



Sensitivity and Specificity in Detection of Labral Tears with 3.0-T MRI of the Shoulder

Thomas H. Magee¹
David Williams

OBJECTIVE. MRI of the shoulder has been found to be sensitive and specific for detection of labral tears at 1.5 T or lower field strength compared with arthroscopy, whereas 3.0-T MRI of the shoulder has not been specifically assessed. This study assesses the sensitivity and specificity of MRI at 3.0 T for labral tears compared with arthroscopy.

CONCLUSION. MRI of the shoulder at 3.0 T is very sensitive and specific compared with arthroscopy in detection of superior, anterior, and posterior labral tears.

MRI of the shoulder has been found to be accurate in the diagnosis of labral tears. In previous studies, conventional MR sensitivity in detection of labral tears has ranged from 44% to 93% sensitivity compared with arthroscopy [1, 2]. Two recent studies have assessed conventional MRI evaluation of the glenoid labrum using a 0.2-T extremity MR system. Shellock et al. [3] found a sensitivity of 89% and a specificity of 100% for detection of labral tears compared with arthroscopy on a 0.2-T MR system. Zlatkin et al. [4] found a sensitivity of 55% and a specificity of 100% for detection of labral tears compared with arthroscopy on a 0.2-T MR system.

Shoulder MR arthrography has been reported to be more sensitive and specific for detection of labral tears compared with conventional shoulder MRI in several previous studies performed at 1.5-T or lower field strength. Applegate et al. [5] found shoulder MR arthrography to be highly accurate for assessing the glenoid labrum in patients with chronic labral tears. Magee et al. [6] found shoulder MR arthrography to be more sensitive for detection of labral tears than conventional shoulder MRI. Palmer and Caslowitz [7] showed a 92% sensitivity and specificity for MR arthrograms in detection of labral lesions. Chandnani et al. [1] found shoulder MR arthrography to be more accurate than conventional shoulder MR examination in detection of labral lesions. Jee et al. [8] found MR arthrography to be highly accurate in detection of superior labral anteroposterior (SLAP) tears. None of these studies was performed on a 3.0-T MR scanner.

To our knowledge, the sensitivity and specificity of 3.0-T MRI of the shoulder for detection of labral tears compared with arthroscopy has not been specifically assessed. We undertook a retrospective review of 100 shoulder MRI examinations to determine the sensitivity and specificity of shoulder imaging at 3.0 T for superior, anterior, and posterior labral tears at 3.0 T.

Materials and Methods

Two experienced musculoskeletal radiologists retrospectively reviewed 3.0-T MR scans of the shoulder in 100 consecutive patients. MRI examinations were assessed for the presence or absence of superior, anterior, or posterior labral tears. Other findings (such as supraspinatus tendon tears) were not included in this retrospective review. Interpretations were performed by consensus review. Any MR arthrography performed in addition to conventional MRI was not included in the retrospective consensus review.

MRI examinations were performed between October and December 2004. The age range of the 100 patients was 14–71 years (mean age, 42 years). The 100 patients all presented with shoulder pain, instability, or both. There was no selection bias for placing patients on the 3.0-T MR scanner because our practice consists exclusively of 3.0-T MR scanners.

All patients underwent MRI of the shoulder in oblique coronal, oblique sagittal, and axial planes on a 3.0-T Signa scanner (GE Healthcare). Oblique coronal and sagittal fast spin-echo T1-weighted (TR/TE, 550/10; number of excitations [NEX], 2), oblique coronal and sagittal fast spin-echo intermediate-weighted (3,850/55; NEX, 4), and fast spin-echo intermediate-weighted axial (3,250/55; NEX, 3) sequences with a field of view

Keywords: labral tears, MRI, shoulder

DOI:10.2214/AJR.05.0338

Received February 27, 2005; accepted after revision June 13, 2005.

¹Both authors: Department of Radiology, Neuroskeletal Imaging, 255 N Sykes Creek Pkwy., Merritt Island, FL 32953. Address correspondence to T. H. Magee (tmageerad@cfl.rr.com).

