

Shoulder direct arthrography: how to do and how to read

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Learning objectives

- Review technique for performing arthrograms of the shoulder
- Describe indications and the added value of arthrography for assessment of shoulder pathology
- Illustrate spectrum of pathological findings on Arthrography

Background

Arthrography was described in the 1930s, when Oberholzer injected air into the glenohumeral joint to evaluate structures of the axillary recess on conventional radiograph. Iodinate contrast, use of CT or use of MR all came naturally after.

Today MR is the first line technique for assessing joints with its' superior soft tissue contrast capabilities.

CT Arthrogram remains a suitable option in claustrophobic patients, patients with contraindications to MRI and postoperative joints leading to artifacts.

Direct arthrography results in joint distention and separates normal intraarticular structures.

Capsular distention enhances visualization of small joint bodies, rotator cuff undersurface, labrum, glenohumeral ligaments, long head of the biceps, and structures of the rotator interval.

Labral, rotator cuff tears, chondral defects are better appreciated when delineated by contrast.

Using anesthetic in the injected solution may function as a diagnostic procedure, ensuring the patient pain does indeed come from the glenohumeral joint.

Findings and procedure details

Common indications for MRI shoulder arthrography usually relate to assessment of anatomical structures poorly visualized without arthrography:

- Labrum

- Biceps-labral complex
- Ligaments
- Rotator interval
- Joint capsule

Direct or Indirect Arthrography?

Indirect arthrography refers to intravenous administration of gadolinium followed by mobilization or exercise of the affected extremity.

Usually, it comprises of a standard dose of 0.1 mmol/kg body weight, endovenous administration followed by 15 minutes of shoulder mobilization, followed by standard imaging of the shoulder.

Obvious advantages are less invasiveness, lack of image guidance or necessity of a procedure-performing physician. Despite good sensitivity and specificity for certain rotator cuff and labral tears, there is diminished signal intensity of intraarticular fluid, lack of absence capsular distention, potential for misinterpretation due to enhancement of vessels, granulation tissue, synovial structure, bursa and tendon sheaths.

Technique for direct Arthrography

Before procedure:

- Review indication and previous exams and procedures
- Assess possible contraindications
- Conduct brief clinical history (bleeding risk, medication, allergy)
- Ensure patient's consent and understanding of the procedure and possible complications, and patient's consent

Medications:

- 1%Lidocaine
- For CT Arthrography - nonionic iodinated contrast: the injected solution should be diluted 1:1 ratio with normal saline or lidocaine)
- For MR Arthrography - Gadolinium contrast: in a 20mL syringe mix: 1) 5mL iodinated contrast, 2) 15mL normal saline [consider using 5 mL Saline + 10 mL Lidocaine 1%] 3) Gadolinium contrast (~2mmol/L) i.e. (0.1-0.2mL Gadovist ® in 20 mL)

- Use of epinephrine may be considered (0.2 cc, 1:1000 solution) if significant delay is expected before MR

(Optional: Long-acting anesthetic (for diagnostic exam) or steroid use)

- Therapeutic test - helps to determine if pain cause is intraarticular
- Long-acting anesthetic (Ropivacaine 0.2% or bupivacaine 0.5%)
- In vitro reports of cartilage toxicity from long-acting anesthetic
- Some reports have found lower in-vitro toxicity with ropivacaine than bupivacaine or lidocaine
- Corticosteroid can be added after contrast injection without compromising diagnostic exam (do not inject steroid if infection is suspected)
- Cartilage injury has not been reported to occur from arthrography

Material

- Aseptic technique material (skin cleansers, sterile swabs and sterile drapes)
- Contrast (as prepared before)
- Syringe (20mL syringe for preparation; 1mL syringe for gadolinium; 1 mL syringe for injection)
- Needle (25G for local anesthesia and 20-22G spinal needle for arthrogram)
- Image guidance (Fluroscopy, Ultrasound, CT)

Approaches

(usually a opposite approach to patient's pain is preferred)

1 - Through the rotator interval [Fig. 1](#) on page 10

- Supine position, with the arm in external rotation (palm facing upwards - rotates the long head of the biceps tendon lateral).
- Mark needle entry point in the skin
- Anesthetize the skin and subcutaneous tissue (perpendicular to table top)
- Insert needle (vertical) until contact with bone.
- Contrast flow should be without resistance
- CT and US guided allow confirmation of intrarticular position before test injection is performed and allows a more oblique needle course

2 - Inferomedial approach ("Schneider technique") [Fig. 2](#) on page 11

- Same preparation as previous
- Targets the caudal third of the glenohumeral joint
- Needle tract through the infraspinatus muscle
- Disadvantage: distortion of the anteroinferior labroligamentous complex and subscapularis tendon

3- Posterior approach [Fig. 3](#) on page 12

- Prone position, with the arm in external rotation (palm facing downwards)
- Fluoroscopy tube perpendicular to the glenohumeral joint
- Skin marked just lateral to the medial articular cortex of the humerus at the level of the coracoid process

Fluoroscopy, CT or US guided?

- Allows a more oblique needle course
- Better control of needle position

At our institution we usually perform CT guided intervention in shoulder arthrography through an anterior approach, as we found it faster to perform.

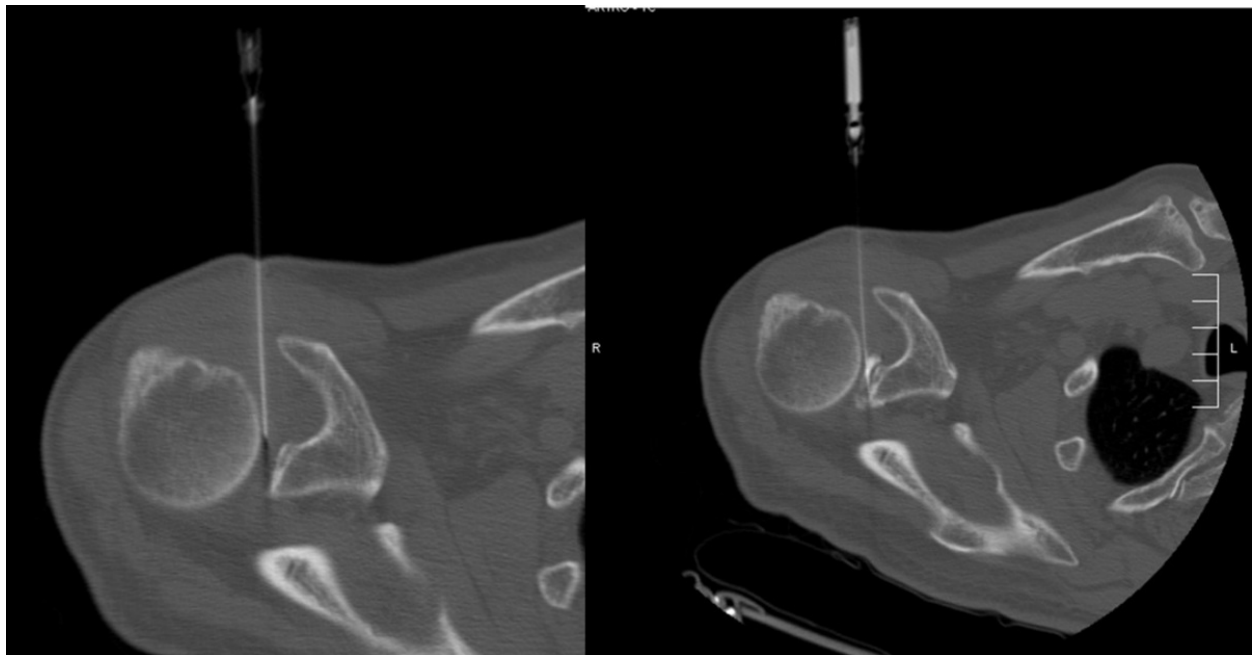


Fig. 4: CT guided arthrogram. Intrarticular position of needle was strongly suspected (left image) and confirmed after injecting a small amount of contrast material.

