Mod Rheumatol (2001) 11:140–144

ORIGINAL ARTICLE

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Diagnostic imaging of unstable superior glenoid labral detachment: a comparison between MR arthrography and unenhanced MRI

Received: December 13, 2000 / Accepted: January 10, 2001

Abstract We compared efficacy of magnetic resonance arthrography (MRA) and magnetic resonance imaging (MRI) for the detection of superior glenoid labral detachment, and especially unstable superior labrum anterior–posterior (SLAP) type 2 lesions. MR imagings and MR arthrograms of 90 shoulders of 90 patients, including 30 shoulders of unstable SLAP 2 lesions, were interpreted by a novice and an expert observer. These results were correlated with arthroscopic findings. For the expert observer, MRI had a sensitivity of 53%, a specificity of 93%, and an accuracy of 80%, which were improved to 60%, 98%, and 85%, respectively, by MRA. These increases were statistically insignificant. For the novice observer, MRI had a sensitivity of 45%, a specificity of 80%, and an accuracy of 64%, which were significantly improved to 76%, 83%, and 80%, respectively, by MRA. In detecting unstable SLAP 2 lesions, MRA proved to be useful to a novice interpreter, but not significantly useful to an experienced interpreter, compared with unenhanced MRI. We advocate MRA as the examination of first choice for detecting unstable SLAP 2 lesions if they are strongly suspected clinically.

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Key words Interobserver difference · MR arthrography · MRI · Shoulder · SLAP lesion

Introduction

Although there has been an increasing awareness of the importance of superior glenoid labral injury of the shoulder as detected by advances in arthroscopy,[1,2] its pathophysiology and diagnostic modalities are still not established.[3,4] However, the biceps tendon labrum complex (BLC), that is formed from the superior labrum, the long head of the biceps (LHB), and the superior glenohumeral ligament, has been clarified by biomechanical studies.[5] A detached and floating BLC, which is identical to the so-called unstable superior labrum anterior–posterior (SLAP) type 2 lesion, has been regarded as the most important clinical entity.[6] This is the only lesion that results in gross instability of the BLC due to the discontinuity of its attachment to the superior glenoid neck.

The efficacy of diagnostic imaging for superior labral injury is still a controversial issue. Previous studies have used computed tomography (CT) arthrography,[7,8] magnetic resonance imaging (MRI),[9–11] and magnetic resonance arthrography (MRA),[12–14] all of which gave favorable results. However, the majority of these studies used only a small group of patients or did not include a control group, which makes them less credible. In addition, the patients in these studies had superior labral lesions other than unstable SLAP 2 lesion, such as fraying or bucket-handle tears, which are not as important clinically. In this work, we studied the efficacy of MRA and MRI on the diagnosis of unstable SLAP 2 lesions.

Materials

From a consecutive series of 190 arthroscopic shoulder surgeries, 90 shoulders of 90 patients fulfilling our criteria

were used in the study. The selection of the patients depended on the availability of the MR images and reports, and a completed shoulder arthroscopic study with videotapes and reports. There were 67 men and 23 women, whose ages ranged from 13 to 56, and averaged 27 years. Thirty patients were finally diagnosed arthroscopically as having an unstable SLAP 2 lesion. The control group comprised 60 patients. These were diagnosed with anterior instability in 43 patients, articular side partial rotator cuff tear in 10 patients, subacromial bursitis in 3 patients, and other problems in 4 patients. There were no superior labral injuries in any patients in the control group. There were four patients in the control group whose superior labrum attached to the glenoid rim with a sulcus, which is a normal variant. Normally, the superior labrum directly attaches to the glenoid surface, but the normal variant with a sulcus shows very proximal attachment to the glenoid rim that produces a sulcus between the glenoid rim and the superior labrum.

