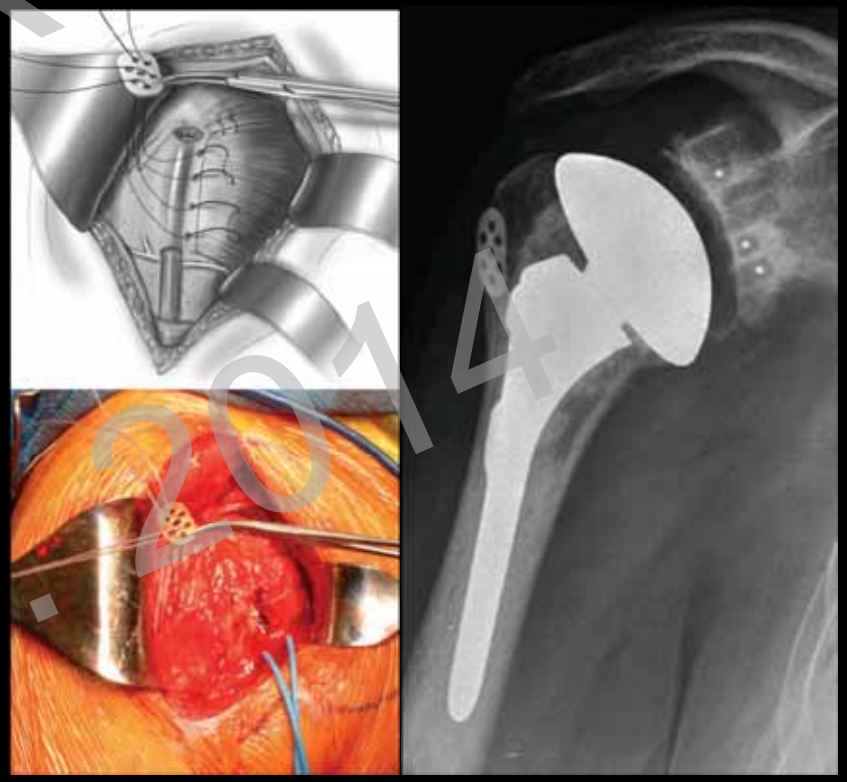
Deltopectoral approach

- Between deltoid and pectoralis major muscle
- Same approach as for instability surgery

Surgical Approach Findings

Deltopectoral approach

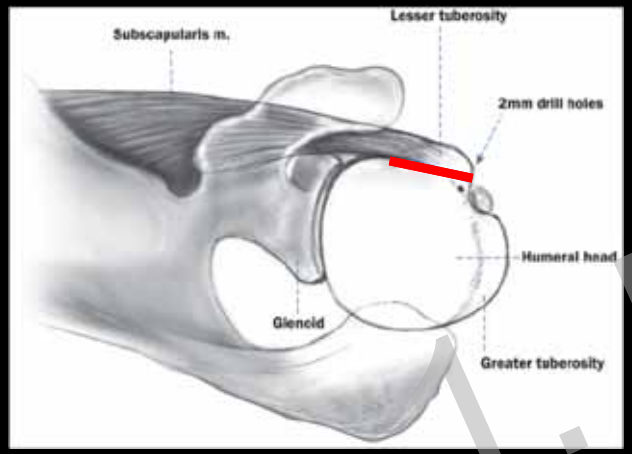
- Detachment of subscapularis tendon more often than lesser tubercle osteotomy
- Fixation with transosseous seam



Surgical Approach Findings

Complications of deltopectoral approach

- Subscapularis muscle insufficiency due to tendon detachment

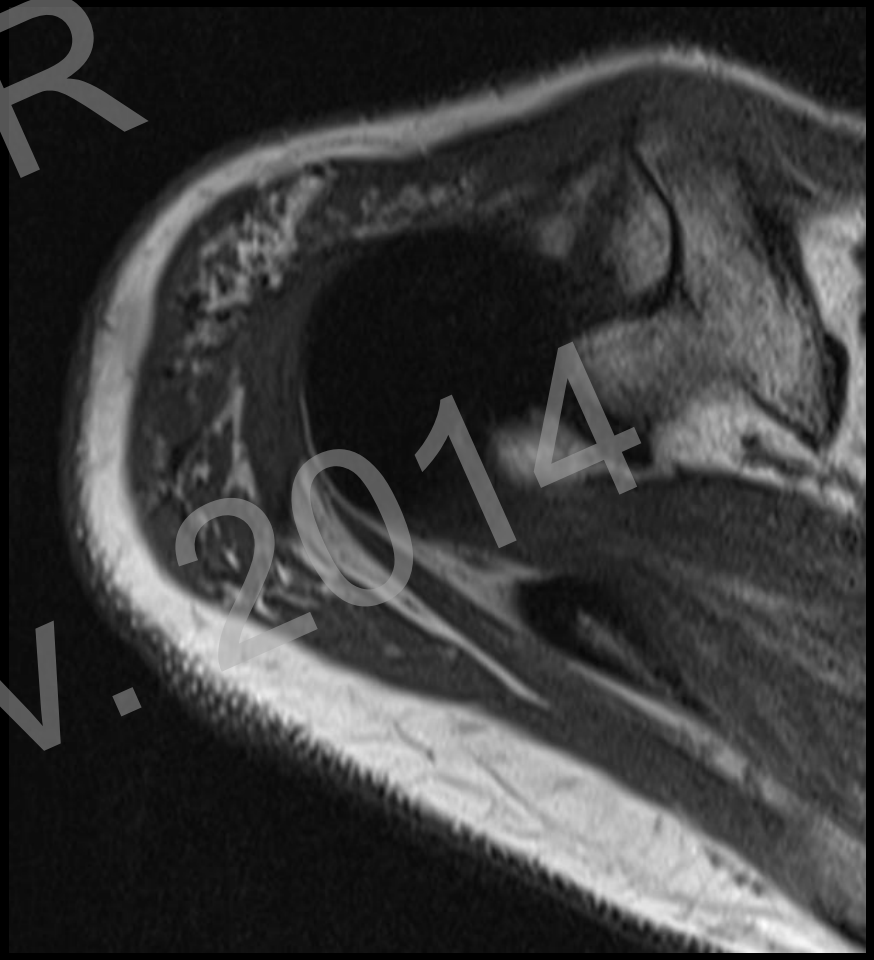


Ref.: Scheibel et al. AJSM, 2007

Intraoperative Nerve Injury

Axillar nerve branch injury

- Deltoideus fatty change



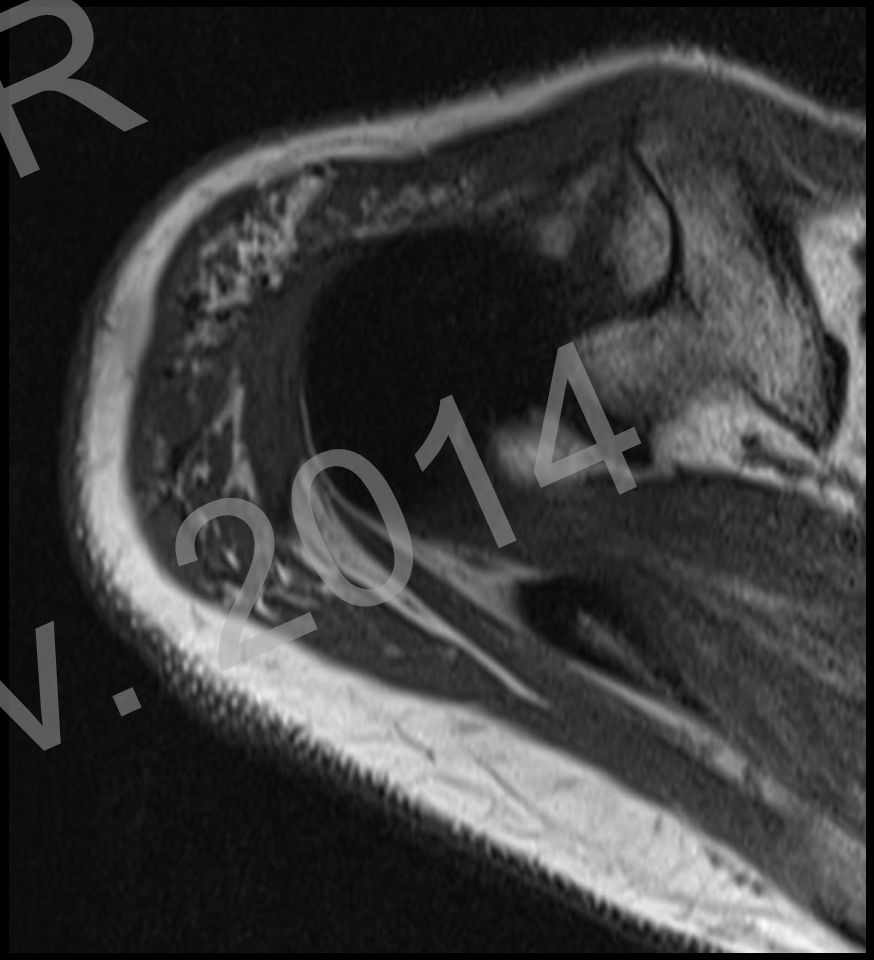
Brachial plexus unjury

- Plexus traction due to lengthening of the arm & preoperatively shortened arm (high Hamda grade)

Intraoperative Nerve Injury

Symptoms

- Deltoid muscle dysfunction
- Inferior instability



- if deltoid muscle function is insufficient not even inverse prosthesis can be used