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Joint capsule often very firm; may be mistaken for bone.

- Firm resistance met from passage through capsule followed by decreased resistance follows as needle enters joint.
- Perform test injection (low resistance to injection)
- Contrast should flow away from needle (contrast pooling at needle tip indicates malposition)

Signs of intraarticular position:

- "Bony touch" from needle tip
- Resistance "give" after passage of capsule
- Image evidence of intraarticular positioning
- Low resistance when small amount of fluid injected (beware: low resistance is also felt if needle tip is in periarticular bursa or tendon sheath). Contrast should flow away, not pool around the needle tip.
- Joint fluid returns spontaneously or with aspiration (aspirate effusion before injecting contrast)

If high resistance to injection is met:

- Needle tip may be tightly apposed to joint surfaces (turn needle bevel until anesthetic flows easily, try retracting 1-2mm while injecting)
- Needle in capsule or exterior to joint
- Needle plugged
- (If all else fails, try different approach)

Complications and Contraindications

Complications are very rare.

This may include: bleeding, infection, allergic reaction.

Post injection pain however is quite common, possibly related to synovitis may affect up to 66% of patients several hours after the procedure and resolves within days.

There are currently no known reports of nephrogenic systemic fibrosis related to arthrography.

Contraindications include

- Active joint infection
- Cellulitis
- Reflex sympathetic dystrophy

Relative contraindications:

- History of contrast allergy (follow standard prophylaxis protocols)
- Consider using normal saline for shoulder distension for MR Arthrography

Anticoagulation

- Perform Arthrography when INR<1.5-2.0
- Risk-benefit of withholding or reverting anticoagulation

- Smaller gauge needle

Image acquisition

For CT, Spiral scanning with isotropic data acquisition, with axial images with 0.625mm thickness. Multiplanar reformats in oblique parallel and perpendicular to the plane of the supraspinatus muscle belly or the glenoid.

For MR, dedicated shoulder coil should be used, with T1-weighted fat suppressed sequences in the axial, oblique coronal, oblique sagittal planes with 3-4 mm slice thickness. Non suppressed T1 (sagittal) is needed for fatty infiltration detection. T2 weighted fat suppressed is used in the coronal plane, for detecting those findings less well depicted in T1. Sagittal T2 further optimizes evaluation of rotator cuff tears in anteroposterior plane, signal changes in the biceps tendon and muscle edema).

ABER (abduction with external rotation) patient with palm behind head, acquiring oblique axial, parallel to the humeral shaft, has been described to increase rotator cuff articular surface teardetection, enhance visibility of nondisplaced anteroinferior labral tears and presence of humeral head decentering, especially in athletes with SLAP tears. However, some authors have found it not to increase their accuracy in practice, increasing scan times (positioning, using surface coil and acquiring a new sequence), therefore it is sometimes suppressed.

Image interpretation

Arthrographic studies provide unique imaging signs, which may usually be described into one of the following:

- Abnormal communication of joint with other compartments/collections [Fig. 15](#) on page 21, [Fig. 14](#) on page 20
- Labral, tendon, and ligament injuries
- Synovitis (irregular capsular margins) [Fig. 14](#) on page 20
- Loose bodies
- Cartilage abnormalities

In the shoulder, structures that require an arthrogram for optimal assessment include the capsule and ligamentous structures; glenoid labrum; biceps-labral complex; totator interval and biceps pulley.

Although an thorough review of pathology is beyond the scope of this review, some important anatomical and pathological remarks will be made.

The glenohumeral ligaments are thickened bands of the anterior joint capsule with attachments to both the glenoid margins and the proximal humerus.

It is composed of three components

- Superior Glenohumeral Ligament (SGHL) [Fig. 5](#) on page 14
- Middle Glenohumeral Ligament (MGHL) [Fig. 6](#) on page 14
- Inferior Glenohumeral Ligament (IGHL) [Fig. 7](#) on page 15

The Glenoid Labrum increases the depth and surface area of the glenoid fossa to better accommodate the humeral head, acts as attachment for the anterior band of the IGL.

There is significant variation in the size, shape and configuration of the labrum, especially in the superior labrum the junction of the upper and middle thirds of the glenoid fossa.

Sublabral foramen is an area of lack of attachment of the glenoid labrum in the anterosuperior quadrant, never located below the equator, which may mimic a superior labral anterior to posterior tear.

The following criteria are used to differentiate biceps-labral sulcus from isuperior labral anterior to posterior tear (SLAP). [Fig. 8](#) on page 16

- Smooth and well-defined with no extension of contrast into the labrum
- Follows the contour of the glenoid rim
- Must measure less than 5mm in medial to lateral diameter and is usually less than 3mm in diameter

Superior labrum anteroposterior lesions comprises of a complex range of lesions, centered at the long head of the biceps tendon and extend anterior and posterior to the tendon.

Four types were initially described by Snyder (6 additional types described subsequently)

Type I - Fraying and degeneration of the superior labrum (irregular labral contour; increased signal in T2)

Type II - Most common. Detachment of the SL from glenoid rim

Type III - Bucket handle tear with inferior displacement of the central labrum while tendon and anchor remain intact

Type IV - Bucket handle tear with inferior displacement of the central labrum as well as tendon and anchor of the biceps

Types V - X are classified by associated labral and ligamentous abnormalities

The Buford complex is a variant that has been described in 1.5% of shoulder arthroscopies and consists of a cord like MGHL, a MGHL that attaches directly to the superior labrum anterior to the biceps and an absent anterosuperior labrum. [Fig. 9](#) on page 16

The antero-inferior labroligamentous complex is also a place of significant pathology, with Arthrography being much more sensitive than conventional MR in detecting this.

Bankart injury consists of avulsion of the antero-inferior labroligamentous complex with disruption of the scapular periosteum. When this is seen with a osteochondral injury, is called a "bony" Bankart. [Fig. 10](#) on page 17

Several variants exist, the most important being Perthes injury, ALPSA (anterior labroligamentous periosteal sleeve avulsion) and GLAD (glenolabral articular disruption)

Perthes injury [Fig. 11](#) on page 17 consist of detachment of the antero-inferior labroligamentous complex with a stripped but otherwise intact scapular periosteum.