Arthroscopic evaluation of each shoulder was performed by a single experienced orthopedic surgeon (MY) who knew the results of the MR examination. The surgeon diagnosed an unstable SLAP 2 lesion when the labral injury was located between the 10 o'clock and 2 o'clock positions, and when the attachment to the superior glenoid neck was detached medially, rendering the BLC unstable. The stability of the detached labrum was tested with a hooked instrument (Fig. 1).

MR scanning technique

Imaging was performed on one of two different clinical magnet systems. For MRI without arthrography, a permanent magnet system (0.3-T Hitachi MRP 20, Hitachi Medical, Japan) with a dedicated solenoidal coil was used. T1-weighted images were obtained by the spin–echo method (repetition time (T_R) 400–500/echo delay time (T_E) 25), and T2*-weighted images were acquired by the field–echo method (T_R 500–700/T_E 35/flip angle (A_F) 30°). The slice thickness was 7 mm without an interslice gap in oblique coronal (perpendicular to the glenoid surface), oblique sagittal (parallel to the glenoid surface), and axial planes. Eight scans were obtained in the oblique coronal and axial planes, and 11 scans were obtained in the oblique sagittal plane in all patients. The field of view was 16 cm, two signals were averaged, and the matrix was 256 × 256 in all planes. MR arthrography was performed by injection with 20 ml of a 1.25 mmol/l solution of gadolinium diethylenetriamine pentaacetic acid: Gd-DTPA (Magnevist, Nihon-Schering, Japan) and saline. Scans were acquired immediately after intraarticular injection using a superconducting magnet system (1.0-T Shimazu SMT100, Shimazu Medical, Japan) with a dedicated surface coil. T1-weighted images were obtained by the spin–echo method (T_R 500/T_E 20). The slice thickness was 5 mm without an interslice gap in the oblique coronal, oblique sagittal, and axial planes. Nine scans were obtained in the oblique coronal and axial planes, and 12 scans were obtained in the oblique sagittal plane in all patients. A 16-cm field of view and a 256 × 256 matrix was used, and two signals were averaged in all planes. During all imaging procedures, the patient's arm was placed in the palm-up position to put the humerus in neutral rotation.

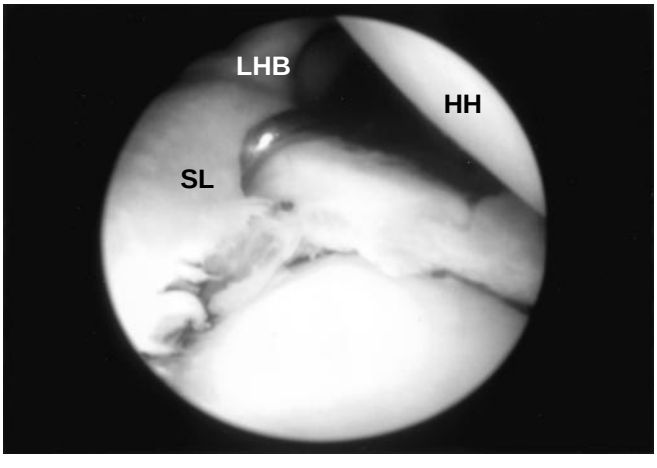

Fig. 1. Detached and floating biceps tendon labrum complex. *LHB*, tendon of the long head of the biceps; *HH*, humeral head; *SL*, superior labrum

Interpretation of MR scans

Two observers (KI, SN) individually evaluated each scan of the preoperative MRA and MRI retrospectively to detect any abnormal findings in the unstable SLAP 2 lesion without any kind of clinical information about the patients. Both observers, one was experienced in diagnostic imaging of the shoulder (observer 1) and the other was a novice (observer 2), were aware of the normal appearance of the labrum on MR imaging and MR arthrograms from prior published studies[15–17] and had seen previous teaching cases with surgical correlation. We had already proved a specific MRI finding of an unstable SLAP 2 lesion in the presence of a linear, high-to-intermediate-intensity area between the superior glenoid labrum and the glenoid rim on oblique coronal T2*-weighted images that passed through the center of the glenoid fossa in our previous comparative study using MRI and CT arthrography[18] (Fig. 2). The linear high-intensity area is not strictly linear, but irregular. Therefore, a specific MRA finding in this study was regarded as a similar finding on oblique coronal T1-weighted images (Fig. 3), and the axial and sagittal images obtained in both of these procedures were not evaluated for this study. The McNemar test and a χ^2 distribution were used for the statistical evaluation of the differences in diagnostic values.