AJR 2006; 187:1448–1452

0361–803X/06/1876–1448

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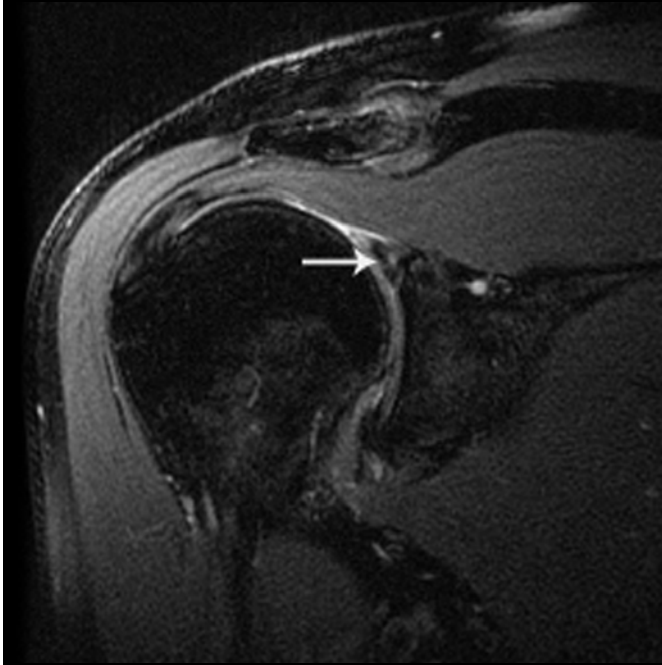


Fig. 1—47-year-old man with shoulder pain. Coronal fast spin-echo intermediate-weighted (TR/TE, 3,850/55) MR image shows findings consistent with superior labral anteroposterior (SLAP) tear (*arrow*). Patient had surgically proven SLAP tear.

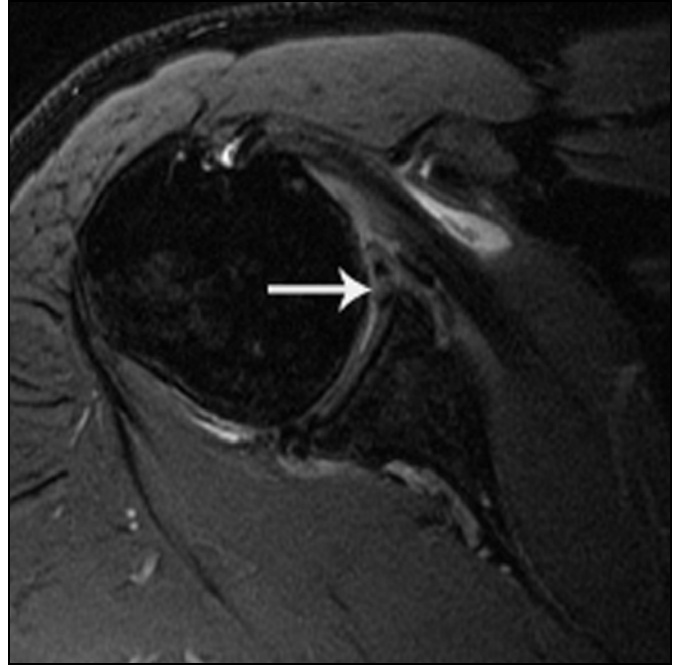


Fig. 2—38-year-old man with shoulder instability. Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings consistent with anterior labral tear (*arrow*). Patient had surgically proven anterior labral tear.



Fig. 3—35-year-old man with shoulder pain and instability. Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings consistent with posterior labral tear (*arrow*). Patient had surgically proven posterior labral tear.

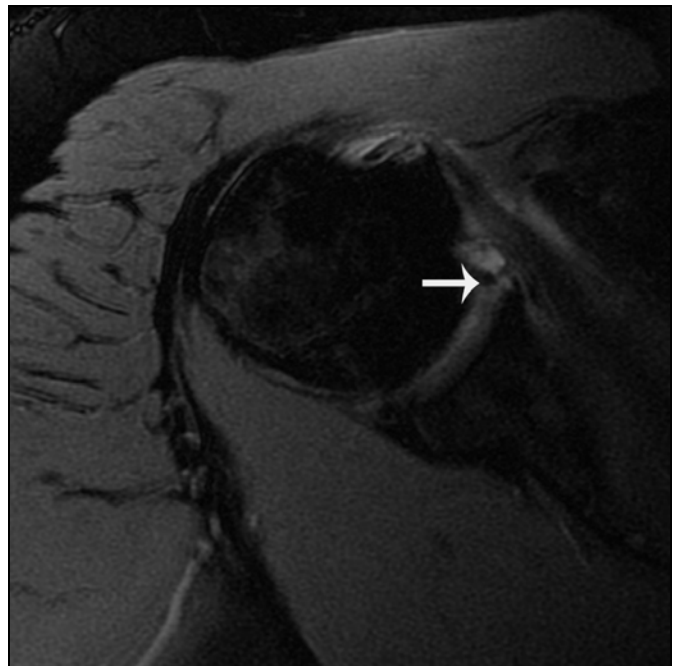


Fig. 4—28-year-old man with shoulder instability. Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings consistent with anterior labral tear (*arrow*). Patient had surgically proven anterior labral tear.