ALPSA [Fig. 13](#) on page 19 is similar to the Perthes, but the periosteum allows medial displacement and inferior rotation of the torn capsulolabral tissue with the labrum remaining attached to the periosteum which overlies the glenoid (hence sleeve)

With GLAD [Fig. 12](#) on page 18 (glenolabral articular disruption) there is a superficial anterior inferior labral tear associated with an anterior inferior glenoid articular cartilage injury.

CT arthrography may be an alternative technique when MR is not possible or feasible, for instance

- MRI is contraindicated
- No MR available
- Claustrophobic patients
- Surgical hardware
- Movement artifacts
- Salvage procedure when MR imaging is inconclusive.

Additionally, some advantages of CT over MR may be considered

- Submillimetre resolution in most standard Multidetector CT scanners
- Usually more accessible
- Extremely fast acquisition

- Better characterization in general of osseous lesions (like Hill-Sachs or bony Bankart), and detection of pathological calcifications (e.g., Bennett lesion, calcific tendinitis)
- Less susceptible to artifacts

CT Arthrography performs adequately in detection of full-thickness and articular surface partial tears of the supraspinatus and infraspinatus, fatty degeneration and volume loss of the rotator cuff muscles are also well demonstrated using CT.

It is effective in accurately detecting SLAP lesions and distinguishing between normal variants affecting the anterosuperior labrum and labral-bicipital complex.

Chondral defects in various joints are well assessed using MDCT arthrography with accuracy in some cases superior to that of direct MR arthrography

This characteristics make CT Arthrography an adequate alternative study option for studying the shoulder in cases of instability or suspected lesion of the gleno-labral complex.

Images for this section:

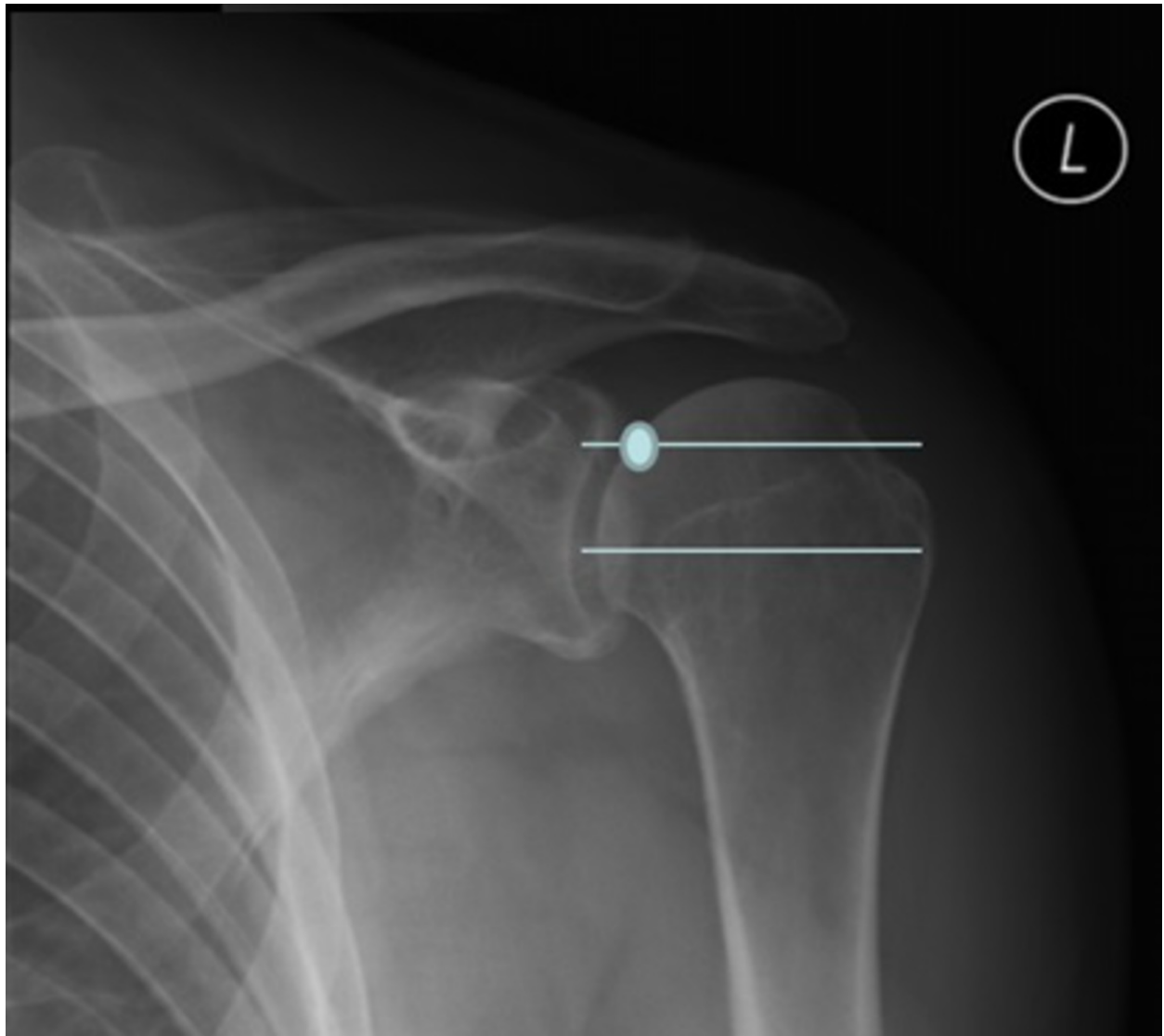


Fig. 1: Lines dividing the humeral head into three thirds. Antero-superior approach aims at the rotator interval. The entry point lies medial to the biceps groove.