Imaging Modalities

Plain Films

Computed Tomography

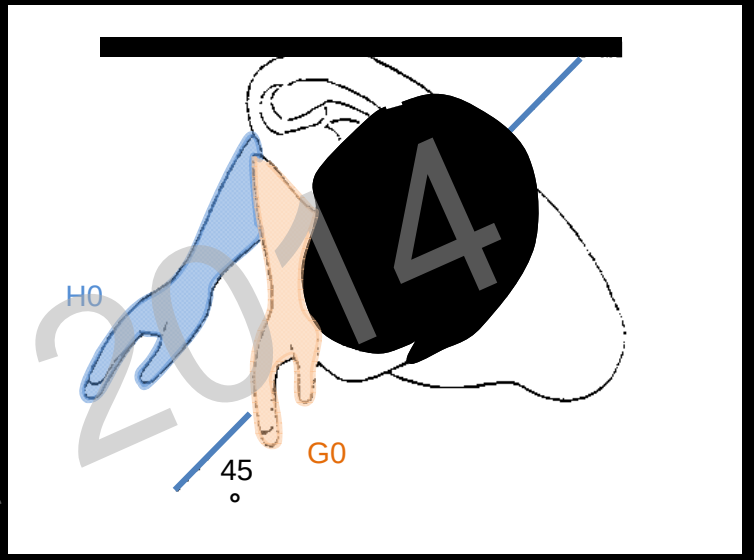
MR Imaging

Plain Films

Shoulder Status

H0 view

G0 view



Plain Films

Shoulder Status

H0 view

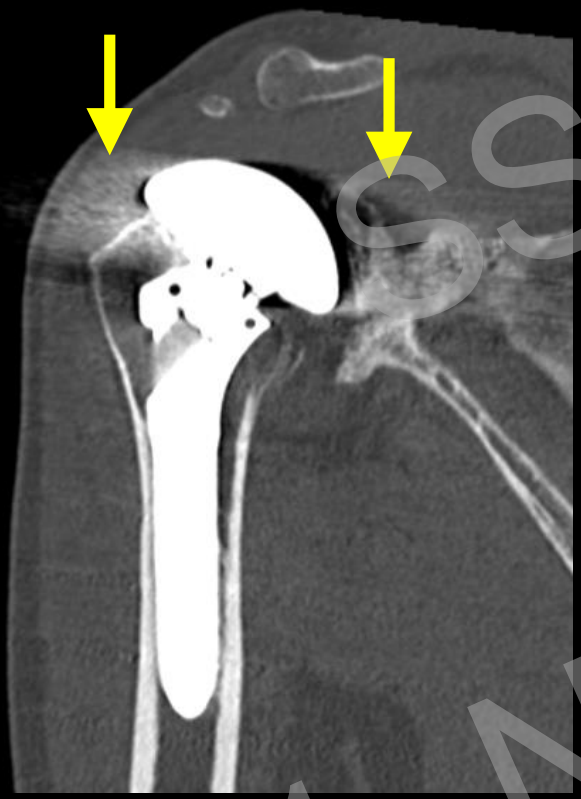
G0 view

Neer view

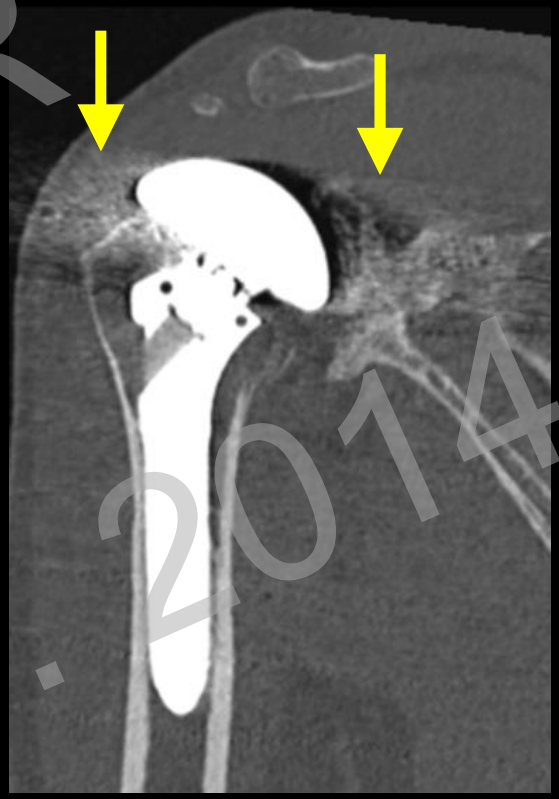
axial / crosstable view

Computed Tomography

Anatomical Prosthesis



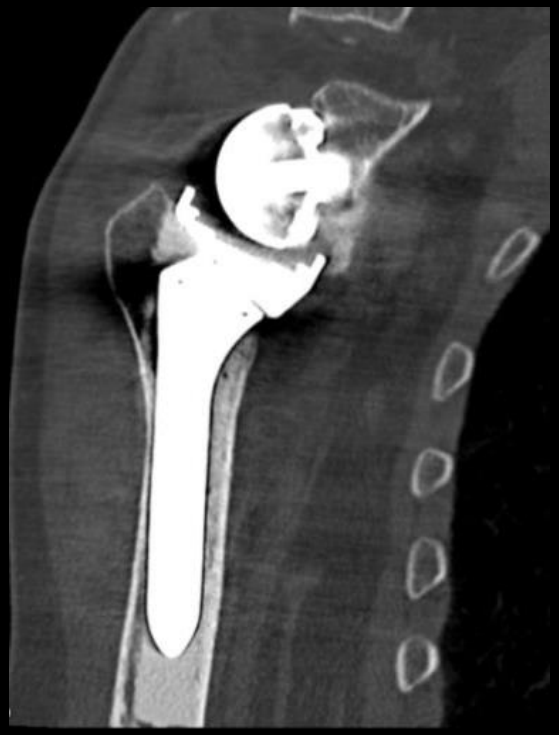
Conventional CT



CT Recon with triple slice thickness

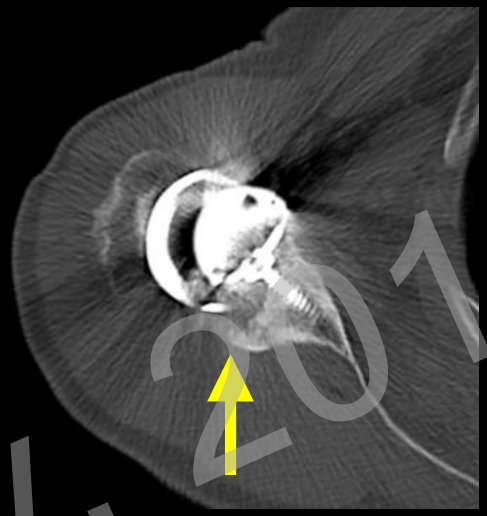
Computed Tomography

Inversed Prosthesis

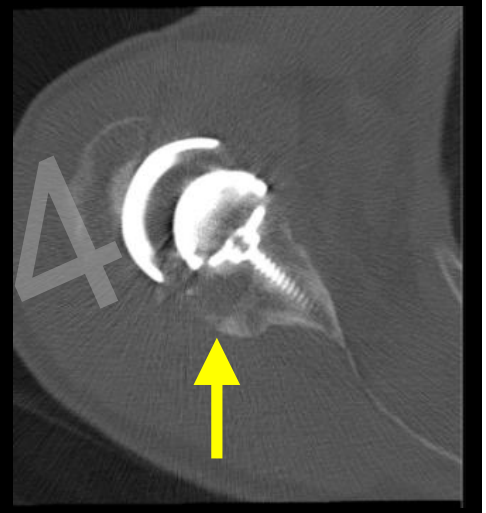


Conventional CT

D60s Kernel &
IMAR 3D



Conventional CT



D60s Kernel &
IMAR 3D

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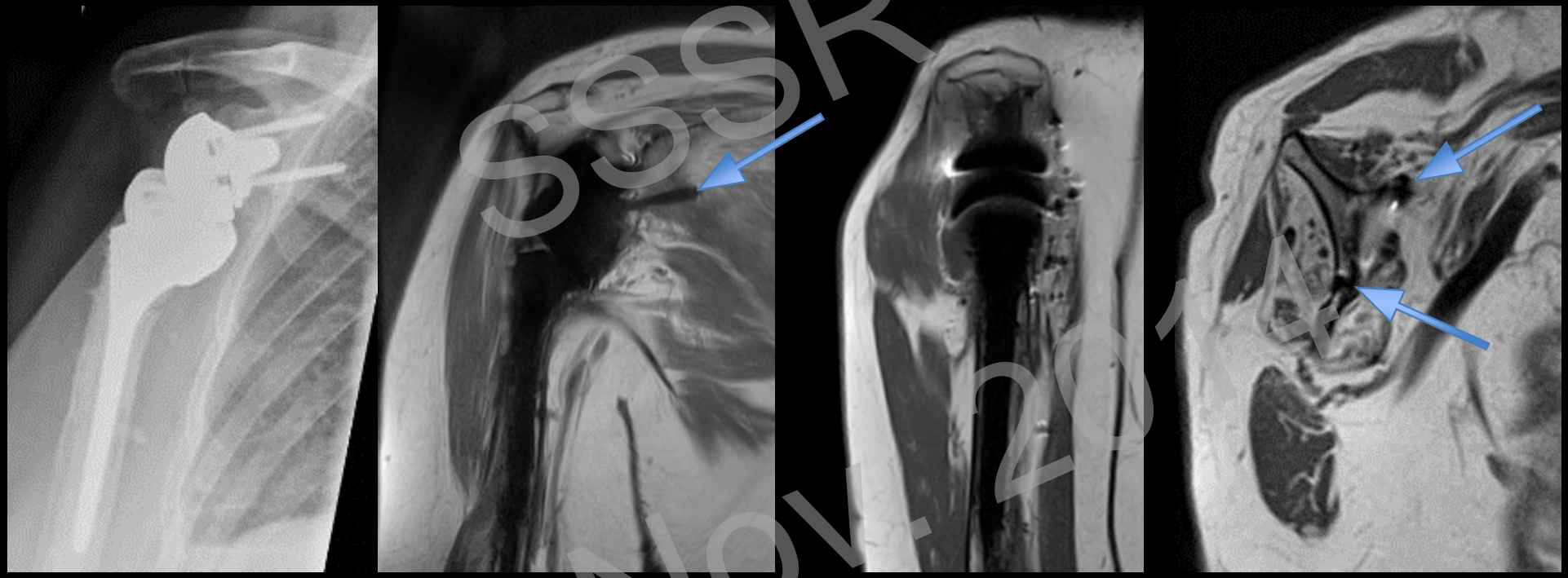
MR Tomography

