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SCIENTIFIC ARTICLE

A comparison of magnetic resonance arthrography and arthroscopic findings in the assessment of anterior shoulder dislocations

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Abstract
Objective The aim of this study is to establish the sensitivity and specificity of MRA in the investigation of patients with traumatic anterior shoulder dislocations.
Materials and methods A retrospective analysis of consecutive patients undergoing both magnetic resonance arthrography and arthroscopic assessment after a traumatic anterior shoulder dislocation between January 2011 and 2014 was performed. Demographic data were collected from electronic records. Images were interpreted by 8 musculoskeletal radiologists and patients were treated by 8 consultant orthopaedic surgeons. Arthroscopic findings were obtained from surgical notes and these findings were used as a reference for MRA. The sensitivity, specificity, and positive predictive value were calculated for the different injuries.
Results Sixty-nine patients underwent both an MRA and shoulder arthroscopy during the study period; however, clinical notes were unavailable in 9 patients. Fifty-three patients (88 %) were male, the mean age was 28 years (range 18 to 50) and 16 subjects (27 %) had suffered a primary dislocation. The overall sensitivity and specificity of MRA to all associated injuries was 0.9 (CI 0.83–0.95) and 0.94 (CI 0.9–0.96) retrospectively. The lowest sensitivity was seen in osseous Bankart 0.8 (CI 0.44–0.96) and superior labral tear (SLAP) lesions 0.5 (CI 0.14–0.86). The overall positive predictive value was 0.88 (CI 0.76–0.91) with the lowest values found in rotator cuff 0.4 (CI 0.07–0.83) and glenohumeral ligament (GHL) lesions 0.29 (CI 0.05–0.7).
Conclusion Magnetic resonance angiography has a high sensitivity when used to identify associated injuries in shoulder dislocation, although in 8 patients (13 %) arthroscopy identified an additional injury. The overall agreement between MRA and arthroscopic findings was good, but the identification of GHL and rotator cuff injuries was poor.

Keywords Shoulder · Dislocation · Instability · Magnetic resonance imaging · Arthroscopy

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Introduction

The shoulder joint sacrifices stability to allow a wide range of movement. The incidence of shoulder dislocation is around 24/100,000 [1, 2] and over 90 % are anteriorly displaced [3]. The highest incidence is in young patients between 20 and 29 years of age [2] and this group of patients has the highest recurrence rate [4–7]. This has seen a change in practice with a survey of UK surgeons demonstrating a doubling of stabilisation in first-time dislocations in young patients [8]. A recent meta-analysis reported that rates of recurrent instability and shoulder function are significantly improved following surgical repair [9].

The desire of surgeons to identify any associated injuries predisposing to recurrent instability has seen a threefold increase in the use of magnetic resonance imaging (MRI) [8]. These include injuries to the humeral head, glenoid, labrum, rotator cuff, glenohumeral ligament (GHL) and superior labral tear (SLAP) lesions. Commonly described lesions include an impression fracture of the humeral head, known as a Hill–Sachs lesion [10], and damage to the glenoid labrum described by Bankart [11]. MRI is frequently used for the investigation of shoulder instability. Interpretation of the images by specialist musculoskeletal radiologists improves detection [12]. A review of MR scans post-dislocation revealed cartilaginous

Bankart lesions in 73 %, osseous Bankart lesions in 27.5 %, SLAP lesions in 14 %, and Hill–Sachs in 71–84 % [13, 14].

The addition of contrast medium for magnetic resonance arthrography (MRA) has the benefit of distending the joint, picking up more subtle or undisplaced labral lesions [15]. One study has shown good correlation between MRA and arthroscopy for labral lesions [16]. However, MRA is more invasive, has a higher cost and is associated with more risks [17]. One study comparing MRA with arthroscopic findings reported only fair to moderate agreement between the modalities [18]. This included the over-reporting of 4 rotator cuff and 13 GHL injuries and the under-reporting of two Bankart lesions in 18 patients [18].

Magnetic resonance angiography is becoming increasingly used to investigate shoulder instability and aid decisions on treatment. However, controversy surrounds how accurate this modality is at identifying associated injuries and whether it should be performed in all cases. The aim of this study is to establish the sensitivity and specificity of MRA in traumatic anterior shoulder dislocations.

