S ORIGINAL ARTICLE

Magnetic resonance arthrogram and arthroscopy of the shoulder: a comparative retrospective study with emphasis on posterior labral lesions and radiologist locality

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None declared

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ABSTRACT

Background Magnetic resonance arthrography (MRA) is a routine diagnostic investigation for glenohumeral lesions; however, diagnostic arthroscopy remains the gold standard. The present study aimed tto investigate the diagnostic accuracy of glenohumeral MRA compared to arthroscopy, with particular interest in previously unreported aspects, such as posterior labral lesions and the locality of the reporting radiologists.

Methods Ninety-five consecutive patients with pre-operative MRA and subsequent arthroscopy were included. Patients were grouped into MRA reported by specialist radiologists within the specialist shoulder unit ($n = 58$) or reported by nonlocal musculoskeletal radiologists ($n = 37$).

Results In the local radiologist group, the sensitivity/specificity for Hill – Sachs lesions was 0.71/0.85, anterior labral tears 0.75/0.73, posterior labral tears 0.50/0.92, superior labral tear from anterior to posterior (SLAP) lesions 0.71/0/91 and rotator cuff tears (RCTs) 0.40/0.81. In the nonlocal radiologist group, the sensitivity/specificity for Hill – Sachs lesions was 0.64/0.88, anterior labral tears 0.70/0.79, posterior labral tears 0.40/0.81, SLAP lesions 0.66/0/82 and RCT 0.40/0.81. A nonsignificant trend of lower sensitivity/specificity for lesions reviewed by the nonlocal radiologists was found.

Discussion MRA is not 100% sensitive or specific and does not negate arthroscopy. There is a lower diagnostic accuracy of posterior compared to anterior labral lesions and improved accuracy of glenohumeral MRA diagnosis may be achieved with the increased experience of radiologists within specialist units and regular surgical feedback of cases.

INTRODUCTION

Magnetic resonance arthrography (MRA) of the shoulder has become a commonly used diagnostic investigation for glenohumeral joint intra-articular lesions, aiding in diagnosis, therapeutic planning and rehabilitation. Direct MRA with gadolinium contrast distends the glenohumeral joint outlining the labral and capsular structures and the under-surface of the rotator cuff [1 – 3]. Although improved techniques, modern MR scanners and increasing radiology experience have led to improved accuracy of MRA [1], glenohumeral arthroscopy remains the gold-standard diagnostic tool for glenohumeral joint pathology [2].

Several previous studies have investigated the reliability of MRA in the diagnosis of common shoulder pathology: rotator cuff tears (RCTs) [4,5], anteroinferior labral tears [6], superior labral tear from anterior to posterior (SLAP) [3,7,8] and Hill – Sachs lesions [8]. These studies show a wide variation in the sensitivities and specificities of MRA for these different lesions. The sensitivity of detection of SLAP lesions varies between 72% [7], 82% [9] and 96% [10].

It is likely that the experience of the radiologist, the type of scanner used and the scan protocol all influence an accurate diagnosis [2] and the increased use of MRA has led to more experienced musculoskeletal radiologists using more well-defined protocols. Therefore, it is important to obtain up-to-date information on the diagnostic accuracy of this investigation and the quality of the reports.

The present study aimed to advance the current information available on the accuracy of MRA for the diagnosis of intra-articular shoulder pathology. In particular, we aimed to compare the quality of reports between local musculoskeletal radiologists who work with the shoulder team and nonlocal musculoskeletal radiologists. This is also one of the first studies to report the accuracy of detecting posterior labral on MRA.

PATIENTS AND METHODS

The patients included in the present study were referred to the senior author over a 24-month period (May 2006 to April 2008) and had diagnostic pre-operative MRA of the shoulder and subsequent arthroscopic examination of the shoulder. The senior author (L.F.) reviewed the MRA report before arthroscopy was performed. The structural lesions of interest included SLAP tears, anterior and posterior labral tears, RCT and Hill – Sachs lesions. Arthroscopic findings and procedures were recorded. All arthroscopic examinations and surgical procedures were performed or directly supervised by the senior author (L.F.). The MRA were performed and reported by experienced consultant musculoskeletal radiologists. The senior author's patients are referred from within a large geographical area and the patients included will potentially have had MRA examination and reports from nonlocal musculoskeletal radiologists before onward tertiary referral to the senior author. MRA examinations requested by the senior author were performed and reviewed by two principal consultant musculoskeletal radiologists. Therefore, two distinct groups are presented for consideration. The local/internal group with MRA examinations and reports within a single unit and a nonlocal group with MRA examinations and reports from other musculoskeletal radiologists, with both groups having a single specialist shoulder surgeon present for the arthroscopic examination. Patients were excluded if the MRA examination was incomplete, if the radiologist's report was not available or incomplete and if the operative data were incomplete.

