MR arthrography of the shoulder: a pictorial educational review

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Learning objectives

1. To describe the benefits of MR arthrography (MRA) of the shoulder over conventional MRI.
2. To describe the technique of MRA, including both direct and indirect arthrography, and the potential benefits of both.
3. To illustrate a spectrum of pathological findings on MRA of the shoulder.
Background

MR arthrography (MRA) has enhanced the capability of conventional MRI in assessing articular pathology of the shoulder, as the contrast facilitates distension of the joint capsule and assessment of the intra-articular structures.

MRA is the preferred imaging technique for the investigation of patients with traumatic and non-traumatic shoulder instability and possible internal joint derangement. It provides accurate assessment of the glenohumeral joint, the rotator cuff, and the bicipital-labral-complex and has been shown to be superior to conventional MRI in the detection of full-thickness and partial-thickness tears, as well as labral tears with most studies reporting sensitivities and specificities of over 90% for the detection of labral lesions with this technique. (1)(2)

MR arthrography is the most accurate technique for diagnosing both full- and partial-thickness rotator cuff tears. In one meta-analysis, MR arthrography was found to be more sensitive and specific than either MRI or ultrasound for the detection of rotator cuff tears with no significant difference observed between MRI and ultrasound. (3) With the addition of fat-suppressed imaging techniques, full-thickness and partial cuff tears were identified with a sensitivity and specificity of 100% in one series. (4)

Conventional MR without intravenous or intra-articular contrast has been shown to be accurate in the detection of anterior labral tears, but poorly specific and less accurate in the detection of superior labral tears. (5) Compared to arthroscopy as the gold standard, direct MRA has a sensitivity of 82% and a specificity of 98% for the overall detection of SLAP lesions and 66% of SLAP lesions could be classified correctly. (6)
Both direct and indirect methods of arthrography have been described. The advantage of direct arthrography is that it distends the joint capsule allowing for separation of the intra-articular structures and better visualization of the labroligamentous complex. T1-weighted sequences, which offer the advantage of a faster image acquisition and higher signal-to-noise ratio, can be used instead of T2-weighted sequences. However, direct MR arthrography is invasive and requires image guidance and exposure to ionizing radiation, as well as additional time and expertise to inject contrast into the joint.

The technique involves supine positioning of the patient with the shoulder in external rotation, marking the skin just lateral to the humeral head cortex, inserting the needle under fluoroscopic guidance, confirming intra-articular needle placement with iodinated contrast material, and injection of dilute gadolinium solution prior to subsequent MR imaging. (7) Proper patient and needle positioning as well as accurate confirmation of intra-articular needle placement are critical to a successful and atraumatic shoulder arthrographic examination.

Traditional, contrast is injected via an anterior approach under fluoroscopic guidance, although other methods such as ultrasound and MR-guided techniques have been described. A posterior approach to injection has also been described. This has been found to be well tolerated by patients as well as avoiding the interpretative difficulties that may arise from extracapsular contrast extravasation when evaluating the anterior joint structures (8).

An alternative and less invasive technique is indirect MR arthrography. This involves the intravenous administration of contrast, which enhances the joint space to produce an arthrographic effect. (9) In one protocol, gadolinium was given at a dose of 0.2 ml/kg body weight up to a maximum of 15 ml. Thereafter, patients performed a succession of standard exercises consisting of abduction, adduction, and rotation of the shoulder for 15 min. (10) Indirect MRA is superior to conventional MR for the detection of labral tears of all types with reported sensitivities of 95 and 97% for indirect MRA compared to 79 and 83% for conventional MRI, with comparable specificities of 91%. (10) With regards to the detection of rotator cuff tears, one study reported that two radiologists improved their accuracy from 67% and 62% with conventional MRI to 92% and 96%, respectively, with indirect MR arthrography. (11) In addition, inflamed or vascularized tissues will enhance with this method. (12) The disadvantage of the technique is that it does not distend the joint space, which may limit the detection of subtle labral detachments. (10) Both methods are generally performed with fat-saturated axial, coronal oblique, and sagittal oblique T1-weighted sequences, as well as axial and coronal oblique T2-weighted sequences.

Both direct and indirect MRA have been shown to be comparable in their diagnostic accuracy, with no significant difference between the techniques in the detection of rotator cuff, labral, and long head of biceps tears. (13) Articular-surface partial-thickness tears
will demonstrate focal extension of contrast into the substance of the tendon while full-thickness tears will demonstrate contrast extending first through a defect in the tendon, most commonly in the rotator cuff, and into the subacromial-subdeltoid bursa.
Fig. 1: Fluoroscopic image of a left shoulder arthrogram with injection via an anterior approach.

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Fig. 2: MR arthrogram. SLAP (superior labral anterior posterior tear) lesion.

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Fig. 3: MR arthrogram. Hill-Sachs impaction fracture.

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**Fig. 4:** MR arthrogram. Detachment of the anterior inferior labrum from the glenoid with an associated impaction fracture (bony Bankart lesion).

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**Fig. 5:** MR arthrogram. Perthes lesion; the anterior labrum is lifted from the glenoid rim with a sleeve periosteum.

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Fig. 6: MR arthrogram. Posterior labral tear with a paralabral cyst.

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Fig. 7: MR arthrogram. Full thickness rotator cuff tear.

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Fig. 8: MR arthrogram. Superior labral tear with associated cyst.

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**Fig. 9:** MR arthrogram. There is a tear through the base of the anterior inferior labrum.

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**Fig. 10:** MR arthrogram. Anterior labroligamentous periosteal sleeve avulsion injury (ALPSA).

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Fig. 11: MR arthrogram. Anterior labroligamentous periosteal sleeve avulsion injury (ALPSA).

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Conclusion

MRA enhances the diagnostic accuracy of conventional MR imaging in the investigation of the unstable shoulder and can clearly delineate the exact location and degree of an abnormality for the operating surgeon. A thorough knowledge of the spectrum of possible imaging findings is essential for the reporting radiologist.
References