Materials and methods

A retrospective analysis was carried out between January 2011 and January 2014 of consecutive patients undergoing MRA for the investigation of a traumatic anterior shoulder dislocation in two District General Hospitals in the United Kingdom. The project was registered locally, but ethics committee approval and patient consent were not sought because of the retrospective nature of data collection. The patient must have had a radiographically proven shoulder dislocation within 6 months of the MRA. MRA without contrast medium and those not proceeding to shoulder arthroscopy were excluded from the study. The decision to obtain an MRA was made in each case by the consultant responsible for the patient's care. Similarly, interpretation of MRA findings and the decision to proceed to arthroscopy were made by the individual consultants in conjunction with clinical symptoms. The arthrogram was performed under radiographic guidance and sterile conditions. Ten to 20 ml of gadolinium was injected via a posterior approach. The images were interpreted by 1 of 8 musculoskeletal radiologists and patients were treated by 1 of 8 consultant orthopaedic surgeons.

Demographic data were collected from electronic records. Arthroscopic findings were obtained from the surgical notes and MRA findings from radiology reports. Arthroscopic findings were used as a reference for MRA findings. The sensitivity, specificity, positive predictive value, and their confidence intervals (CI) were calculated for the different injuries. Analysis of findings in primary and recurrent dislocations was also performed. Complications and the success of arthroscopic treatment were not analysed.

Results

During the study period 69 patients underwent both an MRA and shoulder arthroscopy following anterior shoulder dislocations. Nine patients were lost to follow-up as clinical notes were unavailable for review, leaving 60 study participants. Fifty-three patients (88 %) were male, the mean age was 28 years (range 18 to 50) and 16 subjects (27 %) had suffered a primary dislocation. The mean time from MRA to surgery was 5 months (range 1 to 14 months).

Soft tissue Bankart lesions were present in 51 cases (85 %), osseous Bankart lesions in 10 (17 %) and Hill–Sachs lesions in 19 (32 %). Figures 1–3 give MRA examples of these pathologies. Table 1 demonstrates the presence of the various associated injuries on MRA and arthroscopy. The MRA demonstrated 16 injuries that were not subsequently identified

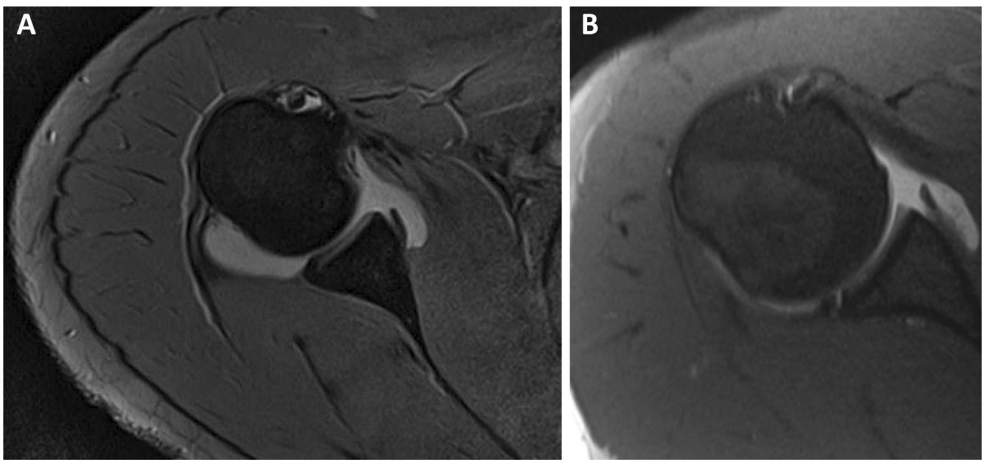

Fig. 1 **a**, **b** Magnetic resonance angiography (MRA) examples of soft-tissue Bankart lesions