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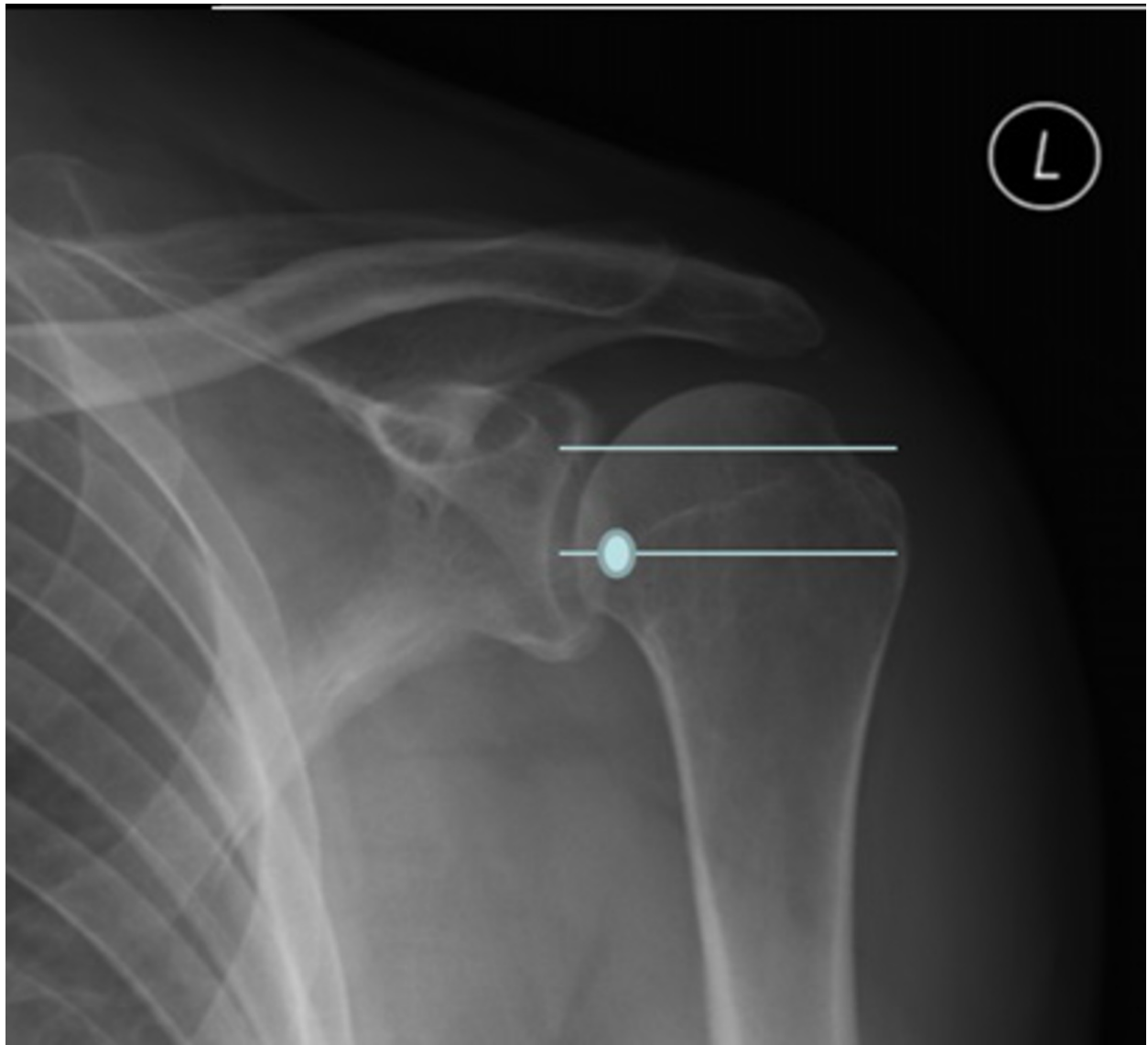


Fig. 2: Lines dividing the humeral head into three thirds. Infero medial corner of the humeral head is approached in a vertical position.

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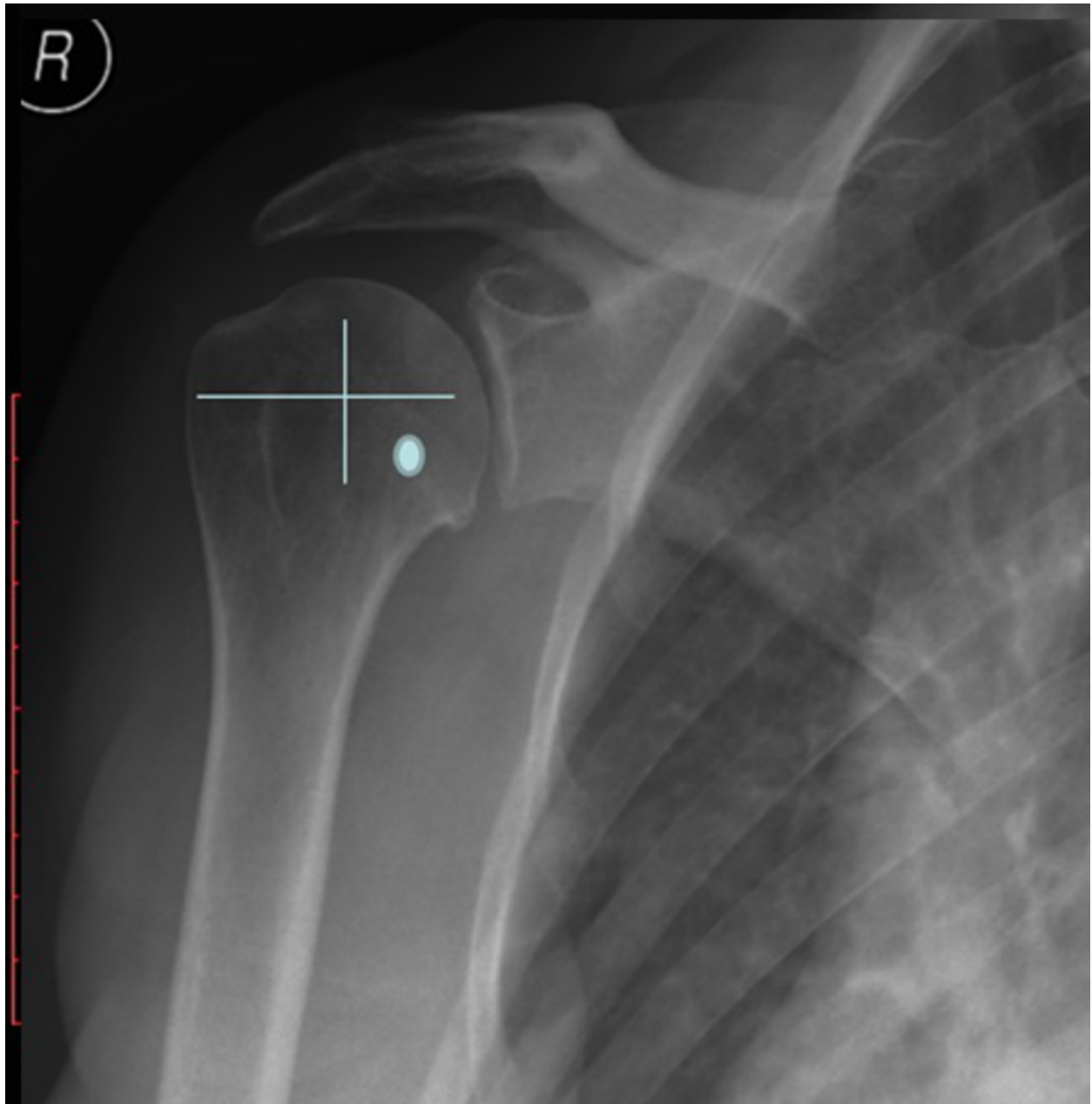


Fig. 3: Note that the glenoid cavity is perpendicular to the beam. Aim at the infero-medial corner of the humeral head in a vertical direction.

