

A Review of the Role of Magnetic Resonance Imaging in the Evaluation of Shoulder Impingement Syndrome and Rotator Cuff Tendon Tears

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Abstract

The objective of this paper is to present a review of the role of magnetic resonance imaging in the evaluation of shoulder impingement syndrome and rotator cuff tendon tears. This imaging modality is effective in demonstrating both the soft tissue and bony abnormalities associated with structural shoulder impingement which include subacromial-subdeltoid bursitis, supraspinatus tendinopathy, rotator cuff tendon tears, subacromial osteophytic spurs and acromioclavicular joint capsular hypertrophy and osteophytosis. The detection of a subacromial osteophytic spur is considered specific for shoulder impingement syndrome.

The 3 most accurate magnetic resonance imaging signs of a full thickness supraspinatus tendon tear reported are: tendon discontinuity, musculotendinous junction retraction and supraspinatus tendon thinning. The most specific sign is tendon discontinuity and the most sensitive is subacromial-subdeltoid bursal fluid.

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Introduction

In the evaluation of chronic shoulder pain and dysfunction clinically suspected to be due to shoulder impingement syndrome and rotator cuff tendon tears, magnetic resonance imaging (MRI) has virtually replaced double contrast shoulder arthrography. MRI has the advantage of demonstrating the shoulder joint in multiple anatomical planes with excellent tissue contrast resolution. MRI has the potential to complement shoulder arthroscopy and provides the surgeon with valuable pre-treatment information.

Shoulder Impingement Syndrome

Shoulder impingement syndrome is a clinical and not an imaging diagnosis. Three clinical findings that can be detected in this syndrome are the painful arc syndrome, the impingement sign and the impingement test.^{1,2}

The recognition of shoulder impingement syndrome as a cause of shoulder pain and dysfunction was documented in the British orthopaedic literature in 1949.³ The concept of shoulder impingement syndrome is based on the complex anatomy of the shoulder joint and the movement at the glenohumeral articulation.

There are 3 key anatomical structures and these are the coracoacromial arch, the subacromial-subdeltoid bursa and the rotator cuff muscles and tendons. The coracoacromial arch is formed by the acromion, the

coracoid and the coracoacromial ligament and constitutes a bony-ligamentous arch at the superior margin of the subacromial space. Under the coracoacromial arch lies the subacromial-subdeltoid bursa which intervenes between the arch superiorly and the rotator cuff muscles and tendons inferiorly. All 3 anatomical structures can readily be demonstrated with MRI in multiple imaging planes.

Shoulder impingement syndrome refers to the condition in which the supraspinatus tendon and the subacromial-subdeltoid bursa are chronically entrapped between the humeral head inferiorly and either subacromial osteophytic spurs, the coracoacromial ligament or the acromioclavicular joint superiorly with aggravation during abduction, external rotation and anterior elevation of the upper limb.⁴ Neer² believed that 95% of rotator cuff tendon tears were caused by structural shoulder impingement.

MRI in both the coronal and sagittal oblique planes is effective in demonstrating the soft tissue as well as bony abnormalities in shoulder impingement syndrome. These include subacromial-subdeltoid bursitis, supraspinatus tendinopathy, rotator cuff tendon tears, subacromial osteophytic spurs and acromioclavicular joint capsular hypertrophy and osteophytosis^{5,6} (Fig. 1). Resnick⁷ stated that the MR demonstration of a subacromial osteophytic spur is specific for shoulder impingement syndrome. A

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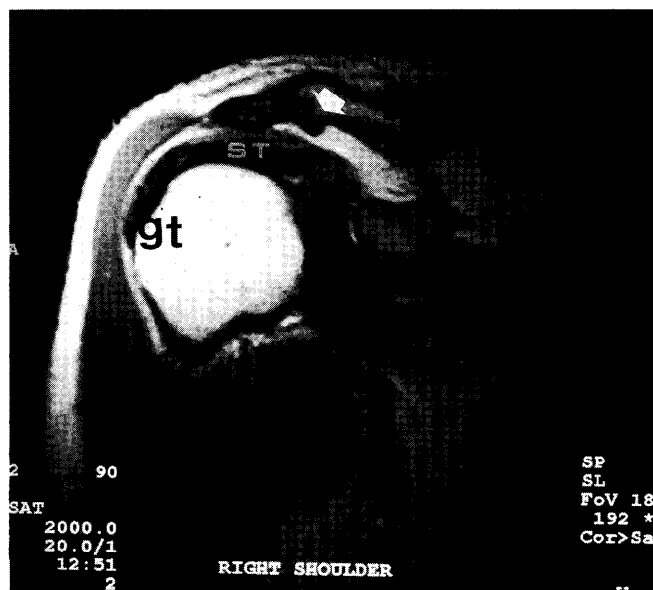