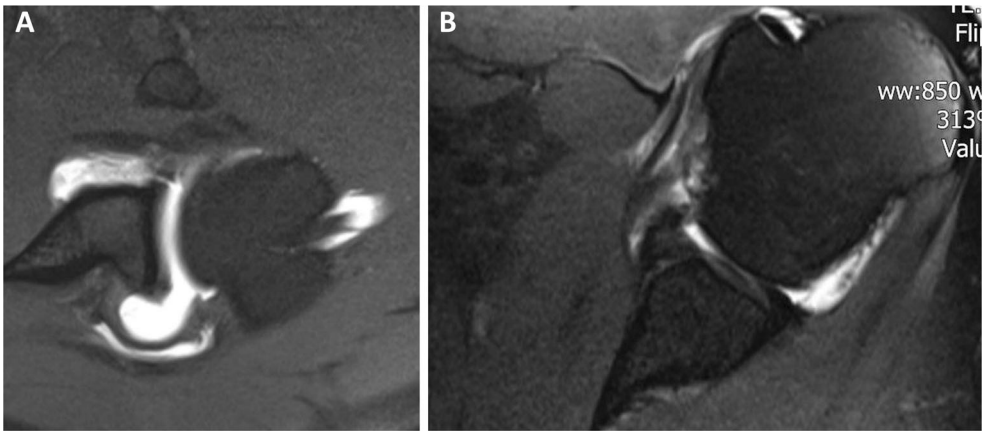

Fig. 2 **a**, **b** MRA examples of osseous Bankart lesions

during arthroscopy: 8 Hill–Sachs, 5 GHL and 3 rotator cuff. The MRA failed to demonstrate 8 injuries: 3 soft-tissue Bankart, 2 osseous Bankart, and 3 SLAP. The sensitivities, specificities and positive predictive values of MRA for the various injuries are illustrated in Table 2.

The incidence of associated injuries in the first-time and recurrent dislocation groups are illustrated in Table 3. Although the incidence in the recurrent dislocation group was higher for Bankart, Hill–Sachs, rotator cuff and SLAP lesions, this did not reach statistical significance. The sensitivity and specificity of first-time dislocations for all injuries were 0.92 (CI 0.72–0.99) and 0.93 (CI 0.85–0.97) respectively, whilst for recurrent dislocations they were 0.9 (CI 0.81–0.96) and 0.95 (CI 0.91–0.97).

Discussion

Magnetic resonance imaging is frequently used in the assessment of shoulder instability and a recent survey demonstrated that UK surgeons are increasingly using this investigation to aid the identification of associated injuries. The patients included in this study were typically young males, a group that typically has both the highest incidence of shoulder dislocation [2] and who are most at risk of recurrent instability [4–7]. Therefore, MRA findings in these patients are of particular interest to surgeons as surgical intervention is becoming increasingly frequent in this group [8].

Fig. 3 MRA example of a Hill–Sachs lesion

Magnetic resonance angiography has been reported to improve the detection rate [15] and a review of 60 cases in this study showed a sensitivity of 0.9 in all injuries. The incidence of soft-tissue Bankart lesions was 85 %, osseous Bankart lesions 17 % and Hill–Sachs lesions 32 %. Previous reports have demonstrated that Bankart lesions are present in 73–90 % and Hill–Sachs lesions 71–84 % of shoulder dislocations [13, 15, 19, 20]. The incidence of Hill–Sachs lesions is considerably lower in the current study, in fact arthroscopic findings suggest that in this series Hill–Sachs were over-reported on MRA. This variation further supports the difficulty in identifying osseous lesions using MRI [15], although a lack of documentation in surgical notes may also have been a factor. The incidence of the majority of injuries was higher in the recurrent dislocation group. Although these differences did not reach statistical significance, the presence of these injuries may have predisposed patients to further dislocations, explaining these higher figures.

The overall sensitivity (0.9) and specificity (0.94) of MRA is high, when broken down to individual injuries this varies with the sensitivity of Bankart lesions 0.92. This sensitivity of Bankart lesions is within the range previously reported in the literature (0.65–0.95) [21–24]. The 1.0 sensitivity of MRA for Hill–Sachs lesions was similar to that presented in the literature (0.96–1.0) [22, 25]; however, the 0.8 specificity is lower than that previously reported [22, 25]. Osseous lesions are known to be more troublesome when identifying using MRA, and this is further supported by the low sensitivity in detecting osseous Bankart lesions (0.8). These findings suggest that

Table 1 Incidence of pathological conditions on magnetic resonance angiography (MRA) and arthroscopy

	MRA (%)	Arthroscopy (%)
Bankart/labral	47 (78)	51 (85)
Osseous Bankart	8 (13)	10 (27)
Hill–Sachs lesion	27 (45)	19 (32)
GHL	7 (12)	2 (3)
Rotator cuff	5 (8)	2 (3)
SLAP	3 (5)	6 (10)

GHL glenohumeral ligament, *SLAP* superior labral tear

Table 3 Incidence of injury in primary and recurrent dislocations

	First dislocation (n=16; %)	Recurrent dislocation (n=44)	Fisher's exact test (P value)
Soft-tissue Bankart	13 (81)	38 (86)	0.45
Osseous Bankart	2 (13)	8 (18)	0.47
Hill–Sachs	5 (31)	14 (32)	0.61
GHL	1 (6)	1 (2)	0.47
Rotator cuff	0 (0)	6 (14)	0.14
SLAP	1 (6)	5 (11)	0.49

CT scans should be considered if further clarification on osseous injuries is required.