Inversed Prosthesis



PD WARP

- Location of glenoshpere screws
- Soft tissues around joint

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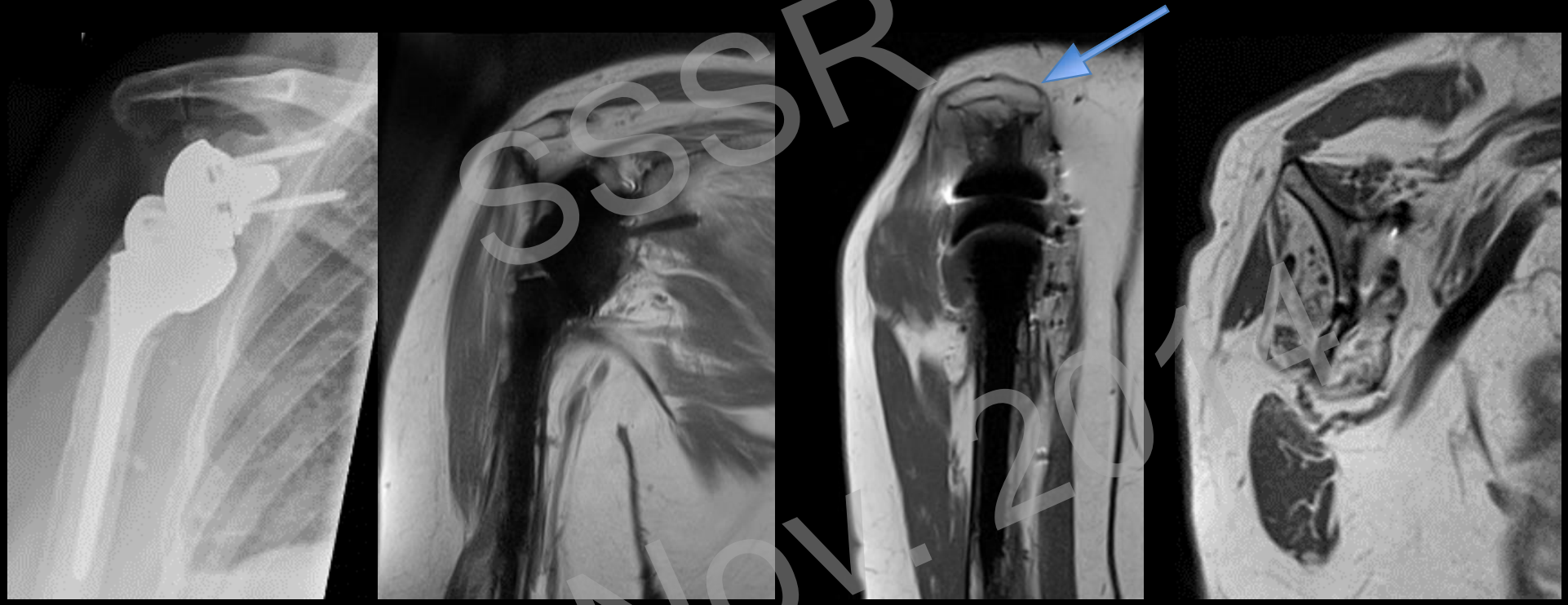
MR Tomography

Inversed Prosthesis

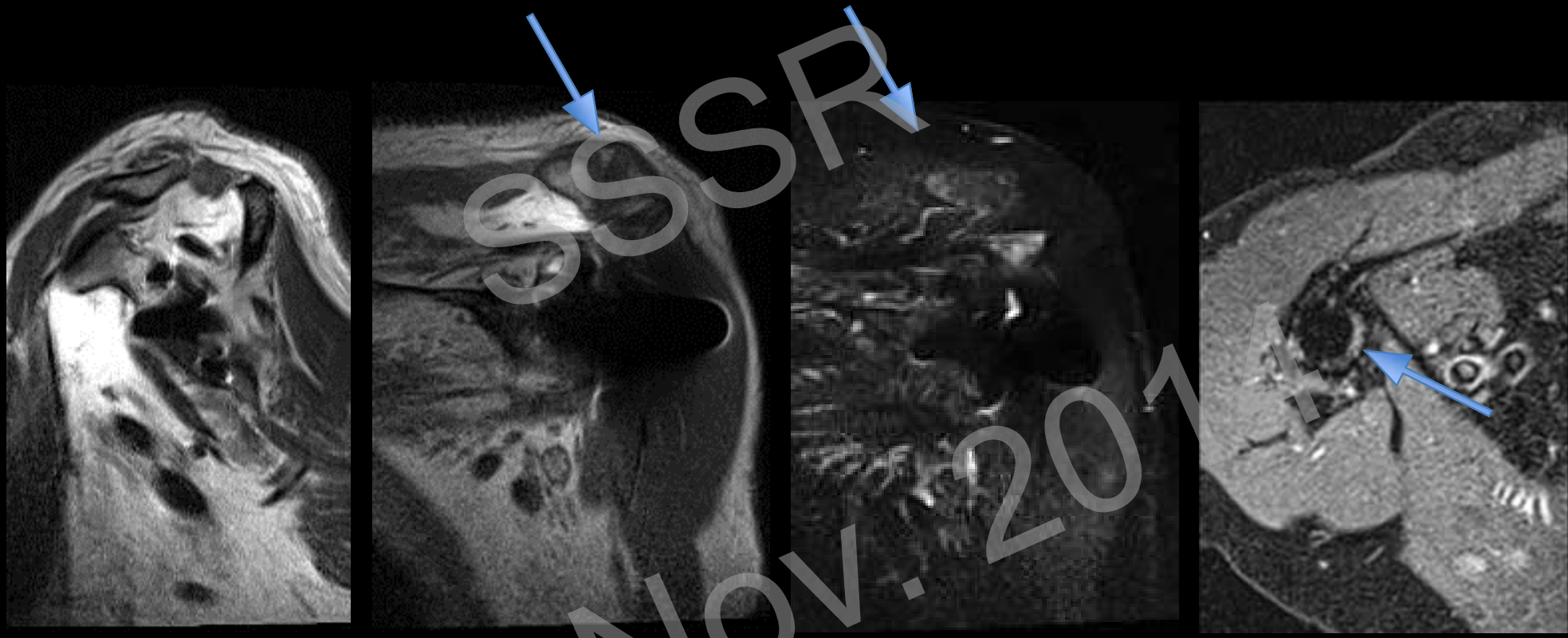


PD WARP

- Osseous structures

MR Tomography

Inversed Prosthesis

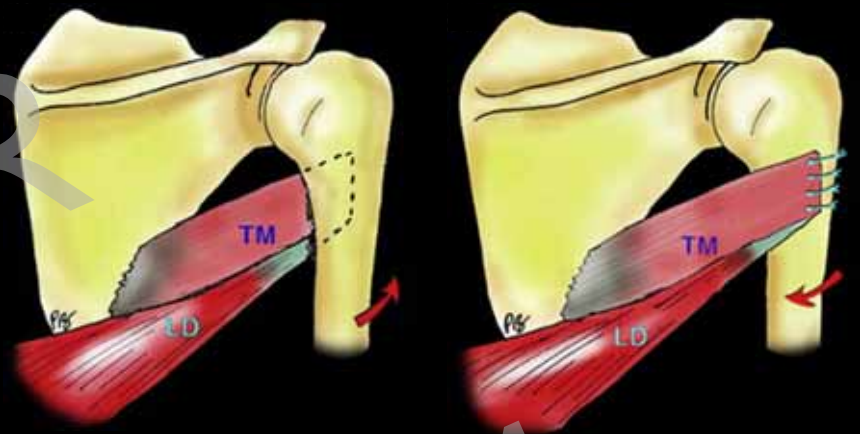


- AC joint arthrosis (DD acromial fx)
- Muscle atrophy
- Humeral shaft loosening

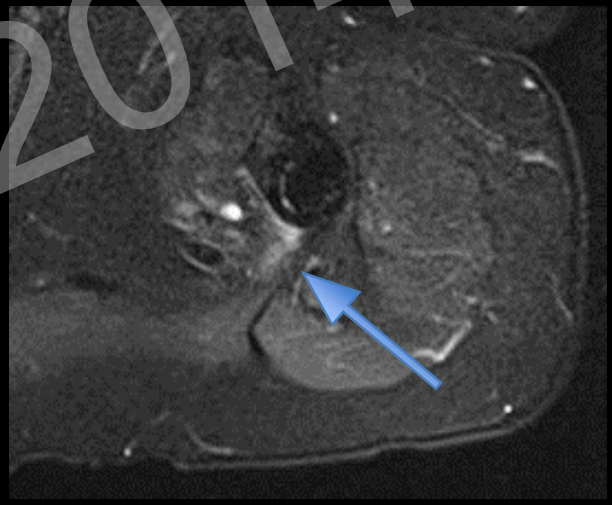
MR Tomography

Teres Major Transfer

Teres major Transfer (L'Episcopo transfer)



Internal rotation External rotation



Ref.: Boileau P. Modified latissimus dorsi and teres major transfer. JSES 2007;16:671-682. Boileau P. Reversed shoulder arthroplasty with modified l'Episcopo. JSES 2010;19:20-30.