MRA technique

The MRA was performed by a standard technique using fluoroscopic guidance for the introduction of a 22-gauge spinal needle into the glenohumeral joint and then position confirmed with Omnipaque 240 (Winthrop-Breon Laboratories, New York, NY, USA). Some 10 ml to 15 ml of dilute gadolinium were injected. All radiologists included in the study used this protocol. There was a wide variation in the magnetic resonance imaging (MRI) scanner manufacturer, although all were performed on 1.5-T rating machines. Abduction external rotation views were performed on all shoulders [11].

Statistical analysis

Data were recorded in an Excel database (Microsoft Corp, Redmond, WA, USA) and analyzed using SPSS statistical software, version 14 (SPSS Inc., Chicago, IL, USA).

RESULTS

One hundred and nineteen patients were identified as having undergone MRI of the shoulder and subsequent arthroscopic examination. Seventeen patients had MRA investigation after arthroscopic surgery, six had MRI rather than MRA scans, and one had an incomplete MRA scan. These patients were therefore excluded from the study. This left 95 patients who had undergone pre-operative MRA of the shoulder and subsequent arthroscopic examination. Fifty-eight patients had their MRA scan performed and reviewed by the two principal consultant musculoskeletal radiologists within the local unit and this formed the primary analysis group. The secondary group included all 95 patients. This comprised the patients who had their MRA examination and report within the local unit (58 patients) and those who had them within the referral region (37 patients) as reported by a further 10 consultant musculoskeletal radiologists.

Five pre-operative MRA investigations were reported as having no abnormalities but the patients went on to have arthroscopic surgery as a result of persistent symptoms. All other patients had abnormalities reported on MRA before arthroscopic investigation.

Primary group analysis: local MRA patients

Fifty-eight patients had their MRA scan performed and reviewed by the two principal consultant musculoskeletal radiologists ($n = 27$ and 31 cases, respectively) within the local unit. The mean age at the time of surgery was 28.8 years (range 16 years to 58 years). There were 34 right shoulders and 24 left shoulders. There were no bilateral cases. The mean time from MRA investigation to surgery was 10 weeks (range 1 week to 52 weeks).

Hill–Sachs lesions

Twelve out of 17 patients with a Hill–Sachs lesion were correctly identified by MRA. Five were not identified. Six out of 41 patients with no lesion were incorrectly identified as having a Hill–Sachs lesion. Thirty-five shoulders had no pathology identified by MRA or arthroscopy [sensitivity, 0.71; specificity, 0.85; positive predictive value (PPV), 0.67; negative predictive value (NPV), 0.88] (Table 1).

Anterior and posterior labral lesions

Forty-two patients were diagnosed with a labral tear (anterior or posterior) on arthroscopy of whom 35 were identified by MRA. Seven labral tears found on arthroscopy were not reported on MRA. Fifteen shoulders had no labral pathology identified by MRA or arthroscopy and one shoulder with no pathology was identified as having a lesion on MRA (sensitivity, 0.83; specificity, 0.94; PPV, 0.97; NPV, 0.68).

Thirty-two lesions were anterior and 12 posterior (by arthroscopy). For anterior lesions, 24/32 were correctly identified as anterior by MRA, and eight lesions were either not reported (3) or reported as a posterior lesion (5). Of the 26 patients who did not have an anterior lesion, seven were reported positive for anterior lesions on MRA, and 19 MRA tests were negative (sensitivity, 0.75; specificity, 0.73; PPV, 0.78; NPV, 0.70). Twelve posterior lesions were found on arthroscopy, of which six were reported as posterior on MRA and four were missed ($n = 1$) or reported as anterior ($n = 3$). In 48 cases with no posterior lesion, the test was positive in four (three of which had an anterior lesion on arthroscopy) and negative in 44 (sensitivity, 0.50; specificity, 0.92; PPV, 0.6; NPV, 0.88).

SLAP tears

Arthroscopy diagnosed 27 SLAP tears, of which 20 were correctly diagnosed by MRA. Three SLAP tears reported from MRA were not identified during arthroscopy. Twenty-eight negative MRA scans were confirmed on arthroscopy (sensitivity, 0.71; specificity, 0.91; PPV, 0.87; NPV, 0.80).

RCTs

Full and RCTs were grouped together for the analysis because of the low incidence. Five out of six patients with a partial or a full thickness RCT were identified by MRA; one positive case was missed. Nine out of 49 patients with no RCT lesion were incorrectly identified as having a lesion on MRA. Forty-three shoulders had no pathology identified on either scope or MRA (sensitivity, 0.83; specificity, 0.82; PPV, 0.35; NPV, 0.97).