The 0.5 sensitivity for SLAP lesions is low and suggests that MRA cannot be relied upon solely for this diagnosis. However, the available evidence on the accuracy of MRA in diagnosing SLAP lesions is conflicting with two studies reporting sensitivity and specificity as high as 0.89 and 0.91 respectively [24, 26]. On the other hand, an alternative study reports a sensitivity of 0.38 after unenhanced MRI [27]. The results from this study suggest that MRA might not be as accurate at diagnosing SLAP lesions as has been reported previously. The specificity and positive predictive values of MRA were lowest for diagnosing GHL and rotator cuff injuries. These findings are supported by a previous study of 18 patients where 13 GHL and 4 rotator cuff injuries reported on MRA were not subsequently present at arthroscopy [18]. Therefore, potentially, patients are undergoing unnecessary surgical intervention because of these false-positive results from the MRA.

In addition, failure of MRA to demonstrate associated injuries in 8 patients (13 %) is a concern: soft-tissue Bankart (5 %), SLAP (5 %) and osseous Bankart lesions (3 %). Surgeons may be basing their management decisions on inaccurate MRA findings, leading to incorrect treatment. This highlights the importance of history and clinical examination findings in these patients. Young patients who plan to return to a high level of physical activity have a high rate of recurrence [4–7]; in the absence of osseous lesions a primary diagnostic arthroscopy proceeding to surgical intervention may be an acceptable approach as a negative MRA does not exclude predisposing injuries to recurrence.

The study does have limitations. Both patients with primary and recurrent shoulder dislocations are included, the frequency and severity of associated injuries may vary between the two groups, affecting the results. A large number of radiologists and surgeons were involved in reporting their findings and a variation in interpretation and documentation may have been present. Arthroscopy has been used as the gold standard for comparison in this study, but identification with this technique is not faultless and failure of the surgeon to accurately document findings may further reduce the accuracy of arthroscopic findings. Nine patients were excluded as operation notes could not be located and this reduced the external validity of the results. The variable time from MRA to surgery (range 1–14 months) may have allowed for further injuries to have occurred in these patients who are prone to recurrent dislocation and thus under-diagnosis on MRA. This may reflect the current differing practice of surgeons regarding the threshold for obtaining MRA after dislocations.

Table 2 Sensitivity, specificity and positive predictive values (*PPV*) of MRA in shoulder instability

Injuries	Sensitivity (CI)	Specificity (CI)	PPV (CI)
All	0.9 (0.83–0.95)	0.94 (0.9–0.96)	0.88 (0.76–0.91)
Bankart/labral	0.92 (0.80–0.97)	1.0 (0.63–1.0)	1.0 (0.91–1.0)
Osseous Bankart	0.8 (0.44–0.96)	1.0 (0.91–1.0)	1.0 (0.6–1.0)
Hill–Sachs lesion	1.0 (0.79–1.0)	0.8 (0.65–0.91)	0.7 (0.5–0.86)
GHL	1.0 (0.2–1.0)	0.91 (0.8–0.97)	0.29 (0.05–0.7)
Rotator cuff	1.0 (0.2–1.0)	0.95 (0.85–0.99)	0.4 (0.07–0.83)
SLAP	0.5 (0.14–0.86)	1.0 (0.92–1.0)	1.0 (0.31–1.0)

CI confidence interval

Conclusion

Magnetic resonance angiography has a high sensitivity when used to identify associated injuries in shoulder dislocation, although in 13 % arthroscopy identified an additional injury. The overall strength of agreement between MRA and arthroscopic findings was good, but identification of GHL and rotator cuff injuries was only moderate. Although the use of MRI for the investigation of shoulder instability is increasing, caution should be exercised as inaccuracies in interpretation are not uncommon.

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