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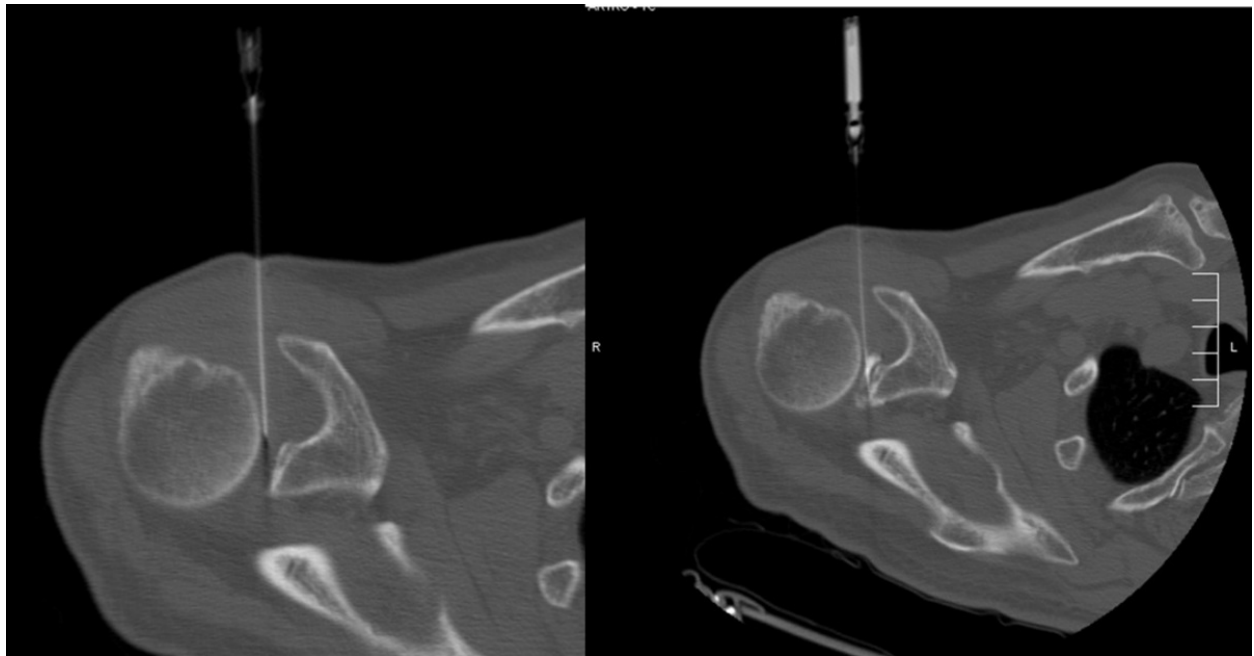


Fig. 4: CT guided arthrogram. Intrarticular position of needle was strongly suspected (left image) and confirmed after injecting a small amount of contrast material.

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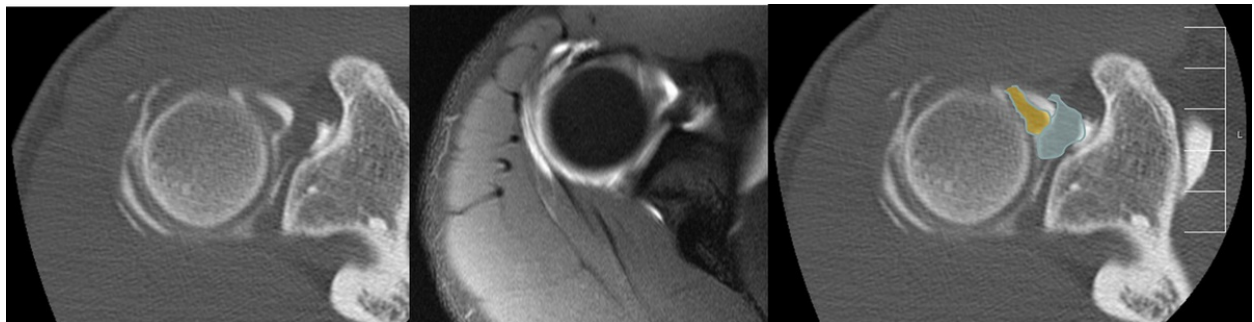


Fig. 5: Superior Glenohumeral Ligament (SGHL): Small calibre ligament Originates from the upper pole of the glenoid and base of the coracoid process Attaches just superior to the lesser tuberosity in the region of the bicipital groove Together with the coracohumeral ligament, forms the biceps pulley. Identified at the level of the coracoid. Note the relation with the biceps long head tendon (orange shade in the rightmost image) and the SGHL (painted blue)

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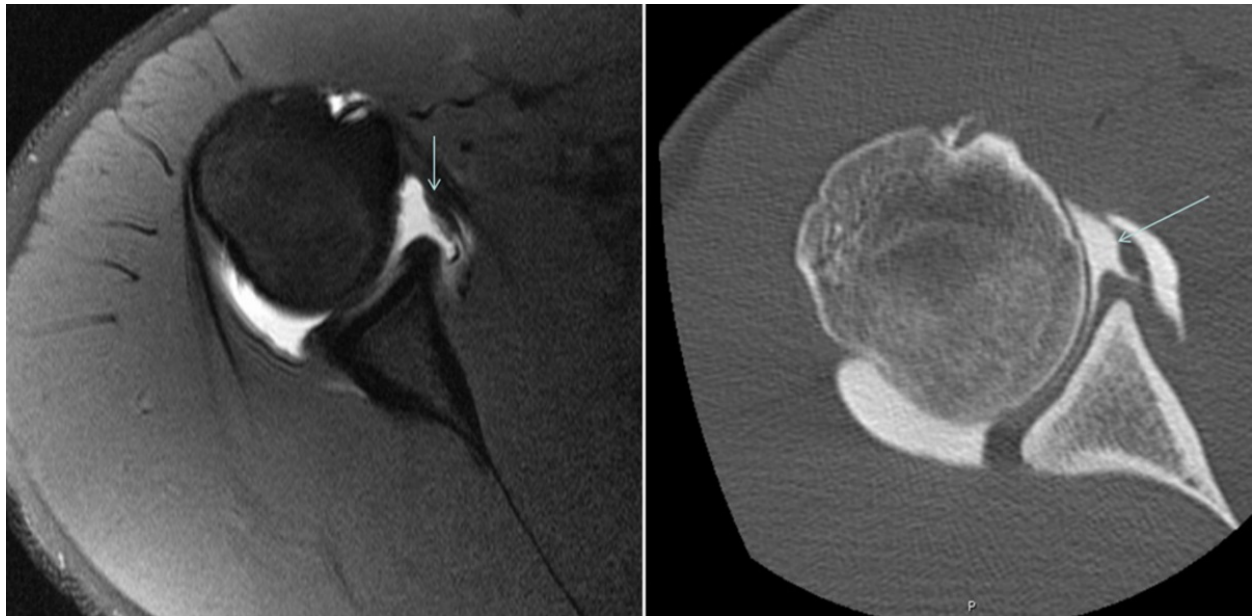


Fig. 6: Middle Glenohumeral Ligament (MGHL) indicated by arrow in MR-Arthrography (left image - axial T1 Fat Saturation) and CT Arthrogram (right image - CT Arthrogram, axial reconstruction) Origin: superior labrum below and scapular neck Insertion: medially to the lesser tuberosity May not be identified in 30% of patients Has a role in stability from 0-45 degrees of abduction TIP: on axial images is located below the coracoid