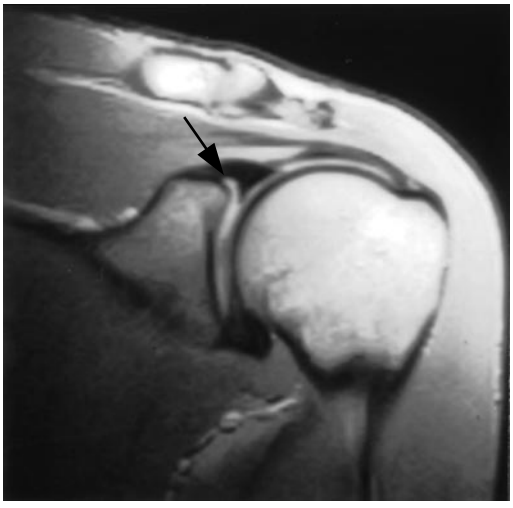

Fig. 2. MRI appearance of a detached superior glenoid labrum (*arrow*). The linear high-intensity area between the superior labrum and the glenoid rim on an oblique coronal T2*-weighted image that passed through the center of the glenoid fossa

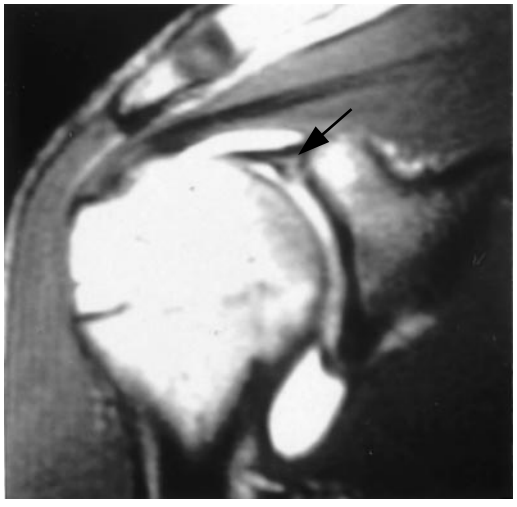

Fig. 3. MRA appearance of a detached superior glenoid labrum (*arrow*). Linear high-intensity area between the superior labrum and the glenoid rim on an oblique coronal T1-weighted image that passed through the center of the glenoid fossa

Results

Diagnostic values (Tables 1 and 2)

On MR imagings, observer 1 correctly identified 16 of the 30 unstable SLAP 2 lesions and 56 of the 60 intact superior labrum (sensitivity 53%, specificity 93%, and accuracy 80%), and on MR arthrograms, he correctly identified 18 of the 30 unstable SLAP 2 lesions and 59 of the 60 intact superior labrum (60%, 98%, 85%, respectively). Fourteen of the unstable SLAP 2 lesions were interpreted correctly on both MR imagings and MR arthrograms, and 11 incorrectly on both. On MR imagings, observer 2 correctly identified 14 of the 30 unstable SLAP 2 lesions and 48 of the 60 intact superior labrum (45%, 80%, 64%, respectively) (Fig. 4), and on MR arthrograms, he correctly identified 23 of the 30 unstable SLAP 2 lesions and 50 of the 60 intact superior labrum (76%, 83%, 80%, respectively). Fourteen of the unstable SLAP 2 lesions were interpreted correctly on both MR imagings and MR arthrograms, and seven were interpreted incorrectly on both (Fig. 5).

