Non-contrast magnetic resonance imaging for diagnosing shoulder injuries

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ABSTRACT

Purpose. To compare preoperative non-contrast magnetic resonance imaging (MRI) with arthroscopy findings in diagnosing labral and rotator cuff tears. Methods. 86 men and 60 women aged 21 to 70 (mean, 52) years underwent non-contrast MRI before arthroscopic operations on the glenohumeral joint. Slices were made in a transverse, parasagittal, and paracoronar orientation. The sequences used were T2- and proton-weighted for paracoronar imaging, T1- and T2-weighted for transverse and parasagittal imaging, and T2-weighted sequences with fat suppression and short tau inversion recovery sequences. MRI was evaluated with the surgeon to eliminate interobserver bias. Arthroscopic surgery was performed by a single surgeon. If a labral or rotator cuff tear was found, surgery was performed using corkscrew anchors. Results. For full thickness rotator cuff tears, MRI and arthroscopy detected them in 76 and 82 patients, respectively. One such tear found by MRI could not be confirmed by arthroscopy. MRI missed 4 subscapularis and 3 supraspinatus tears. The sensitivity and specificity of MRI in diagnosing full thickness rotator cuff tears were 0.90 and 0.91, respectively. For labral tears, MRI and arthroscopy detected them in 16 and 31 patients, respectively. One anterior labral tear detected by MRI could not be verified by arthroscopy. All 16 labral tears detected by MRI were Bankart type-I tears (of the anterior glenoid) except for one superior labral tear from anterior to posterior (SLAP tear). All 13 SLAP tears (10 type 2 and 3 type 3) except for one could be found by arthroscopy only. The sensitivity and specificity of MRI in diagnosing labral tears were 0.52 and 0.89, respectively. Conclusion. Non-contrast MRI is reliable only for diagnosing full thickness rotator cuff tears and anterior labral tears. Direct or indirect contrast enhancement is recommended for more differentiation. Special scan orientation is necessary for SLAP tears.

Key words: arthroscopy; magnetic resonance imaging; rotator cuff; shoulder

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INTRODUCTION

Non-contrast magnetic resonance imaging (MRI) is widely used for diagnosing labral or rotator cuff lesions and planning surgical procedures. Other tools used are arthroscopy\(^1,^2\) and computed tomography.\(^3\) To obtain high-quality images, there should be no artefacts in the glenoid and humeral cartilage, spongiosa structure, subchondral bone, the glenoid labrum, muscles, tendons, and ligaments of the shoulder. Standard techniques for MRI sequences and cross-sections have been established. The shoulder should be shown in a transverse, parasagittal, and paracoronar orientation.\(^3\) To verify a rotator cuff tear, the sequences include non-contrast MRI, T2- and proton-weighted paracoronal imaging, T1- and T2-weighted transverse and parasagittal imaging, and T2-weighted sequences with fat suppression or short tau inversion recovery (STIR) sequences.\(^4\) This enables differentiation of normal variants from pathological findings,\(^5,^7\) for example differentiating a Buford complex (a congenitally missing anterior-superior labrum) from a labral tear. We compared preoperative non-contrast MRI with arthroscopy in diagnosing labral and rotator cuff tears.

MATERIALS AND METHODS

Between August 2005 and August 2009, 86 men and 60 women aged 21 to 70 (mean, 52) years underwent preoperative radiography (anterior-posterior and outlet views), ultrasonography, and non-contrast MRI before arthroscopic operations on the glenohumeral joint (Fig.). All patients had shoulder pain secondary to trauma and had failed conservative therapy (non-steroidal anti-inflammatory drugs and physiotherapy for >3 months).

Slices were made in a transverse, parasagittal, and paracoronar orientation. The sequences used were T2- and proton-weighted for paracoronal imaging, T1- and T2-weighted for transverse and parasagittal imaging, and T2-weighted sequences with fat suppression and STIR sequences. Two identical 1.5 tesla tomographs were used by 2 radiologists. MRI was evaluated with the surgeon to eliminate interobserver bias.

Arthroscopic surgery was performed in the beach chair position by a single surgeon. For glenohumeral joint distension, sterile Ringer lotion was applied through a pump with high flow and low pressure to avoid the inhibition of surrounding soft tissues. If a labral or rotator cuff tear was found, surgery was performed using corkscrew anchors.\(^1,^2\)

MRI and arthroscopic findings were compared using contingency tables.

RESULTS

For full thickness rotator cuff tears, MRI and arthroscopy detected them in 76 and 82 patients, respectively, according to the Bateman classification.\(^4\) One such tear noted by MRI could not be confirmed by arthroscopy. MRI missed 4 subscapular and 3 supraspinatus tears. 24 partial tears from both the articular side and the bursa side were found by arthroscopy only. Partial tears on MRI were shown as a bright range of signal varieties and were mostly incoherent. The S/N ratio of the sequences could not differentiate partial tears from artefacts, even when STIR sequences were used. The sensitivity and specificity of MRI in diagnosing full thickness rotator cuff tears were 0.91 (75/82) and 0.98 (63/64), respectively (Table).

For labral tears, MRI and arthroscopy detected them in 16 and 31 patients, respectively. One anterior
labral tear detected by MRI could not be verified by arthroscopy. All 16 labral tears detected by MRI were Bankart type-I tears (of the anterior glenoid), except for one superior labral tear from anterior to posterior (SLAP tear). All 13 SLAP tears (10 type 2 and 3 type 3 according to the Snyder classification) except for one were found by arthroscopy only. The slice orientations used for the superior labrum did not represent more than a cross-section of the labrum. The SLAP lesions could not be shown on the glenoid plane by MRI. The sensitivity and specificity of MRI in diagnosing labral tears were 0.48 (15/31) and 0.99 (114/115), respectively (Table).

**DISCUSSION**

Non-contrast MRI is reliable only for diagnosing full thickness rotator cuff tears and anterior labral tears; it is not reliable for diagnosing exact SLAP or partial rotator cuff tears. Partial tears are often misdiagnosed as normal variants. Direct or indirect contrast enhancement is recommended for more differentiation. Correct slice orientation is important for diagnosing rotator cuff tears. For supraspinatus or infraspinatus tears, the parasagittal orientation is useful, whereas for subscapular tears the transverse orientation should be used.

Tears found by MRI but not confirmed by arthroscopy could be due to a magic angle phenomenon, which is an artificial signal inhomogeneity caused by a certain angle of the magnetic impulse to the tissue leading to an unpixelled area. Nonetheless, non-contrast MRI can be used to evaluate muscle atrophy or fatty degeneration of the rotator cuff using parasagittal slices and predict the success rate of rotator cuff surgery in cases of atrophy.

Indirect or direct contrast enhancement is also beneficial for labral tears. It may avoid pitfalls such as the Buford complex or normal variants such as a sublabral anterior foramen. Exact classification of SLAP tears by non-contrast MRI is difficult. Contrast-enhanced MRI provides better results for the exact diagnosis of SLAP tears. Abduction and external rotation of the shoulder should be used for more detailed anatomic assessment of SLAP tears. Contrast enhancement by direct application into the joint space or intravenous application of a contrast medium like gadolinium for indirect arthrography broadens the range of MRI diagnostic possibilities, and should be part of the routine used for diagnosing shoulder injury.

**REFERENCES**