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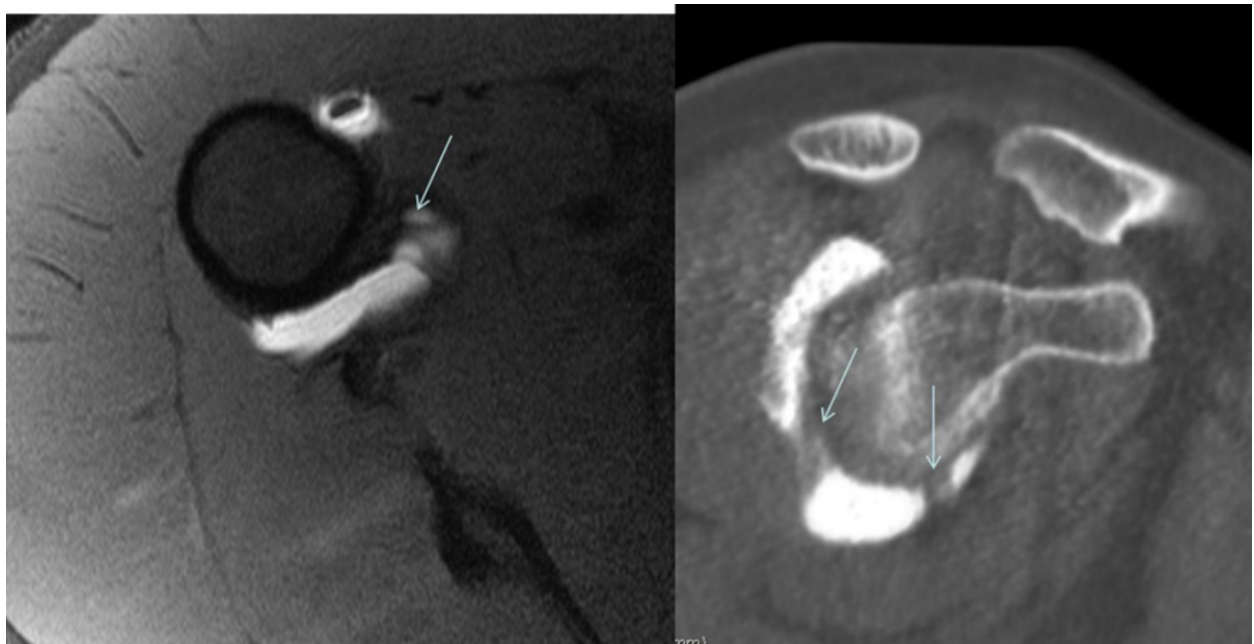


Fig. 7: Inferior Glenohumeral Ligament (IGHL): Consists of an anterior and posterior band and axillary pouch Origin: the glenoid labrum or neck Insertion: humeral neck at the periphery of the articular margin Look in the axial slices for axillary pouch, which should be

bordered anteriorly and posteriorly by both limbs of the glenohumeral ligament Axial MR Arthrograph (right) demonstrating the anterior branch of the IGHL. Oblique sagittal CT-Arthrograph reformat demonstrating both anterior and posterior branch, with the axillary pouch between them.

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Fig. 8: Lower left image, red square: CT Arthrograph, coronal reconstruction, showing a smooth and well-defined contrast filling beneath the labrum, following the contour of the glenoid rim - sublabral recess. Top right, top left and lower right image show axial MR Arthrograph (T1FS), coronal (T1 FS) and Coronal CT arthrograph reconstruction (respectively). Contrast filling into the labrum is evident with detachment from the glenoid, without displacement, fitting SLAP II criteria.

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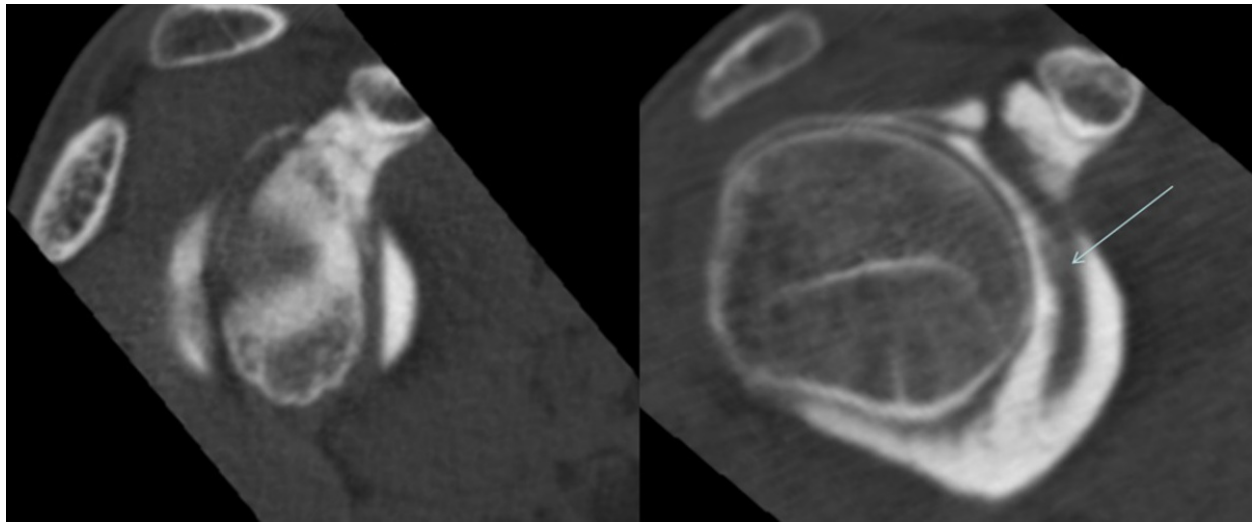


Fig. 9: Buford complex. CT Arthrogram, with sagittal and oblique coronal reconstructions. No labrum is seen in the anterosuperior quadrant of the glenoid, and a thick and cordlike MGHL is seen, originating from the superior labrum, close to the origin of biceps long head.

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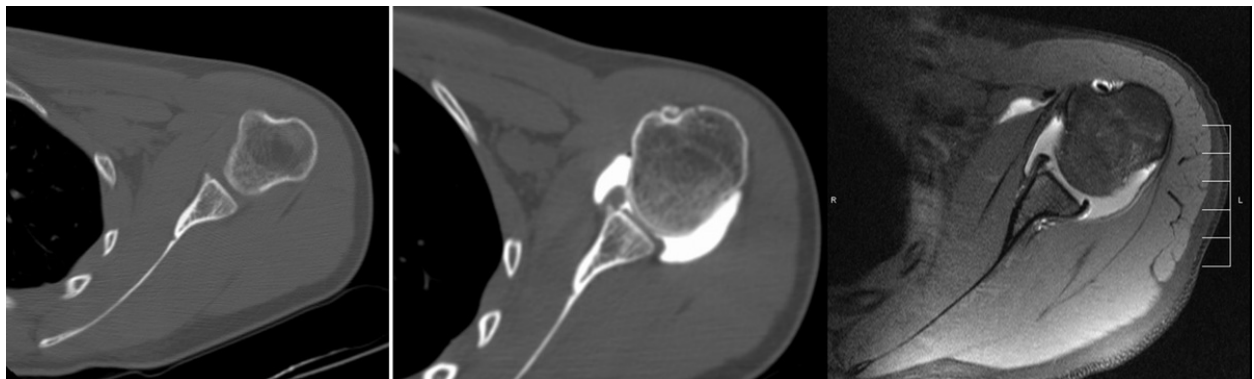