Table 1. Summary of interpretation results for observer 1

	MRI	MRA
Interpretation results		
True-positive	16	18
False-negative	14	12
False-positive	4	1
True-negative	56	59
Diagnostic value		
Sensitivity (%)	53	60
Specificity (%)	93	98
Accuracy (%)	80	85

Table 2. Summary of interpretation results for observer 2

	MRI	MRA
Interpretation results		
True-positive	14	23
False-negative	16	7
False-positive	12	10
True-negative	48	50
Diagnostic value		
Sensitivity (%)	45	76
Specificity (%)	80	83
Accuracy (%)	64	80

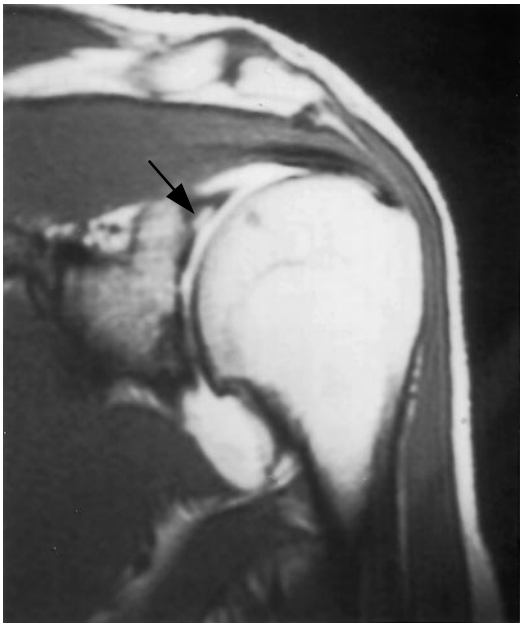

Fig. 4. A 30-year-old woman with a partial rotator cuff tear. A false-positive finding on MRA by observer 2 (the novice interpreter). Observer 1 (the expert interpreter) diagnosed this image as a negative finding

Fig. 5. A 25-year-old man with an unstable SLAP 2 lesion. A false-negative finding on MRA by both observers

Statistical analysis

For observer 1, the sensitivity and accuracy improved on MRA but this was not statistically significant ($P = 0.35$), while there was a statistically significant improvement for observer 2 ($P = 0.004$). For both observers, the improvement in the specificity remained small, but interobserver comparisons showed that false positive findings increased for observer 2, which decreased the specificity significantly.

Discussion

For the expert observer in this study, MRI had a sensitivity of 53%, a specificity of 93%, and an accuracy of 80%, all of which were improved to 60%, 98%, and 85%, respectively, by MRA. These increases were statistically insignificant. Although our results showed relatively low sensitivity and high specificity, Snyder et al.[19] reported that the normal anatomical variations of the superior glenoid labrum might cause false-positive results. Their early detection results for SLAP lesions using MRI indicated a false-positive finding of partial detachment which was related to normal aging.[13] In fact, there have been many reports of normal variants of the superior labrum[20] and pitfalls in diagnostic imaging regarding superior labral tears.[21] The sublabral foramen and the Buford complex are the most common variations, and several studies on their MRI appearance proved that they could be incorrectly interpreted as tears.[22,23] However, we did not have many normal variants that could be false-positive interpretations in this study, and consequently the specificity of both MRA and MRI was relatively high. In our previous study on the diagnosis of unstable SLAP 2 lesions using MRI and CT arthrography,[18] there was only one case with a sulcus (a normal variant) at the attachment of the superior labrum out of 76 cases (a completely different patient group from the one in this study).