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Complications of Shoulder Arthroplasty

Multitude of complications reported:

- Prosthetic loosening
- Glenohumeral instability
- Periprosthetic fracture
- Rotator cuff tears
- Infection
- Neural injury
- Deltoid muscle dysfunction

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Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

Complications

Complications in 33 series including 2540 shoulders:

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

Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

Prosthetic Loosening

Humeral Component

- rare
- often in combination with infection

Migration

Infection
Loosening

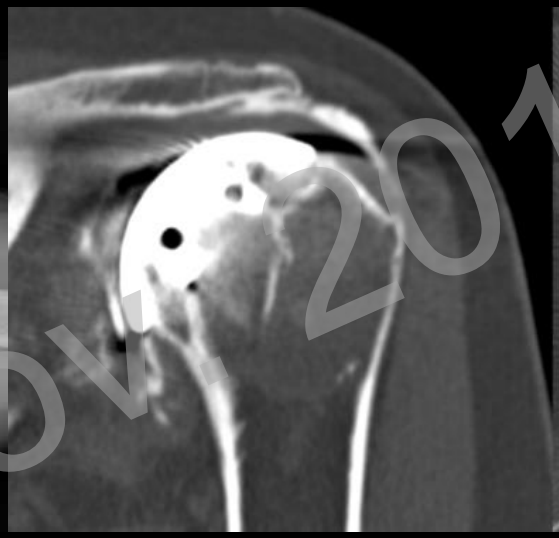
Ref.: Buck FM, et al. Shoulder arthroplasty. Eur Radiol. 2008 Dec.;18(12):2937-2948

Prosthetic Loosening

Humeral Capping

- 1% loosening (instead of 0.5% - double risk)
- Granuloma formation

Resurfacing – Cap



Granuloma in humeral head

Prosthetic Loosening

Glenoid Component

- frequent
- unresolved problem

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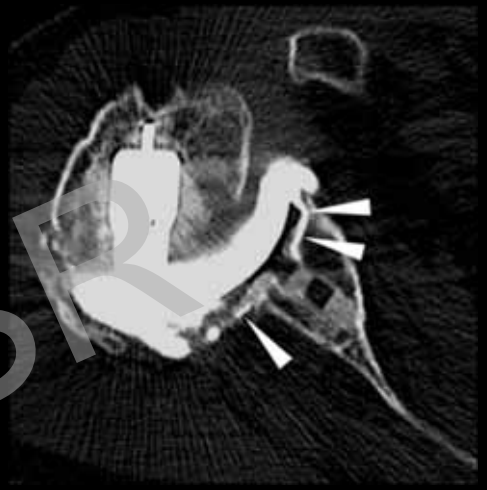
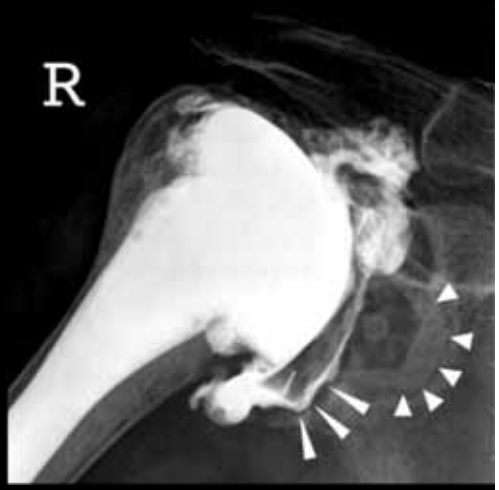
Prosthetic Loosening

Glenoid Component

- frequent
- unresolved problem





Glenosphere Loosening - superior tilting/dislocation

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Ref.: Buck FM, et al. Shoulder arthroplasty. Eur Radiol. 2008 Dec.;18(12):2937-2948

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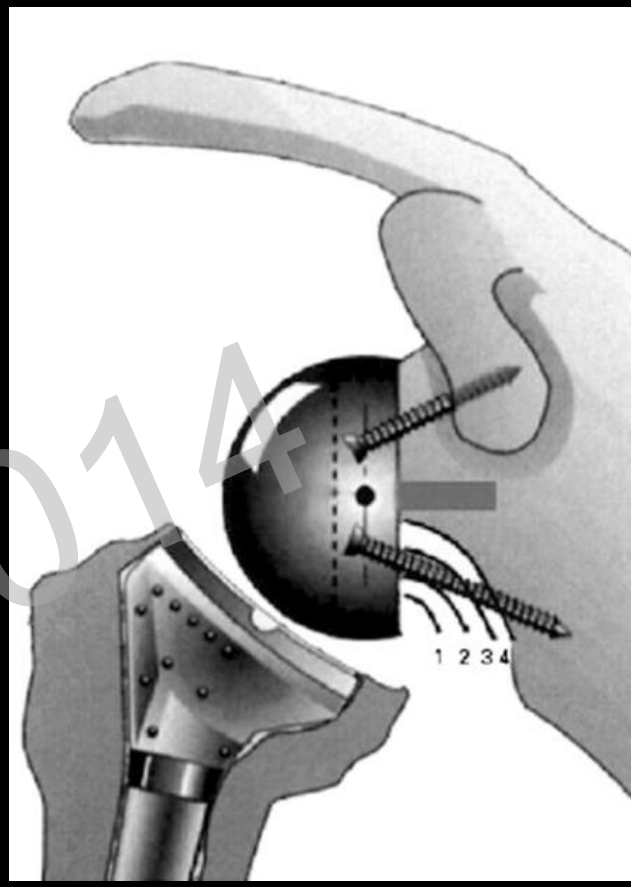
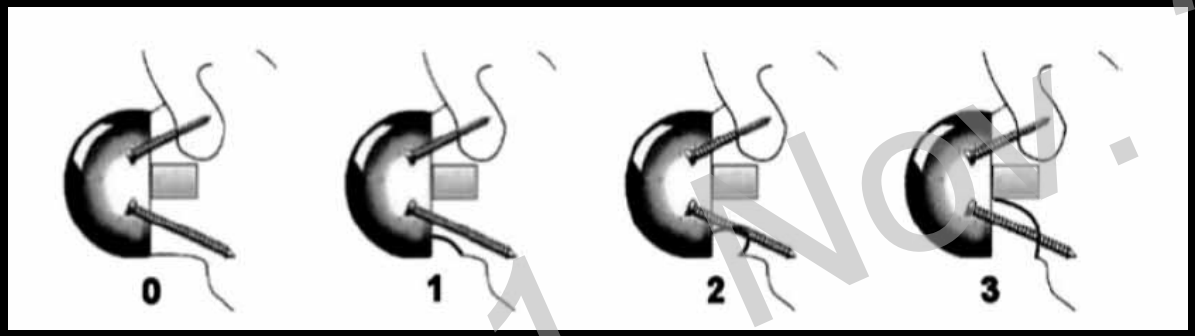
Scapular Notching

Inversed Prosthesis

- frequent (ca. 60% after 4 years)
- not associated with inferior functional outcome



Grading:



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Ref.: Boileau P et al. Neer Award 2005: The Grammont reverse shoulder prosthesis: results in cuff tear arthritis, fracture sequelae, and revision arthroplasty. JSES 2006 Sep;15(5):527–40. Levigne C et al. Scapular notching in reverse shoulder arthroplasty. JSES 2008;17(6):925-35.

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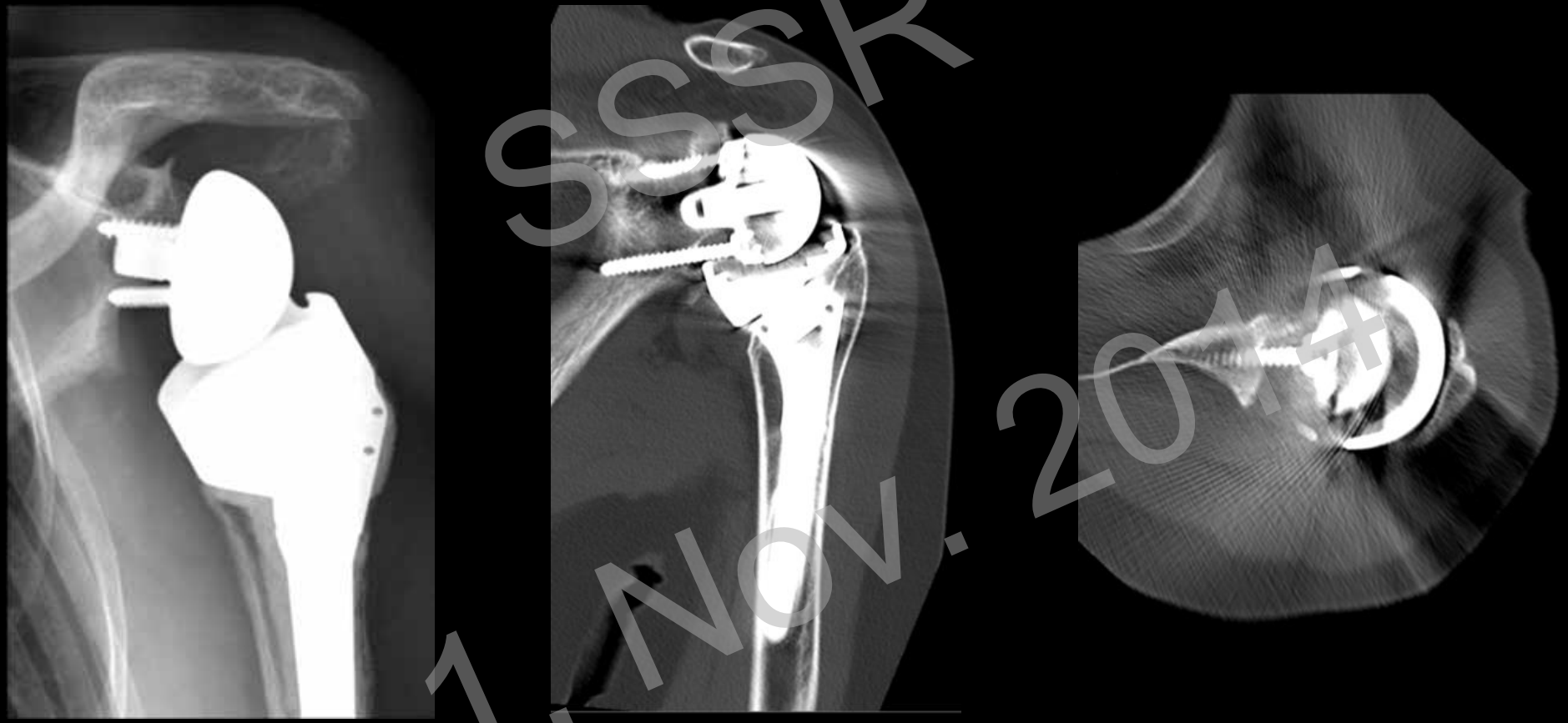
Scapular Notching