Secondary analysis group: nonlocal MRA patients

The secondary group included 37 patients who had a pre-operative MRA examination and report from outside the local specialist

Table 1 Primary analysis group ($n = 58$)

	n (prevalence)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value	Negative predictive value
Hill–Sachs	17 (0.29)	0.71 (0.44–0.89)	0.85 (0.7–0.94)	0.67	0.88
Labral lesion (anterior or posterior)	42 (0.71)	0.83 (0.68–0.92)	0.94 (0.68–0.99)	0.97	0.68
Anterior labral lesion	32 (0.55)	0.75 (0.56–0.88)	0.73 (0.52–0.88)	0.77	0.7
Posterior labral lesion	12 (0.21)	0.5	0.92	0.6	0.88
SLAP	24 (0.41)	0.71 (0.53–0.88)	0.91 (0.73–0.97)	0.85	0.82
RCT	11 (0.12)	0.83 (0.36–0.99)	0.82 (0.69–0.91)	0.36	0.98

Magnetic resonance arthrography examined by two local radiologists. CI, confidence interval; RCT, rotator cuff tear; SLAP, superior labral tear from anterior to posterior.

Table 2 Secondary analysis group ($n = 37$)

	n (prevalence)	Sensitivity (95% CI)	Specificity (95% CI)	Positive predictive value	Negative predictive value
Hill–Sachs	11 (0.3)	0.64 (0.32–0.88)	0.88 (0.69–0.97)	0.7	0.85
Labral lesion (anterior or posterior)	29 (0.78)	0.76 (0.56–0.89)	0.88 (0.47–0.99)	0.96	0.5
Anterior labral lesion	25 (0.68)	0.70 (0.47–0.86)	0.79 (0.49–0.94)	0.84	0.61
Posterior labral lesion	10 (0.27)	0.4 (0.14–0.73)	0.81 (0.61–0.93)	0.44	0.79
SLAP	15 (0.41)	0.66 (0.39–0.87)	0.82 (0.59–0.94)	0.71	0.78
RCT	5 (0.14)	0.4 (0.07–0.83)	0.81 (0.63–0.92)	0.25	0.89

Magnetic resonance arthrography by one of nine different radiologists. CI, confidence interval; RCT, rotator cuff tear; SLAP, superior labral tear from anterior to posterior.

unit by one of nine musculoskeletal radiologists and subsequent referral, review and shoulder arthroscopy by the senior author (L.F.). The mean age at the time of surgery was 30.1 years (range 15 years to 59 years). There were 30 right shoulders and seven left shoulders. There were no bilateral cases. The mean time from MRA investigation to surgery was 10 weeks (range 1 weeks to 40 weeks).

The analysis of the regional group demonstrated sensitivity and specificity values lower than for that for the local unit patient group for all lesions (Table 2). Because the groups were of different sizes, the standard statistical test to compare sensitivity and specificity (i.e. McNemar test) was not applicable and we were unable to test theses differences [12,13]. However, the sensitivity and specificity values were within the 95% confidence interval for the 58-patient group (Table 1), indicating that differences were not significant.

DISCUSSION

The data reported in the present study represent one of the largest patient series to have undergone MRA and arthroscopy performed by one surgeon. MRA has enhanced diagnostic accuracy over MRI for intra-articular lesions [5,6,9,14]. The primary analysis was restricted to 58 patients to reduce potential differences in radiologist experience and reporting. The senior author and the two principle consultant musculoskeletal radiologists at the local unit liaise closely with respect to feedback and review of MRA and arthroscopic images. This is one of the major benefits of working within a local specialist unit. A secondary analysis that included reports from nine different radiologists showed a trend towards reduced sensitivity and specificity for all lesions examined. Although this group was small ($n = 37$), and the differences between results in the two patient groups were not significant (compared to the confidence interval range in the primary analysis group), the data suggest that MRA diagnostic accuracy is better when both the surgeon and radiologist work closely together. This process is critical for both the radiologist and surgeon to maximize the benefit of expensive diagnostic interventions. It is also noteworthy that the shoulder MRA experience of the regional referral radiologists was not known and that this could affect the accuracy of the MRA [15].

The sensitivity results reported in the present study are consistent other studies comparing MRA and arthrography for labral tears, Hill–Sachs lesions and SLAP lesions (Table 3). The probability of finding a lesion in a patient with shoulder pathology is approximately 75% to 80%. It is notable, therefore, that approximately one in five patients with pathology will be missed on MRA.