Fig. 1. This coronal oblique proton density weighted image of the right shoulder joint shows acromioclavicular joint osteoarthritis with capsular hypertrophy and osteophyte formation (white arrow). There is structural impingement on the subacromial fat at the anterior-superior surface of the supraspinatus muscle (ST: supraspinatus tendon, GT: greater tuberosity of the humerus).

potential imaging pitfall is the deltoid tendon attachment to the acromion which may be mistaken for a subacromial osteophytic spur (subacromial pseudospur) when not imaged in continuity^{8,9} (Fig. 2). The tendon of the long head of the biceps muscle may also be compressed. A SLAP (superior labrum, anterior and posterior) injury involves a tear of the superior glenoid labrum

with extension into the proximal biceps tendon. These structures will show diffuse hyperintense areas on T2 weighted images.¹⁰

Lateral down-sloping acromion on coronal oblique images is not a reliable diagnostic sign of structural impingement.¹¹ More promising is the sagittal oblique plane which can demonstrate the type of acromial morphology. There are 3 different morphological types of acromion based on the shape of the undersurface of this structure and these are believed to be developmental variations. Type 1 has a flat undersurface, type 2 shows a concave and curved undersurface and type 3 exhibits an anteroinferior hook at the anterior edge of the undersurface (Fig. 3). The type 3 acromion has been reported to be significantly associated with full thickness rotator cuff tendon tears.^{12,13}

Magnetic Resonance Imaging of Rotator Cuff Tendon Tears

MRI has been employed in the evaluation of rotator cuff tears for over a decade. Several studies have shown excellent correlation between MRI and either arthroscopic or surgical findings with regard to the presence, site and size of a tendon tear and also the condition of the torn tendon edges.¹⁴⁻¹⁶ Isolated tears of the subscapularis and teres minor muscle tendons are uncommon and usually occur with extensive tears of the supraspinatus and infraspinatus muscle tendons.¹⁷

The 3 most accurate MRI signs of a full thickness rotator cuff tendon tear are tendon discontinuity, musculotendinous junction retraction and supraspinatus



Fig. 2a.

Fig. 2. Fig. 2a is a coronal oblique T1 weighted image showing a subacromial pseudospur (white arrow). Fig. 2b is a sagittal oblique T2 weighted image which does not confirm the presence of a true subacromial osteophytic spur as suggested in the coronal oblique image. The acromion process (black arrow) and the coracoclavicular ligament (curved black arrow) are indicated (SS: supraspinatus muscle, ST: supraspinatus tendon).

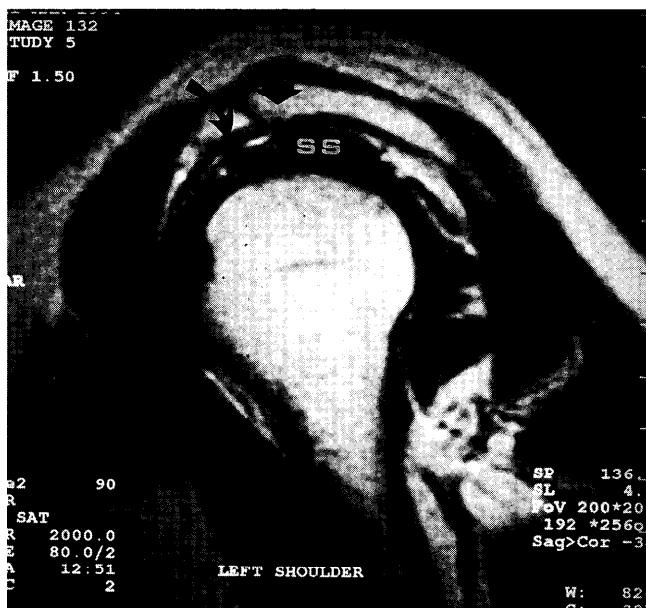


Fig. 2b.