Grade III



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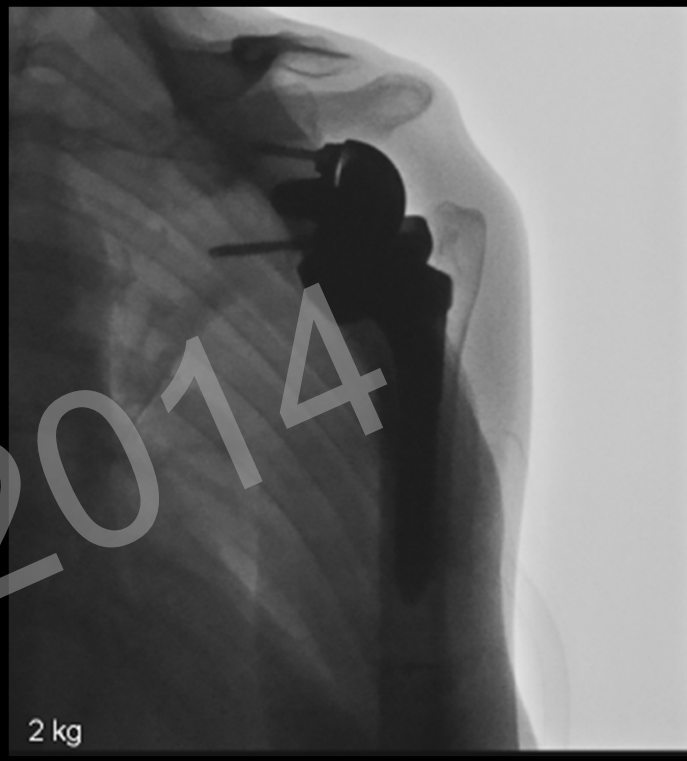
Scapular Notching

Inversed Prosthesis

- associated with:
  - too high position of glenosphere
  - superior tilting
- mostly posteroinferior location
- probably caused by abduction/elevation and external rotation



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Glenohumeral Instability

Second leading cause of prosthesis dysfunction

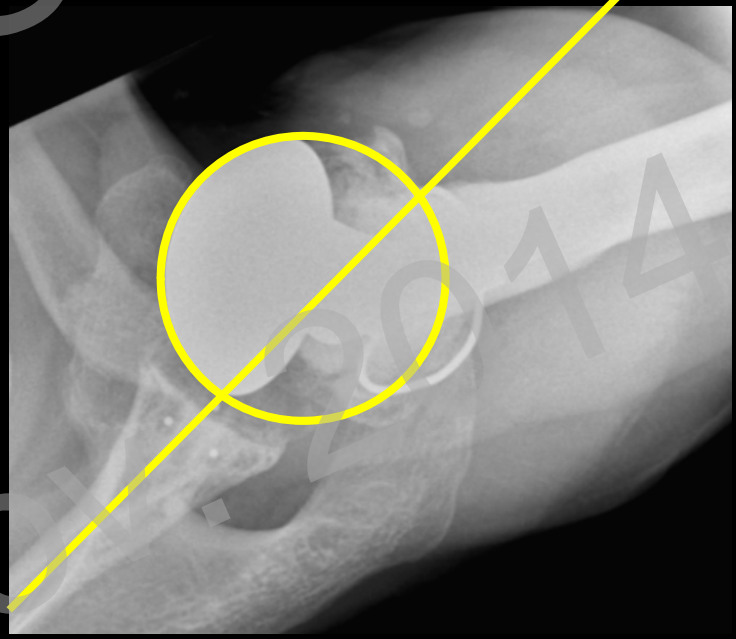
Anterior:

- most common instability (80%)
- subluxation of > 5 mm seen on cross-table view
- Causes:
  - Subscapularis insufficiency
  - Anteversion of glenoid component
  - Oversized humeral head
  - Decreased humeral retroversion (< 20 °)

Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

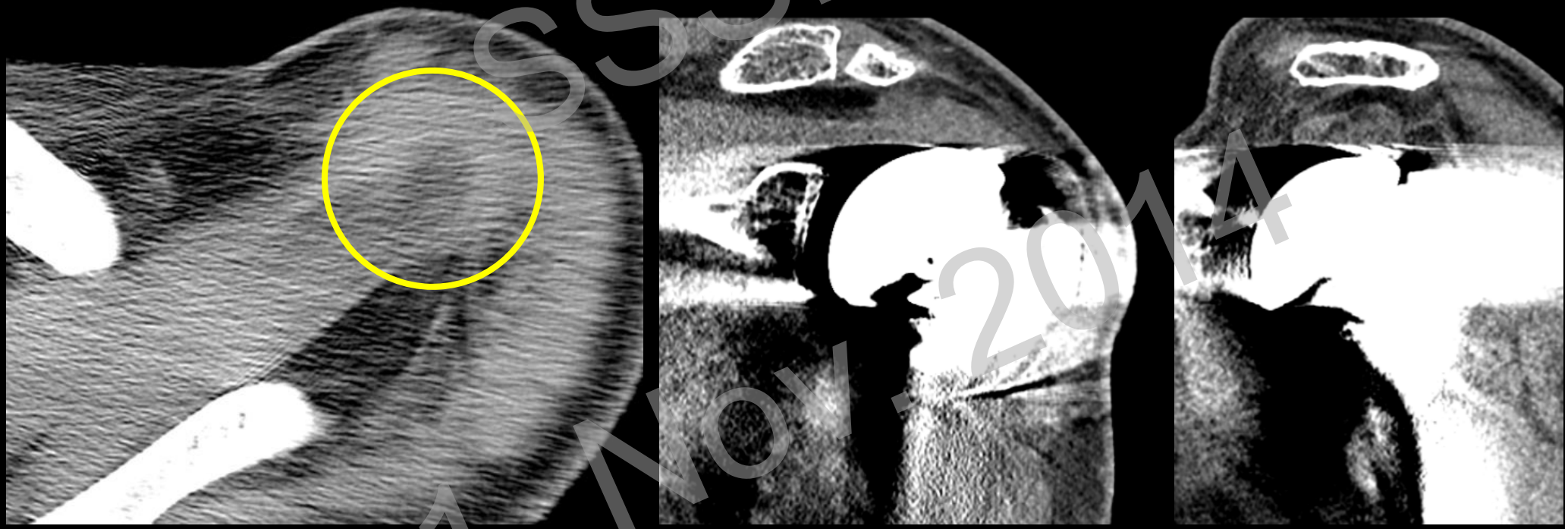
Glenohumeral Instability

Anterior Subluxation of Humeral Head?



Glenohumeral Instability

Anterior Deltoid Muscle Detachment



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Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Superior:

- Acromiohumeral distance < 5mm on G0 a.p. view
- Associated:
  - Anterior instability and rotator cuff tears (supraspinatus tendon)
  - Cranial placement of the humeral component with relative lengthening of the humerus
  - Superior tilting of glenoid component

Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Posterior:

- Causes:
  - Wide dorsal capsule
  - Anterior soft tissue contracture
  - Infraspinatus tendon deficiency
  - Malrotation of humeral component (retroversion > 45 °)
  - Dorsal glenoid defect
  - Retroversion of glenoid component (> 20 °)

Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

Glenohumeral Instability

Second leading cause of prosthesis dysfunction

Inferior:

- Causes:
  - Shortened humerus (e.g. after proximal humeral fractures or after humeral defects in tumor surgery)
  - Deltoid muscle weakness in axillary nerve palsy or deltoid muscle detachment

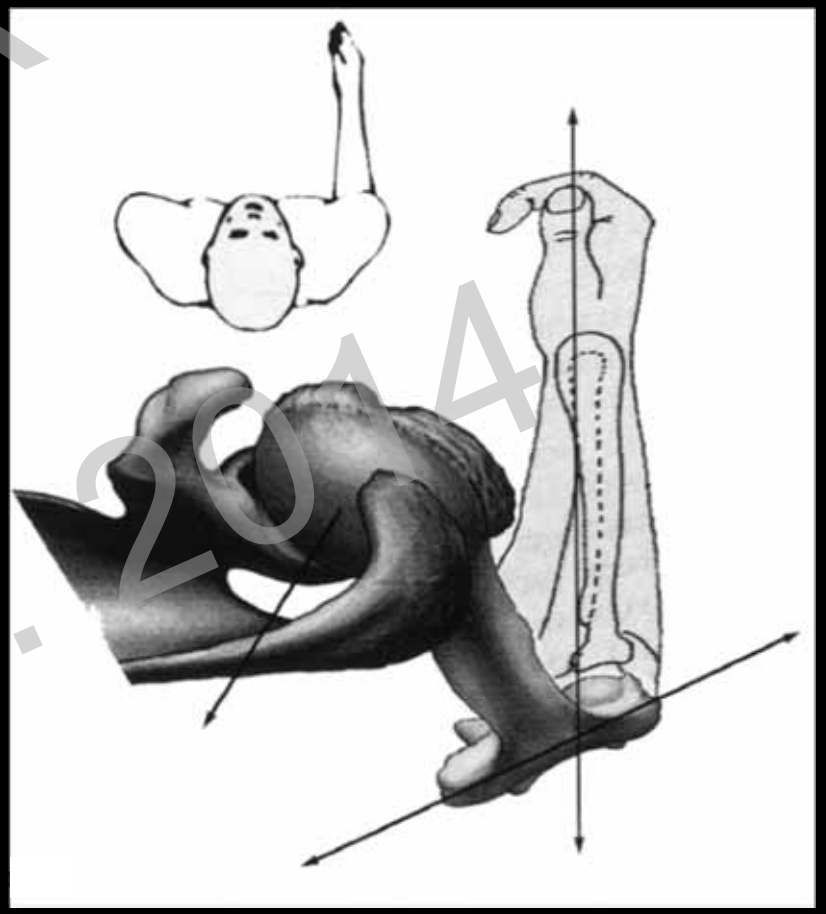
Ref.: Bohsali KI, Wirth MA, Rockwood CA. Complications of total shoulder arthroplasty. J Bone Joint Surg Am. 2006 Oct;88(10):2279-92.

Humeral Torsion

Measurement according to Hernigou et al.

- Proximal:
  Line perpendicular to
  the articuar surface

- Distal Reference:
  Transepicondylar line



Ref.: Hernigou et al. Determining humeral retroversion with CT. JBJS Am. 2002;84-A(10):1753-62.