Fig. 5—37-year-old woman with shoulder pain. Coronal fast spin-echo intermediate-weighted (TR/TE, 3,850/55) MR image shows findings consistent with superior labral anteroposterior (SLAP) tear (arrow). Patient had surgically proven SLAP tear.



of 14 cm on all images were used. Slice thickness was 4 mm with a 10% interslice gap on all sequences except the fast spin-echo intermediate-

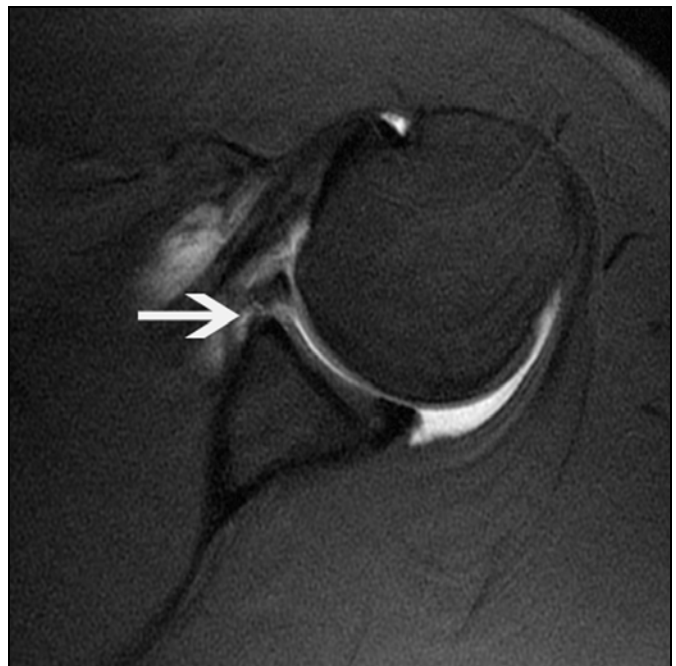
weighted axial sequence, which had a 3-mm slice thickness. The echo-train length was 10 on all T2-weighted and proton-density sequences and 3 on

the T1-weighted sequences. The bandwidth was 31.25 kHz on all sequences. The imaging time for the coronal and sagittal T2-weighted sequences was 4 minutes 43 seconds. The imaging time for the axial intermediate-weighted sequences was 3 minutes 26 seconds, whereas the imaging time for the T1-weighted sequences was 2 minutes 28 seconds. The matrix for all intermediate-weighted images was 320×320 , and the matrix on all T1-weighted images was 320×256 . A three-channel phased-array shoulder coil was used.

All 100 patients had their MRI examinations retrospectively interpreted by consensus of two reviewers. The reviewers were blinded to the results of arthroscopy at the time of consensus review. Consensus was achieved when both reviewers agreed that a superior, anterior, posterior, or combined labral tear was present or not present on an MRI examination. Retrospective MR interpretations were then correlated with results in those patients who underwent arthroscopy ($n = 67$). The surgeons were aware of prospective MR interpretations before the patients underwent arthroscopy. The MR criterion used for diagnosis of a labral tear was an abnormality of the glenoid labrum morphology, signal intensity, or both. All arthroscopies were performed within 4 weeks of the MRI examination.



A



B

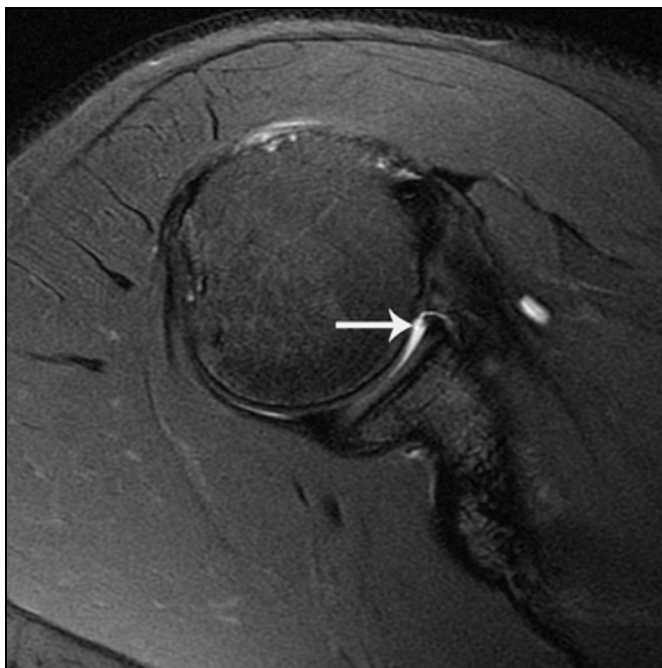
Fig. 6—19-year-old man with shoulder pain and instability. Patient had surgically proven anterior labral tear.

A, Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings that could not be definitively described as anterior labral tear (arrow) by either MR reviewer.

B, Axial fat-saturated T1-weighted MR arthrogram (550/10) shows findings consistent with displaced anterior labral tear (arrow). This was confirmed at arthroscopy. MR arthrography images were not included in consensus retrospective MR review. Displaced labral tear could be definitively seen only at MR arthrography in this case.

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Fig. 7—24-year-old man with shoulder pain and instability. Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings that could not be definitively described as anterior labral tear (*arrow*) by either MR reviewer. Patient had surgically proven anterior labral tear.

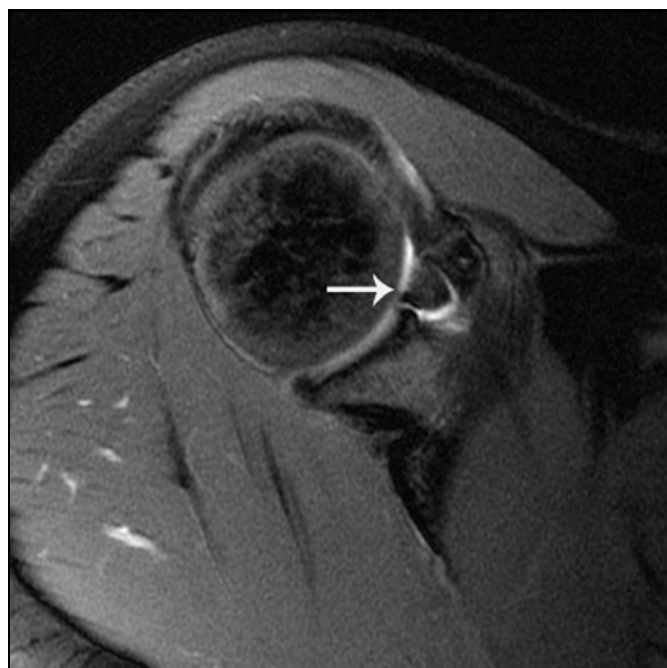


Results

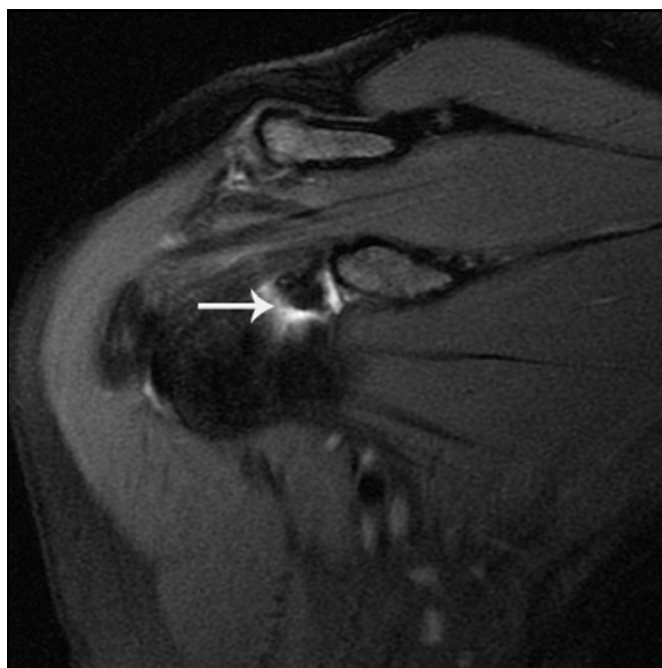
Of the 67 patients who went on to arthroscopy, 42 patients had a total of 46 labral tears. Twenty-one patients had SLAP tears. Eighteen patients had anterior labral tears, and seven patients had posterior labral tears. Three patients had both a SLAP tear and an anterior labral tear, and one patient had a SLAP tear and a posterior labral tear.