Fig. 3. This sagittal oblique proton density weighted image demonstrates a type 2 acromial morphology (white arrow). Note the concave and curved undersurface of the acromion. The supraspinatus muscle is situated inferiorly (SS: supraspinatus muscle, IS: infraspinatus muscle, TM: teres minor muscle).

tendon thinning. The most specific MRI sign is tendon discontinuity and the most sensitive is subacromial-subdeltoid bursal fluid. The appearance of the subacromial-subdeltoid fat plane is not a reliable diagnostic sign.¹⁸⁻²⁰

An intermediate signal intensity focus in a rotator cuff tendon on T1 weighted images that does not become

more hyperintense on T2 weighted images is considered to represent either degeneration or tendinopathy and not a tear. If the focus becomes more hyperintense on T2 weighted images, then a tear is considered to be present. MRI is not able to reliably differentiate tendon degeneration from tendinopathy or tendinosis.²¹

A full thickness rotator cuff tendon tear is a defect that allows communication between the glenohumeral joint and the subacromial-subdeltoid bursa. On MRI, a full thickness tear of the supraspinatus tendon is seen as a sizeable hyperintense area representing fluid in the tendinous defect on T2 weighted images. The hyperintense area should extend through the entire thickness of the tendon from the synovial to the bursal surfaces to qualify as a full thickness tear. A full thickness tear may be present without musculotendinous junction retraction (Fig. 4). In contradistinction, a partial thickness tear would be a more focal hyperintense area in the tendon that cannot be traced from one surface to the other. A partial thickness rotator cuff tendon tear may be intratendinous or situated at either the bursal or articular surface of the rotator cuff tendon.

A possible cause for a false positive MRI diagnosis is supraspinatus "pseudotendinopathy".^{8,9} In normal subjects, an intermediate signal intensity focus may be seen about 1 cm proximal to the insertion of the supraspinatus tendon on to the greater tuberosity of the humerus i.e. the critical zone. This intermediate signal intensity focus contrasts well with the hypointensity of the rest of the tendon and remains unchanged in signal intensity on

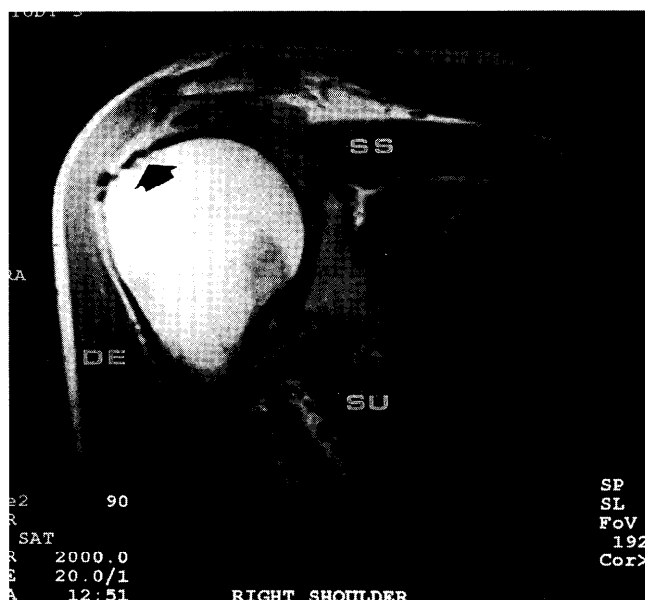


Fig. 4a.