Humeral Torsion

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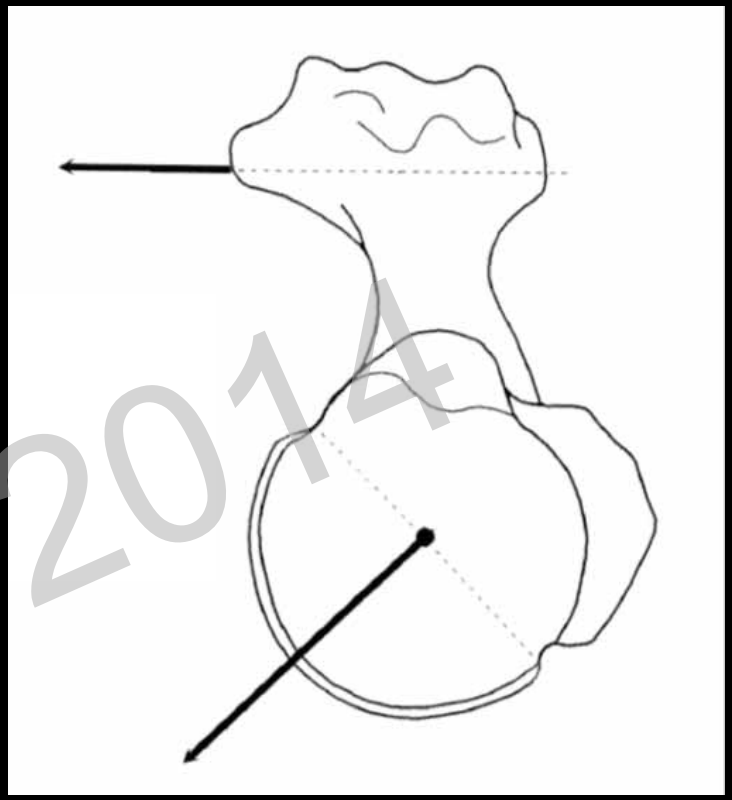


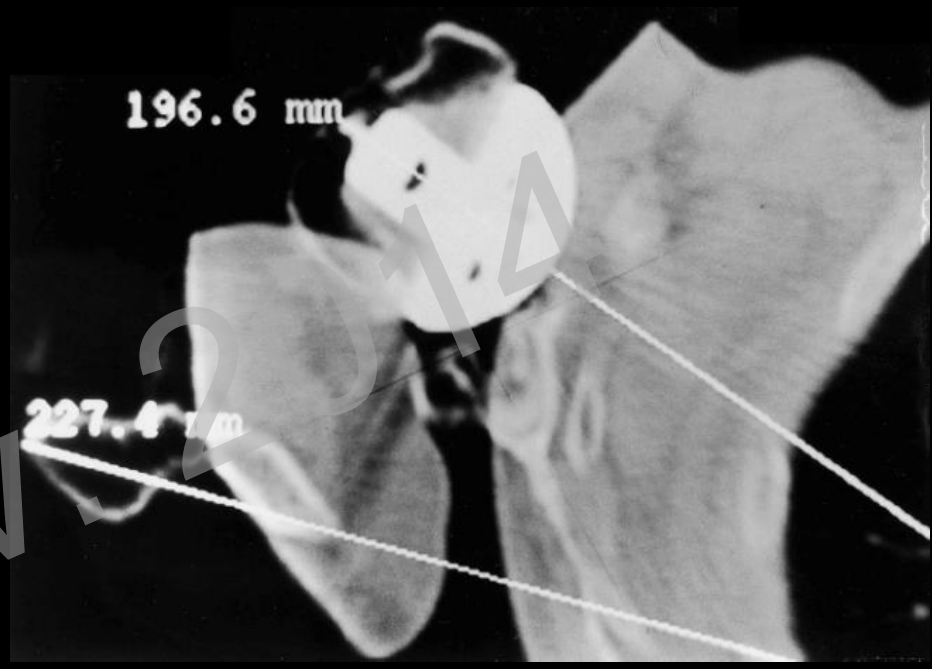
- Normal values:
  - Retroversion of 10-50 °
    (wide range)
  - Side-to-Side Difference only 2 °

Ref.: Hernigou et al. Determining humeral retroversion with CT. JBJS Am. 2002;84-A(10):1753-62.

Rotational Misplacement

A rare problem

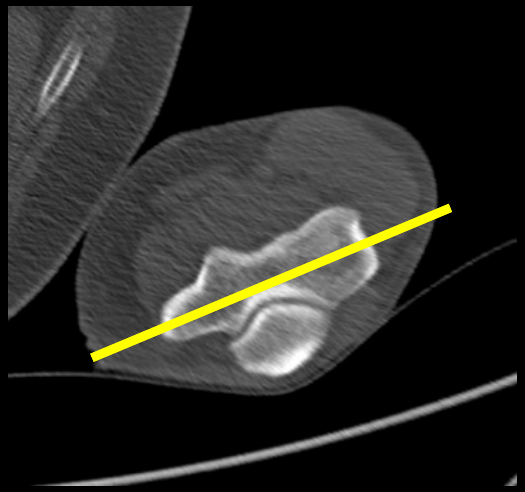
- Shaft is placed to allow for future conversion to inverse prosthesis
- Head can be positioned almost freely on the shaft
- Problem Fracture prosthesis: Tubercula do not fit tendon position



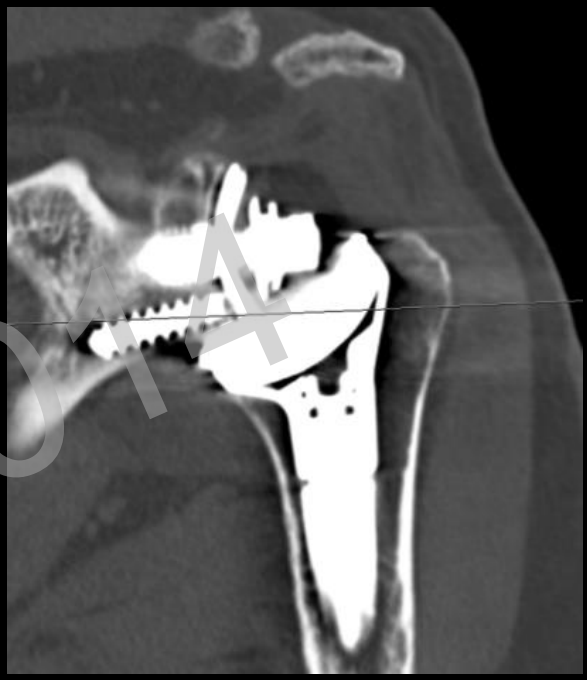
Ref.: Hernigou et al. Determining humeral retroversion with CT. JBJS Am. 2002;84-A(10):1753-62.

Rotational Misplacement

Case: Inversed Prosthesis, 10 ° Antetorsion



Reference Line



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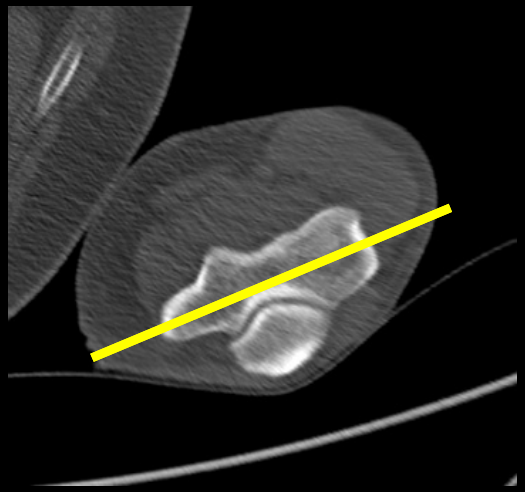
Rotational Misplacement

Case: Inversed Prosthesis, 10 ° Antetorsion



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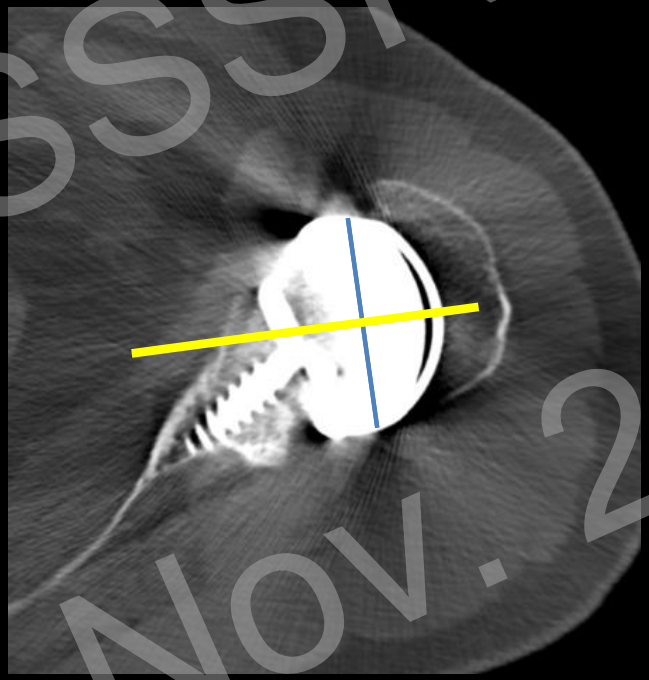

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Periarticular Ossification

Grading according to Kjaersgaard

Grade 0: No ossification

Grade 1: Ossification occupying < 50% of joint space

Grade 2: Ossification occupying > 50% of joint space

Grade 3: Bridging of joint

Ref.: Kjaesgaard P et al. Heterotopic bone formation following total shoulder arthroplasty. J Arthroplasty 4:99-104.

Periarticular Ossification

Grading according to Kjaersgaard

- Develop early in the postoperative course
- Typically low grade and often clinically unimportant

Ref.: Kjaesgaard P et al. Heterotopic bone formation following total shoulder arthroplasty. J Arthroplasty 4:99-104.

Scapular Fractures & Inverse Prosthesis

Prevalence

- Around 5%

TABLE I Prevalence of Acromial Fractures Reported in Studies in the Literature

Study	No. of Patients	No. of Acromial Fractures	Prevalence
Crosby et al.[6] (2011)	400	22	5.5%
Hamid et al.[11] (2011)	162	8	4.9%
Hattrup[7] (2010)	125	9	7.2%
Walch et al.[8] (2009)	457	17	3.7%
Cuff et al.[9] (2008)	114	1	0.8%
Frankle et al.[1] (2005)	60	2	3.3%
Wemer et al.[2] (2005)	58	4	6.8%
Boileau et al.[4] (2005)	45	2	4.4%
Katzer et al.[10] (2004)	21	1	4.7%

Ref.: Levy JC et al. Classification of postoperative acromial fractures following reverse shoulder arthroplasty. JBJS Am. 2013 Aug 7;95(15):e1041.