However, the specificity results are lower in the present study compared to those values previously reported (Table 3); in our patient population, the probability of a patient with no pathology on MRA having shoulder pathology was higher than previously reported (i.e. lesions being missed on MRA).

This is the second reported study to investigate anterior and posterior labral tears; 19 out of 24 anterior and six out

Table 3 Sensitivity and specificity of magnetic resonance arthrography investigation of shoulder pathology

	Sensitivity	Specificity	Reference
Hill–Sachs	70–75	98–99	[15,16]
Anterior labral tears	72–77	91–95	[6,16]
SLAP	72–100	96–95	[16–19]
RCT Full	96–100	99	[4,5,20]
Partial	80–84	96–97	

RCT, rotator cuff tear; SLAP, superior labral tear from anterior to posterior.

of 12 posterior tears were correctly identified on MRA. Analysis of anterior and posterior labral lesions separately revealed that, although MRA was sensitive for the presence of a labral tear, its ability to accurately determine the location of the lesion was low. Posterior lesions were less accurately detected than anterior lesions, in agreement with previous findings [16]. Although radiologists included in the present study wrote reports in a carefully structured format, MRA reporting would benefit from a routine protocol. For example, consistency when describing the location of labral lesions (e.g. some reports used a clock-face, others used the term Bankart lesion or the terms anterior, posterior or reverse) could be easily achieved. We suggest the introduction of a reporting form as an adjunct to the radiologists' written report.

The low sensitivity and specificity for RCTs is likely a result of their low occurrence in this patient group (11/95). The MRA examinations were requested in this group of patients predominantly for shoulder injuries with instability problems. The senior author's choice for the investigation of rotator cuff pathology is predominantly office ultrasound.

The data reported in the present study, together with previous data, suggest that whilst guidance from MRA can be helpful and informative; surgeons must not rely solely on the MRA findings when planning therapeutic intervention. All radiological investigations should be put into the context of the clinical picture. When presented with a patient with shoulder instability symptoms, a negative MRA examination still means that there is a 20% chance of having a labral tear on arthroscopic examination that may benefit from arthroscopic reconstruction. Therefore, a negative MRA should not preclude arthroscopic examination in those patients with appropriate clinical signs and symptoms.

It is not well established that clinical tests can reliably and accurately diagnose shoulder pathology [17]. A recent review concluded that six tests of labral lesions are accurate (Biceps load I, Biceps load II, Internal Rotation Resistance, Crank, Kim and Jerk), although further evaluation is required before these tests can be used with confidence [18]. Another review reported sensitivity and specificity for the active compression test (47% to 78%, 11% to 73%), the Crank test (13% to 58%, 56% to 83%) and the Speed test (4% to 48%, 67% to 99%) [19]).

Tests for rotator cuff disease have a sensitivity/specificity between 77%/68% (Jobe) [20], 66%/64% (Full can test) [20] and 76%/57% (resisted external rotation with elbow flexed at the side at 90°) [21,22]. The palm-up test for the long head of the biceps has sensitivity in the range 63% to 69% and specificity in the range 35% to 60% [23,24]. Hegedus et al. identified the Apprehension test (sensitivity 72%, specificity 96%), Relocation test (81%, 92%) and Anterior Release (53%, 85%) test as having high sensitivity and specificity for pathological shoulder instability (either a Bankart lesion, Hill–Sachs lesion or a humeral avulsion of the glenohumeral ligament) [17,25].

In future, the use of higher power MRI machines might negate the need for intra-articular contrast injections [26]. Furthermore, computed tomography and ultrasound techniques may also prove useful. X-ray computer tomography has limited soft tissue contrast and spatial resolution and has been replaced by multidetector computed tomography arthrography (MDCT). MDCT has been reported to have similar sensitivity and specificity to MRA for labral, SLAP Hill–Sachs lesions and full-thickness RCTs, but lower than MRA for partial thickness RCTs [27]. Ultrasound has been used successfully for accurate diagnosis of full thickness RCTs (sensitivity > 95%, specificity > 90%) [28,29] and for partial thickness tears (96/70%) [30]. Ultrasound may also be used accurately to diagnose long head of biceps abnormalities [31] and Hill–Sachs lesions [32] and has been reported to provide a sensitivity and specificity of 89%/77% for Bankart lesions [33].

The findings of the present study support the use of MRA as a supplementary investigation in patients with shoulder pathology. However, any negative scan results are not absolute and should not preclude investigation with arthroscopy should the clinical symptoms warrant. Furthermore, the improved results from the local radiologists hints that the best results are obtained when a feedback loop between the surgeon and radiologist is available. This is essential for maximizing the potential benefits of the MRA investigation.

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