On the other hand, our results for the novice observer indicated that MRI had a sensitivity of 45%, a specificity of 80%, and an accuracy of 64%, all of which were significantly improved to 76%, 83%, and 80%, respectively, by MRA. Therefore, MRA can be an effective method to decrease interobserver differences in the diagnosis of SLAP 2 lesions. The results also suggested that MRA might not be superior to unenhanced MRI for an experienced interpreter. Feldman et al.[24] reported the accuracy of unenhanced MRI studies for 17 SLAP lesions, including eight type II lesions, which were interpreted by radiologists from community-based centers. Surprisingly, no true positive result was obtained in their study, suggesting not only the need for an improvement in the low reliability of the community-based MRI study for SLAP lesions, but also the significance of interobserver differences in the interpretation. Tuite et al.[25] reported a comparison of three MRI signs for the diagnosis of SLAP lesions and interobserver reliability. They concluded that laterally curved and posterior high signal intensities are specific signs for a diagnosis of SLAP lesions. This indicates that the proper definition of MRI signs can lessen interobserver differences.

One potential limitation of this study is that we did not try to compare several pulse sequences at a time. Gusmer et al.[26] reported the high diagnostic value for anterior, superior, and posterior labral injuries by unenhanced MRI using a combination of gradient–echo and high-resolution fast spin–echo axial pulse sequences. With appropriate sequences, there is the possibility of detecting the lesion more precisely by MRI. Although we used a low-powered permanent magnet system for unenhanced MRI, we believe that this study has clinical significance because such a system has certain advantages in clinical use, such as the ease of positioning the patient, a larger gantry which can decrease motion artifacts caused by the patient's stress, and low initial and maintenance costs.[27] The other limitation is that we included only arthroscopically proved SLAP tears in our study. This bias toward more symptomatic tears, which may be easier to identify on MRI, is a weakness in studies in which arthroscopy is the standard-of-reference procedure.

In conclusion, MRA proved to be useful in the detection of unstable SLAP 2 lesions by a novice interpreter, but not significantly useful for an experienced interpreter, compared with unenhanced MRI. We can advocate MRA as the examination of first choice in detecting an unstable SLAP 2 lesions if it is strongly suspected clinically, although MRA is more invasive and costly than unenhanced MRI.

Acknowledgments We are indebted to Atsushi Hirooka and Kiyofumi Iida for their technical expertise, and Scott Rodeo for reviewing the manuscript.

References

1. Andrews JR, Carson WG Jr, McLeod WD. Glenoid labrum tears related to the long head of the biceps. Am J Sports Med 1985; 13:337–41.