Periprosthetic Fractures

Classification

Classification	Definition
Groh et al.	
I	Fracture exclusively proximal to the tip of the stem
II	Fracture at the tip of the stem, running from proximal of the tip to distal
III	Fracture exclusively distal of the tip of the stem
Campbell et al.	
I	Fracture of the greater or lesser tuberosity
II	Fracture of the proximal humeral metaphysis
III	Fracture of the proximal humeral diaphysis
IV	Fracture of the mid and distal humeral shaft
Worland et al.	
A	Fracture of the tuberosities
B1	Spiral fracture with stable stem
B2	Short oblique or transverse fracture with stable stem
B3	Any fracture with unstable stem
Wright and Cofield	
A	Fracture at the tip of the stem extending proximally more than one third the length of the stem
B	Fracture at the tip but with less proximal extension
C	Fracture distal to the implant and fractures extending into the humeral metaphysis

Periprosthetic Fractures

Intraoperative Fracture

Scapular Fractures

Classification

- Type I: Acromion

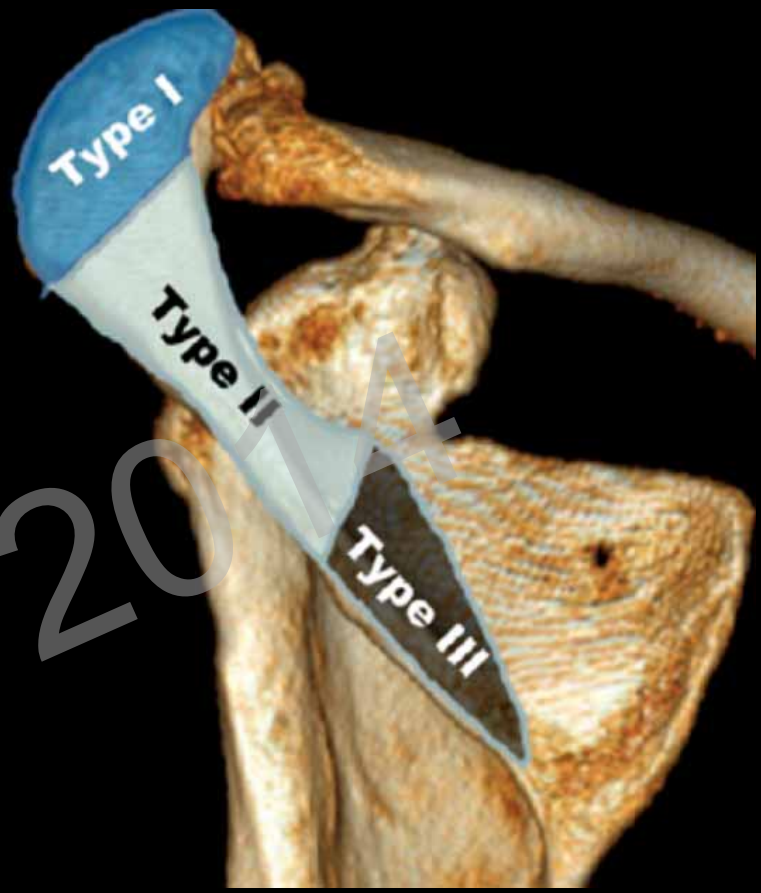
  Involvement of insertion of a portion of anterior and middle deltoid origin

- Type II: Scapular spine

  Involvement of at least the entire middle deltoid origin

- Type III: Base of scapular spine

  Involvement of the entire middle and posterior deltoid origin



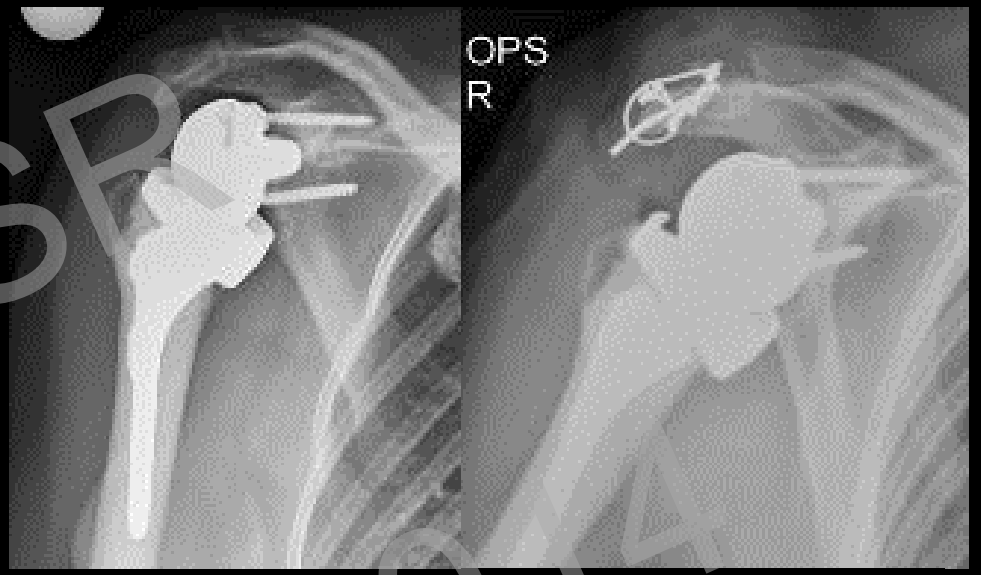
Ref.: Levy JC et al. Classification of postoperative acromial fractures following reverse shoulder arthroplasty. JBJS Am. 2013 Aug 7;95(15):e1041.

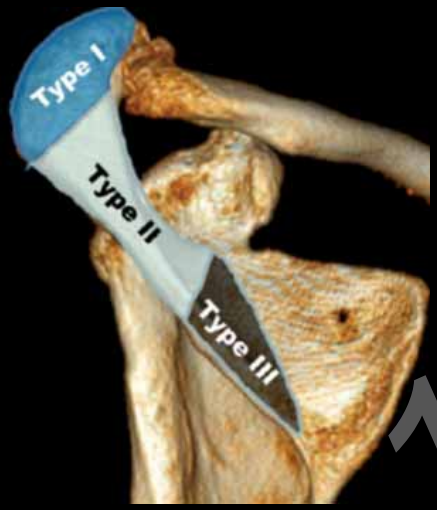
Scapular Fractures

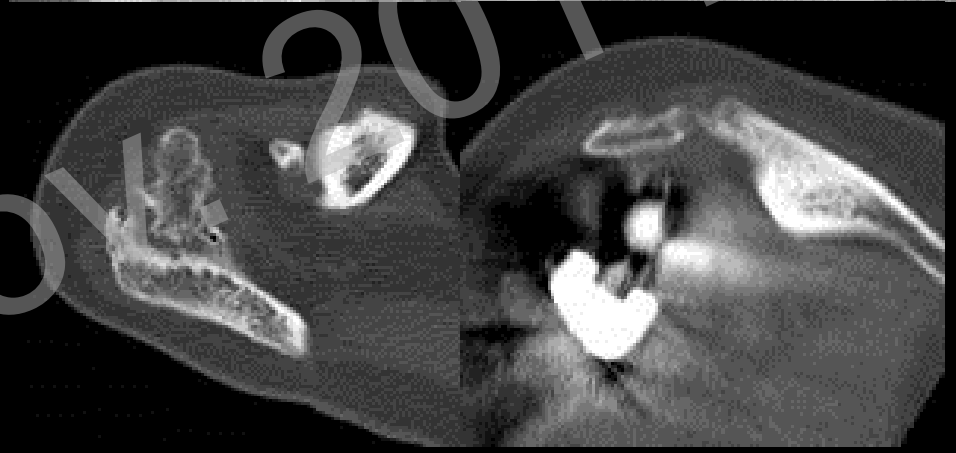
Classification

- Type I

  often chronic





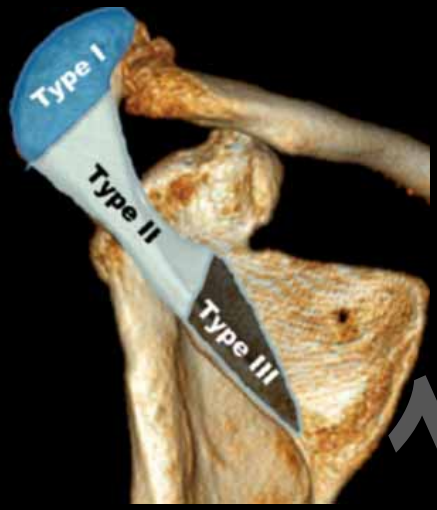


Ref.: Levy JC et al. Classification of postoperative acromial fractures following reverse shoulder arthroplasty. JBJS Am. 2013 Aug 7;95(15):e1041.

Scapular Fractures

Classification

- Type II

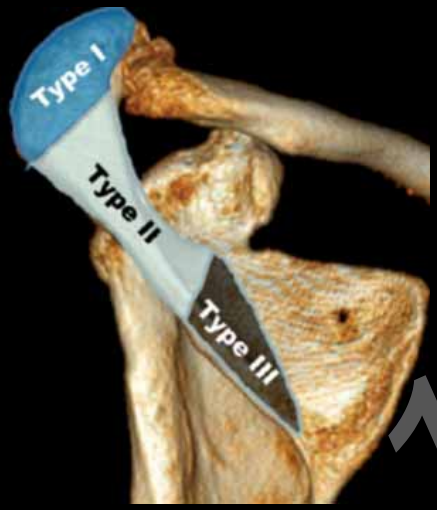


Ref.: Levy JC et al. Classification of postoperative acromial fractures following reverse shoulder arthroplasty. JBJS Am. 2013 Aug 7;95(15):e1041.