Nineteen of the 21 SLAP tears seen at arthroscopy were seen on retrospective consensus MRI review. Sixteen of the 18 anterior labral tears and six of the seven posterior labral tears seen at arthroscopy were seen on retrospective consensus MRI review.

In this study, MRI sensitivity for detection of SLAP tears was 90% (19 of 21 full-thickness supraspinatus tendon tears seen at arthroscopy were seen on MRI) and specificity was 100%. MRI sensitivity for detection of anterior labral tears was 89% (16 of 18 anterior labral tears seen at arthroscopy were seen on MRI) and specificity was 100%. MRI sensitivity for detection of posterior labral tears was 86% (six of seven posterior labral tears seen at arthroscopy were seen on MRI) and specificity was 100% (Figs. 1–8).



A



B

Fig. 8—42-year-old woman with shoulder pain. Patient had surgically proven superior labral anteroposterior (SLAP) tear.

A, Axial fast spin-echo intermediate-weighted (TR/TE, 3,250/55) MR image shows findings that could not be definitively described as anterior labral tear (*arrow*) by either MR reviewer. Even in retrospect after arthroscopy results were known, this had appearance of sublabral foramen to both MR reviewers.

B, Coronal fast spin-echo intermediate-weighted (3,850/55) MR image shows findings both MR reviewers considered to be appearance of sublabral foramen (*arrow*).

Discussion

MRI of the shoulder at 3.0 T is highly sensitive and specific for the detection of labral tears compared with arthroscopy. Previous studies have shown MRI at 1.5-T field strength or less to be sensitive for detection of labral tears [1, 2]. To our knowledge, shoulder imaging at 3.0 T has not been specifically assessed.

In this study, 3.0-T MRI without intraarticular contrast material was highly sensitive and specific in the detection of SLAP, anterior labral, and posterior labral tears with sensitivities at or above those achieved with 1.5-T MRI. In addition, there were no false-positive readings of labral tears at MRI that were not seen at arthroscopy. The consensus interpretations were highly specific.

Two SLAP tears, two anterior labral tears, and one posterior labral tear were not seen on prospective MRI consensus review but were seen at arthroscopy. In one case at arthroscopy, a SLAP tear was described and an anchor was placed. On consensus MRI review, this was thought to represent a sublabral foramen. Even when arthroscopy results were known and MR images were retrospectively reviewed, it was thought this represented a sublabral foramen (Fig. 8).

One surgically proven displaced anterior labral tear was not seen on retrospective consensus MRI review of conventional shoulder MR images. In this case the patient also had an MR arthrogram. The displaced anterior labral tear was seen on the MR arthrogram but not on conventional MR images. The MR arthrography images were not included in retrospective MRI consensus review (Fig. 6).

The other SLAP tear, anterior labral tear, and posterior labral tear were not seen on prospective MRI consensus review but were seen at arthroscopy. These three tears were

all débrided by the orthopedic surgeon. The three tears were not seen even on retrospective review after arthroscopy results were known. It is possible these were nondisplaced tears that may have been visible if MR arthrography was performed. However, in each of the three cases, the orthopedic surgeons indicated that surgery was performed for reasons other than a labral tear. A prospective MRI review of a labral tear in these cases would not have affected the decision to perform arthroscopy.

MRI at 3.0 T allows a higher signal-to-noise ratio (SNR) compared with 1.5-T MRI. The spin-spin relaxation time, T2, remains fairly constant at different field strengths. However, the spin-lattice relaxation time, T1, increases as the field strength increases. Therefore, at 3.0 T, the TR must be longer than on 1.5-T MR scanners to maximize the SNR gain. At 3.0 T, the TR must be longer to attain the same type of contrast on T1-weighted images as seen on a 1.5-T scanner. Also on 3.0-T MR scanners, the TE must be slightly shorter than on 1.5-T MR scanners to account for decreased T2 relaxation time [9].

The parameters used on our shoulder imaging have a slightly increased TR and a slightly decreased TE on all sequences compared with parameters previously used on our 1.5-T MR scanner. This was done to optimize our SNR on the 3.0-T MR scanner.

Limitations of this study include its retrospective nature and the fact that MR images were interpreted by consensus rather than independently. Most of our referrals came from orthopedic surgeons. These patients have a high prevalence of positive findings on MRI. The surgeons were aware of prospective MRI interpretations before arthroscopy. This may have biased their arthroscopy results.

In conclusion, MRI of the shoulder at 3.0 T is highly sensitive, specific, and accurate in the diagnosis of labral tears compared with arthroscopy.

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