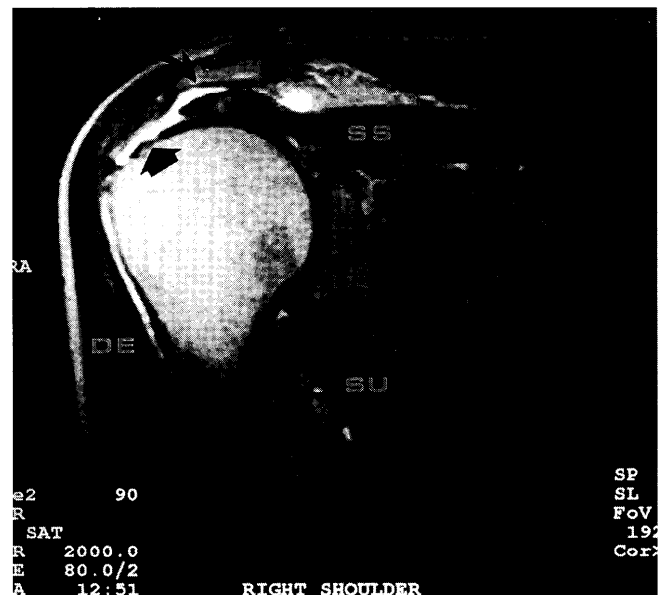


Fig. 4b.

Fig. 4. The figures represent coronal oblique proton density and T2 weighted images respectively of the right shoulder joint. The proton density image shows loss of the normal signal intensity of the distal supraspinatus tendon (black arrow). The corresponding T2 weighted image shows this area to become markedly hyperintense indicating fluid in a tendon defect (black arrow). Fluid also tracks superiorly into the subacromial-subdeltoid bursa (curved black arrow). The imaging diagnosis was a full thickness tear. Open surgery confirmed a 4 cm full thickness tear with a hypertrophied bursa. Repairs of the torn tendon and bursectomy were performed (SS: supraspinatus muscle, SU: subscapularis muscle, DE: deltoid muscle).

all pulse sequences. The "magic angle" effect (a MRI physics phenomenon) has been invoked to explain this finding which may lead to the erroneous MRI diagnosis of a tendon tear.^{22,23}

The differentiation of full and partial thickness rotator cuff tendon tears is an important diagnostic challenge faced by the radiologist in the interpretation of MRI of the shoulder joint. The reported sensitivity and specificity for the diagnosis of full thickness rotator cuff tendon tears are 100% and 95%, respectively. For partial thickness rotator cuff tendon tears, the reported sensitivity and specificity fall to 82% and 85%, respectively. The main difficulty appears to be differentiating partial from small full thickness rotator cuff tendon tears.²⁴⁻²⁶

If MRI can reliably detect partial thickness tears in symptomatic patients, this group can be managed medically initially and arthroscopy reserved for those who fail to respond to conservative measures. Arthroscopic decompression with anterior acromioplasty and tendon repair may be performed for those with full thickness tears.^{27,28}

MRI in Relation to other Imaging Modalities in the Evaluation of Rotator Cuff Injuries

Before the introduction of MRI, double contrast shoulder arthrography was used in the investigation of suspected full thickness rotator cuff tendon tears. Intratendinous tears and partial thickness tears on the bursal surface could not be detected. Arthrography does not permit assessment of the state of the torn tendon margins. It is an invasive procedure and false negative studies for full thickness tears are known to occur when the tendon defect is closed off by fibrous scar tissue.^{29,30}

Ultrasound is a highly operator-dependent technique which requires a significant learning curve period before reliable results can be expected. It is a non-invasive procedure and is much less costly and time consuming than MRI. Some studies have suggested that ultrasound can be as effective as arthrography and MRI in the diagnosis of full thickness tears.^{31,32}

Following a plain radiograph series, MRI is the preferred imaging modality of choice in the investigation of patients presenting with chronic shoulder pain and dysfunction.³³ The use of new fast spin echo sequences has significantly shortened the time of acquisition of T2 weighted images.^{34,35} It can be anticipated that cost differences would be a major factor in deciding which imaging modality would ultimately be chosen.³⁶

Conclusion

Where available, MRI has become the imaging modality of choice in the evaluation of patients with suspected shoulder impingement syndrome and rotator cuff tendon tears. It can provide the surgeon with valuable pre-

treatment information as to the presence, site, size of a torn tendon and also the condition of the torn tendon edges. MRI is unique in being able to provide global demonstration of both soft tissue and bony structural abnormalities in the shoulder joint with multiplanar imaging capability and excellent tissue contrast resolution. With new fast spin echo sequences, the overall imaging time for MRI has been shortened with no compromise in image quality.

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