Scapular Fractures

Classification

- Type III



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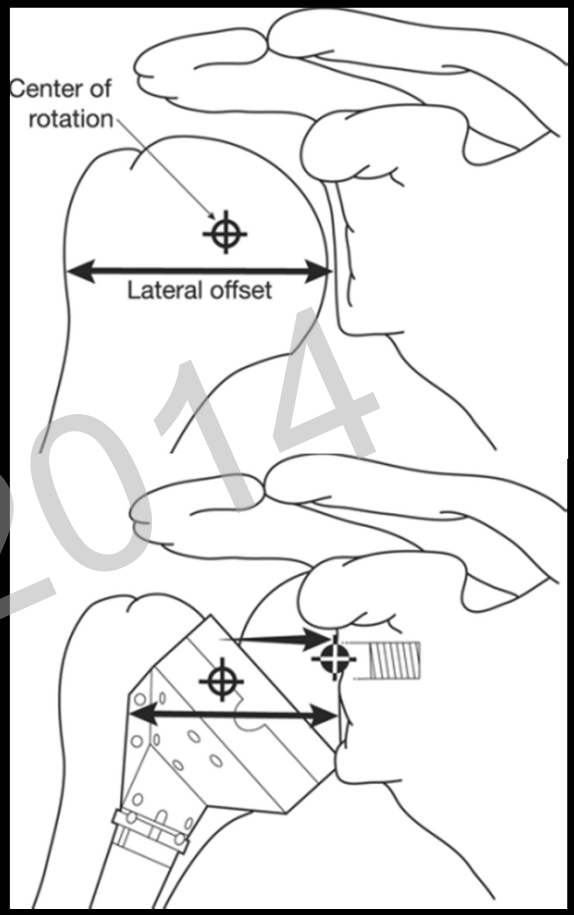
Ref.: Levy JC et al. Classification of postoperative acromial fractures following reverse shoulder arthroplasty. JBJS Am. 2013 Aug 7;95(15):e1041.

Acromion Fractures & Inversed Prosthesis

Lateral position of rotation center

- Deltoideus can act
- Less force needed
- More stress on acromion

- Lengthening of arm – Tension on deltoideus muscle



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Ref.: Frankle M et al. The reverse shoulder prosthesis for glenohumeral arthritis associated with severe rotator cuff deficiency. JBJS Am. 2006 Sep;88 Suppl 1 Pt 2:178-90.

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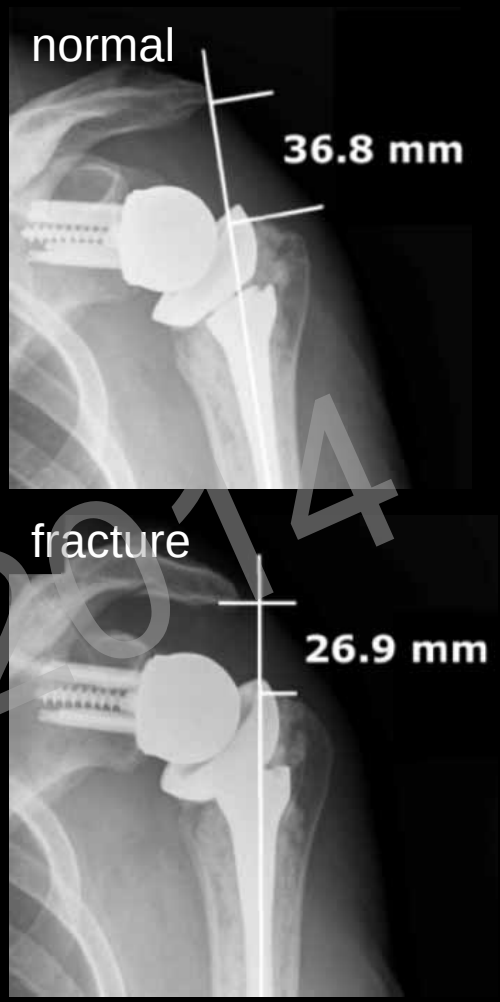
Acromion Fractures & Inverse Prosthesis

Detection of Fractures

- 80% visible on plain films
- Helpful signs:
  - Decreasing acromion-tuberosity distance



Ref.: Otto RJ et al Scapular fractures after reverse shoulder arthroplasty: evaluation of risk factors and the reliability of a proposed classificaton. JSES. 2013 Nov;22(11):1514-21.

Acromion Fractures & Inverse Prosthesis

Detection of Fractures

- 80% visible on plain films
- Helpful signs:
  - Decreasing acromion-tuberosity distance
  - Increasing acromial tilt

Don’t forget to inspect cross-table and Neer view for spine fractures!

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Ref.: Otto RJ et al Scapular fractures after reverse shoulder arthroplasty: evaluation of risk factors and the reliability of a proposed classificaton. JSES. 2013 Nov;22(11):1514-21.

Conclusion

Take Home Messages

- Knowledge about the prosthesis types used
- Surgical approach and associated problems
- Imaging of the postoperative shoulder
- Most common postoperative complications

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Thank you for your attention!

University of Zurich[UZH]

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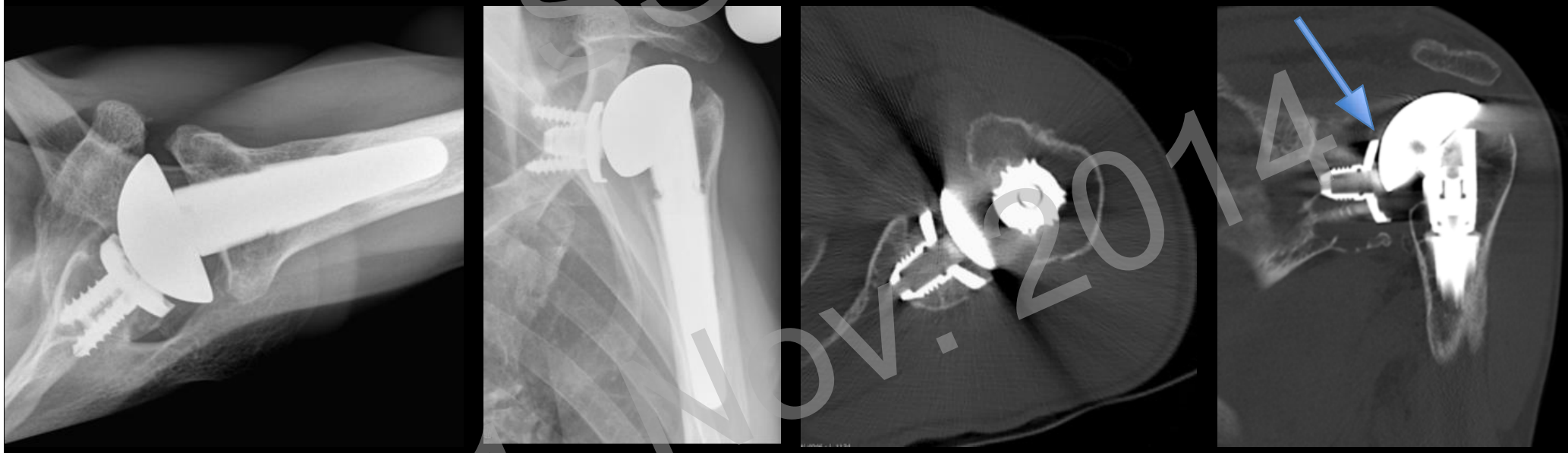
EXPERTISE IN MOTION

Articular Metallosis

Metal-on-Metal

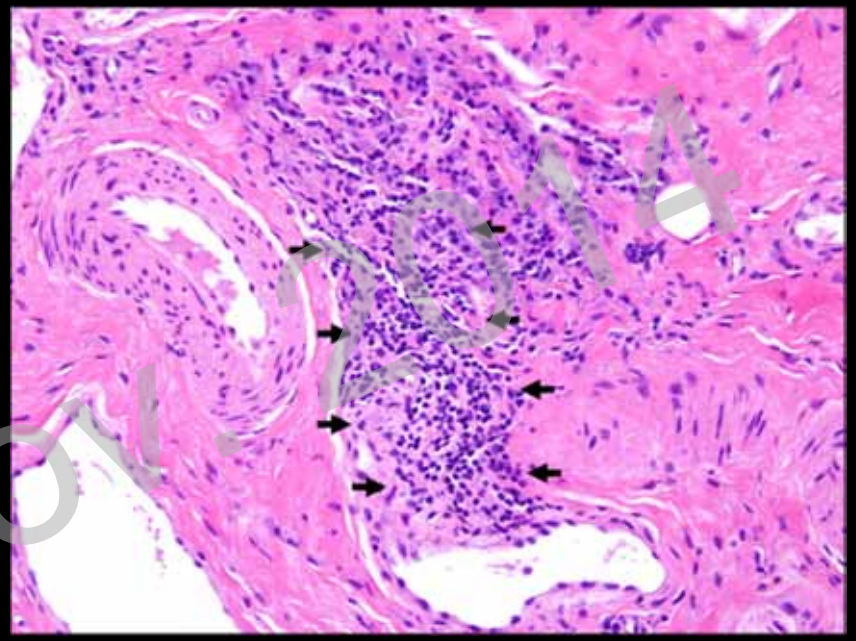
- Polyethylene wearing



Articular Metallosis

Metal-on-Metal

- Lymphocellular infiltration



Fractures

Early, Late or Incidental

- Early:
  Intraoperative Fractures
- Late:
  Insufficiency fractures
- Incidental:
  Traumatic (e.g. fall)

Risk factors:

Osteoporosis, Surgery Technique

Inversed prosthesis, Hamada ⇧, Os aromiale

Ref.: Hamada K et al. Roentgenographic findings in massive rotator cuff tears. A long-term observation. CORR 1990;(254):92-6.
Wall B et al. Reverse Total Shoulder Arthroplasty: A review of results according to etiology. JBJS Am. 2007;89:1476-85.

Fractures

Hamada Classification

Pathologic Stage:

1. AHI > 6mm
2. AHI < 6mm
3. Acetabulatsation – 2 subtypes:
   - concave underfurface of acromion
   - spur along coraco-acromial lig.
4. Narrowing glenohumeral joint
5. Humeral head collapse

Ref.: Hamada K et al. Roentgenographic findings in massive rotator cuff tears. A long-term observation. CORR 1990;(254):92-6.

Fractures

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  Insufficiency fractures
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  Traumatic (e.g. fall)

Risk factors:

Osteoporosis, Surgery Technique

Hamada ⇧, Os aromiale, Inversed prosthesis

Age: Comorbidity, osteoporosis

Ref.: Hamada K et al. Roentgenographic findings in massive rotator cuff tears. A long-term observation. CORR 1990;(254):92-6.
Wall B et al. Reverse Total Shoulder Arthroplasty: A review of results according to etiology. JBJS Am. 2007;89:1476-85.