Fig. 10: Bankart injury. Non contrast CT, CT arthrogram and MR arthrogram shows fracture of the anterior glenoid rim with dislocated antero-inferior labroligamentous complex. ("Bony" Bankart)

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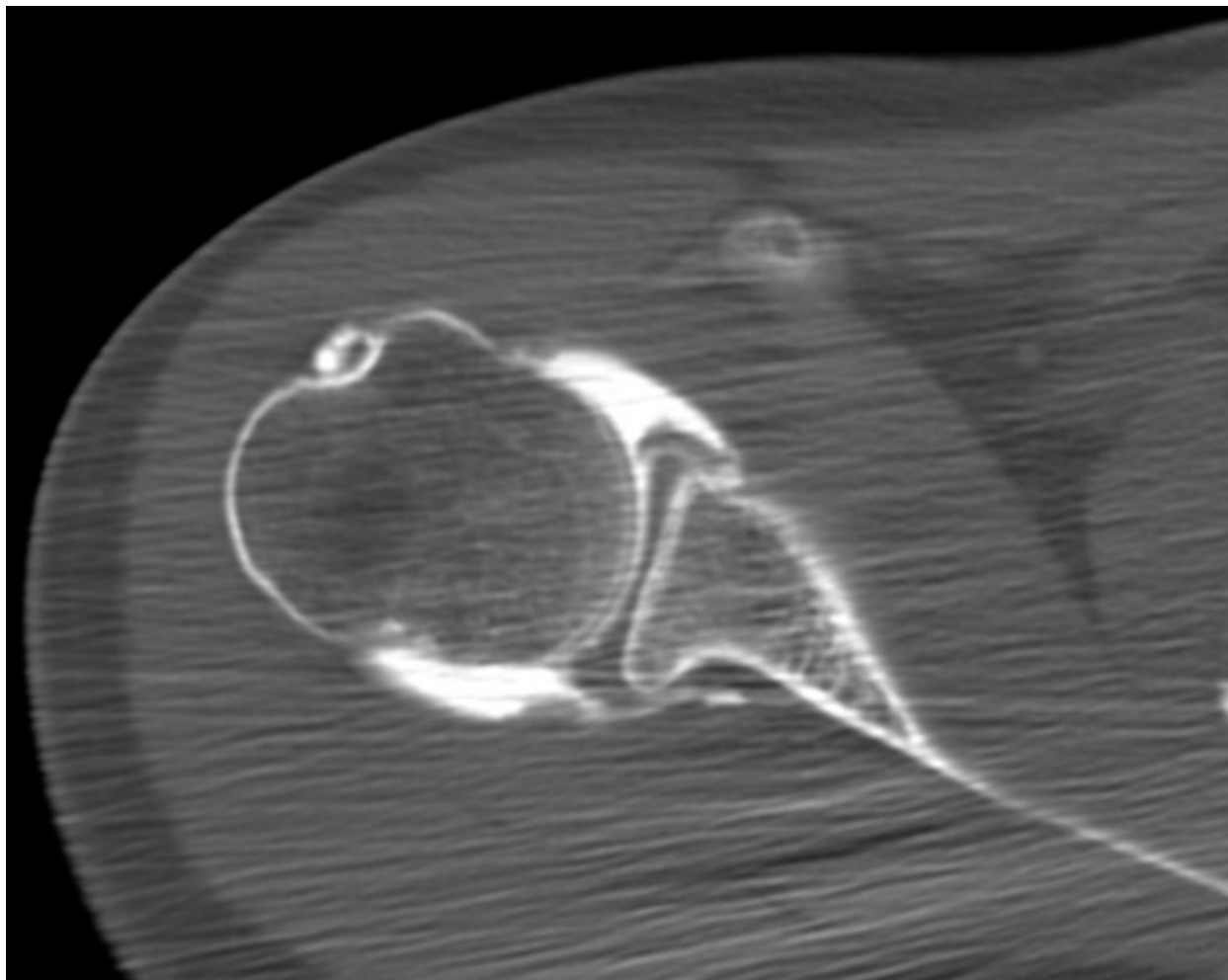


Fig. 11: Perthes Injury:CT arthrogram shows a detachment of the antero-inferior labroligamentous complex with a stripped but otherwise intact scapular periosteum

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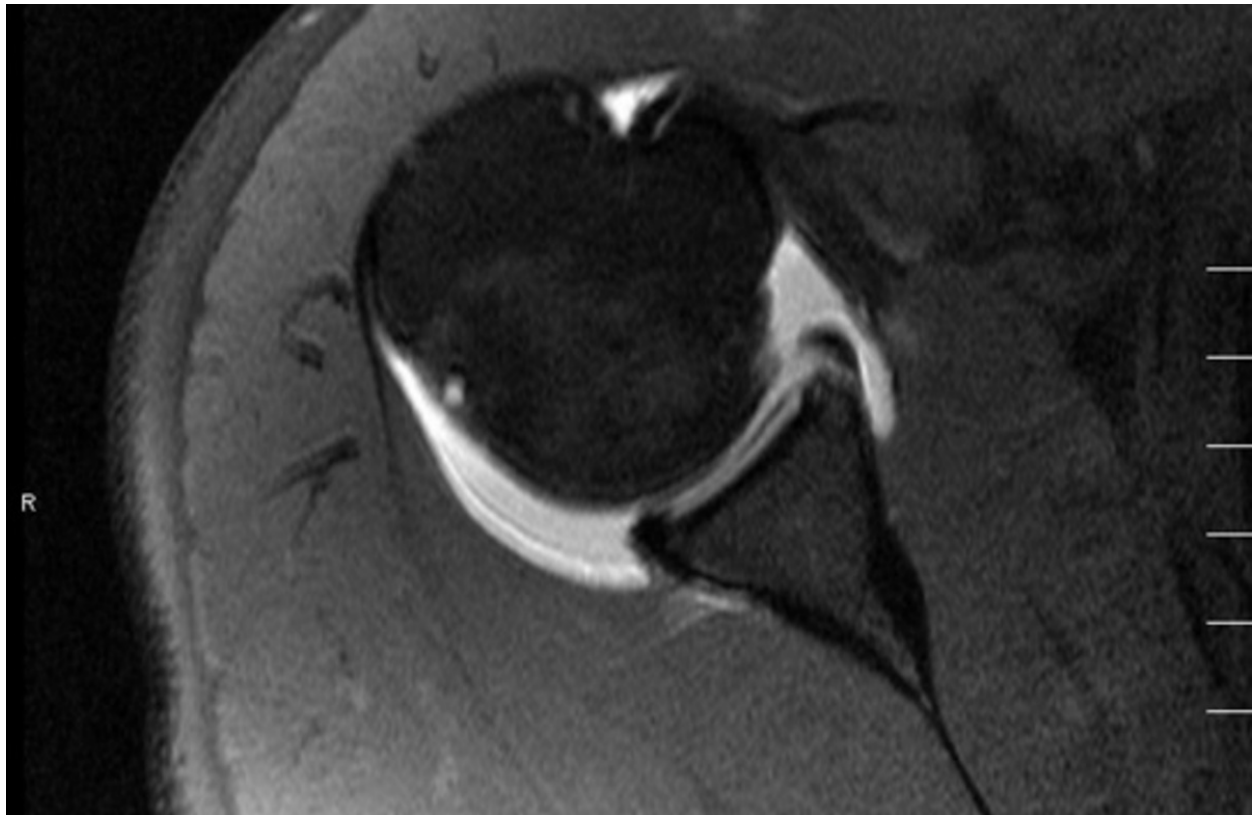


Fig. 12: GLAD injury: MR arthrogram shows cartilage defect and contrast entering the glenolabral junnction.