2. Snyder SJ, Karzel RP, Del Pizzo W, Ferkel RD, Friedman MJ. SLAP lesions of the shoulder. Arthroscopy 1990;6:274–9.
3. Kibler WB. Specificity and sensitivity of the anterior slide test in throwing athletes with superior glenoid labral tears. Arthroscopy 1995;11:296–300.
4. Liu SH, Henry MH, Nuccion S, Shapiro MS, Dorey F. Diagnosis of glenoid labral tears: a comparison between magnetic resonance imaging and clinical examinations. Am J Sports Med 1996;24:149–54.
5. Itoi E, Kuechele K, Newman SR, Morrey BF, An KN. Stabilising function of the biceps in stable and unstable shoulders. J Bone Joint Surg Br 1993;75:546–50.
6. Yoneda M, Hirooka A, Saito S, Yamamoto T, Ochi T, Shino K. Arthroscopic stapling for detached superior glenoid labrum. J Bone Joint Surg Br 1991;73:746–50.
7. Blum A, Boyer B, Regent D, Simon JM, Claudon M, Mole D. Direct coronal view of the shoulder with arthrographic CT. Radiology 1993;188:677–81.
8. Hunter JC, Blatz DJ, Escobedo EM. SLAP lesions of the glenoid labrum: CT arthrographic and arthroscopic correlation. Radiology 1992;184:513–8.
9. Cartland JP, Crues JV, Stauffer A, Nottage W, Ryu RKN. MR imaging in the evaluation of SLAP injuries of the shoulder. Am J Roentgenol 1992;159:787–92.
10. Legan JM, Burkhard TK, Goff WB, Balsara ZN, Martinez AJ, Burks DD, et al. Tears of the glenoid labrum: MR imaging of 88 arthroscopically confirmed cases. Radiology 1991;179:241–6.
11. Monu JUV, Pope TL, Chanbon SJ, Vanarthos WJ. MR diagnosis of superior labral anterior posterior (SLAP) injuries of the glenoid labrum: value of routine imaging without intraarticular injection of contrast material. Am J Roentgenol 1994;163:1425–9.
12. Chandnani VP, Yeager TD, DeBerardino T, Christensen K, Gagliardi JA, Heitz DR, et al. Glenoid labral tears: prospective evaluation with MR imaging, MR arthrography, and CT arthrography. Am J Roentgenol 1993;161:1229–35.
13. Hodler J, Brahme SK, Flannigan B, Snyder SJ, Karzel RP, Resnick D. Injuries of the superior portion of the glenoid labrum involving the insertion of the biceps tendon. Am J Roentgenol 1992;159:565–8.
14. Tirman PFJ, Bost FW, Garvin GJ, Peterfy CG, Mall JC, Steinbach LS, et al. Posterosuperior glenoid impingement of the shoulder: findings at MR imaging and MR arthrography with arthroscopic correlation. Radiology 1994;193:431–6.
15. Coumas JM, Waite RJ, Goss TP, Ferrari DA, Kanzaria PK, Pappas AM. CT and MR evaluation of the glenoid labral capsular ligamentous complex of the shoulder. Am J Roentgenol 1992;158:591–7.
16. Loredo R, Longo C, Salonen D, Yu J, Haghighi P, Trudell D, et al. Glenoid labrum: MR imaging with histologic correlation. Radiology 1995;196:33–41.
17. McCauley TR, Pope CF, Joki P. Normal and abnormal glenoid labrum: assessment with multiplanar gradient–echo MR imaging. Radiology 1992;183:35–7.
18. Yoneda M, Izawa K, Hirooka A, Hayashida K, Wakitani S. Indicators of superior glenoid labral detachment on magnetic resonance imaging and computed tomography arthrography. J Shoulder Elbow Surg 1998;7:2–12.
19. Snyder SJ, Banas MP, Karzel RP. An analysis of 140 injuries to the superior glenoid labrum. J Shoulder Elbow Surg 1995;4:243–8.
20. Esch JC, Baker CL. Surgical arthroscopy: the shoulder and elbow. Philadelphia: Lippincott; 1993. p. 134.
21. Palmer WE. Reply 2. Radiology 1994;190:644.
22. Tirman PFJ, Feller JF, Palmer WE, Carroll KW, Steinbach LS, Cox I. The Buford complex – a variation of normal shoulder anatomy: MR arthrographic imaging features. Am J Roentgenol 1996;166:869–73.
23. Tuite MJ, Orwin JF. Anterosuperior labral variants of the shoulder: appearance on gradient-recalled-echo and fast spin–echo MR images. Radiology 1996;199:537–40.
24. Feldman AJ, Sheskier S, Wiener B. The accuracy of community-based magnetic resonance imaging studies for detecting SLAP lesions. First Biennial Congress of the International Society of Arthroscopy, Knee Surgery and Orthopaedic Sports Medicine; 1997 May 11–16; Buenos Aires, Argentina.
25. Tuite MJ, Cirillo RL, De Smet AA, Orwin JF. Superior labrum anterior–posterior (SLAP) tears: evaluation of three MR signs on T2-weighted images. Radiology 2000;215:841–5.
26. Gusmer PB, Potter HG, Scatz JA, Wickiewicz TL, Altchek DW, O'Brien SJ, et al. Labral injuries: accuracy of detection with unenhanced MR imaging of the shoulder. Radiology 1996;200:519–24.
27. Schneider D. MRI goes back to the future: new design embraces simpler magnets – and lower costs. Sci Am 1995;272:42.