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Fig. 13: ALPSA injury. CT arthrogram in the axial and oblique sagittal. Note the defect in the anterior portion of glenoid in the coronal reformat. In the axial reformats, medial displacement with the labrum remaining attached to the periosteum (as in a sleeve)

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Fig. 14: Axial MR image of the shoulder (T1FS). Note the irregular contour of the synovial in the posterior recess, suggestive of synovitis. Contrast filling of the subacromial-subdeltoid bursa is also indicative of a full-thickness tear.

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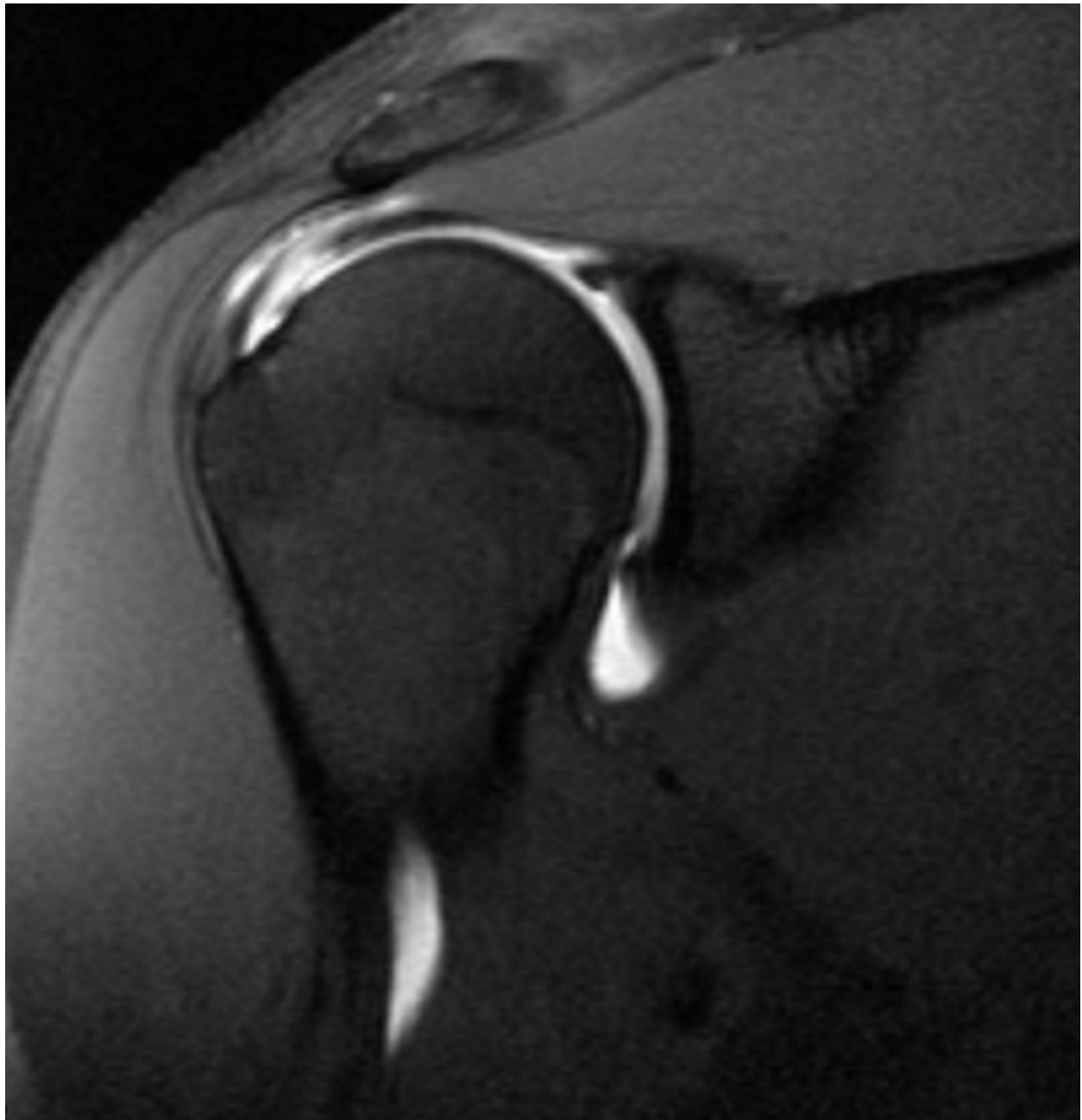


Fig. 15: Coronal MR Arthrogram (T1FS). Full thickness tear in the supra-spinatus, with contrast filling the subacromial-subdeltoid bursa.

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Conclusion

Direct arthrograms enhance the diagnostic accuracy of in the investigation of the unstable shoulder allowing a more accurate and confident detection and characterization of pathology.

Knowledge of the interventional procedure, of normal and pathological findings in imaging are essential for best patient care and for study reporting.

Personal information

References

Jung, J., et al., Comparison study of indirect MR arthrography and direct MR arthrography of the shoulder. *Skeletal Radiology*, 2009. 38(7): p. 659-667.

Rhee, R.B., et al., MR and CT Arthrography of the Shoulder. *Semin Musculoskelet Radiol*, 2012. 16(01): p. 003-014.

Dépelteau, H., et al., Arthrography of the Shoulder: A Simple Fluoroscopically Guided Approach for Targeting the Rotator Cuff Interval. *American Journal of Roentgenology*, 2004. 182(2): p. 329-332.

Schneider, R., B. Ghelman, and J.J. Kaye, A Simplified Injection Technique for Shoulder Arthrography. *Radiology*, 1975. 114(3): p. 738-739.

Rutten, M.J.C.M., et al., Glenohumeral joint injection: a comparative study of ultrasound and fluoroscopically guided techniques before MR arthrography. *European Radiology*, 2009. 19(3): p. 722-730.

Mulligan, M.E., CT-Guided Shoulder Arthrography at the Rotator Cuff Interval. *American Journal of Roentgenology*, 2008. 191(2): p. W58-W61.

Giacconi, J.C., et al., Morbidity of direct MR arthrography. *AJR Am J Roentgenol*, 2011. 196(4): p. 868-74.

Helms, C., et al., Magnetic resonance arthrography of the shoulder: accuracy of gadolinium versus saline for rotator cuff and labral pathology. *Skeletal Radiology*, 2011. 40(2): p. 197-203.

DW, S., Magnetic Resonance Imaging in Orthopaedics and Sports Medicine. 3rd Ed. Philadelphia: 2007: Lippincott Williams & Wilkins; .

de Jesus, J.O., et al., Accuracy of MRI, MR Arthrography, and Ultrasound in the Diagnosis of Rotator Cuff Tears: A Meta-Analysis. American Journal of Roentgenology, 2009. 192(6): p. 1701-1707.