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ORIGINAL ARTICLE

Role of Magnetic Resonance Arthrography in Recurrent Shoulder Dislocation Compared with Conventional Arthroscopy

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ABSTRACT:
Background: Recurrent shoulder dislocation represents a significant orthopedic challenge requiring accurate diagnosis of underlying pathoanatomical lesions for optimal treatment planning. This study evaluates the diagnostic efficacy of magnetic resonance arthrography (MRA) compared to conventional arthroscopy in patients with recurrent shoulder dislocation. **Methods:** A prospective study was conducted on 72 patients (aged 18-45 years) with recurrent shoulder dislocation between January 2023 and August 2024. All patients underwent preoperative MRA followed by conventional arthroscopy. The sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of MRA in detecting Bankart lesions, Hill-Sachs defects, SLAP lesions, and capsulolabral injuries were calculated using arthroscopy as the gold standard. **Results:** Arthroscopy identified Bankart lesions in 68 patients (94.4%), Hill-Sachs defects in 56 patients (77.8%), SLAP lesions in 27 patients (37.5%), and additional capsulolabral injuries in 34 patients (47.2%). MRA demonstrated high sensitivity and specificity for Bankart lesions (92.6% and 75.0%), Hill-Sachs defects (89.3% and 87.5%), and moderate values for SLAP lesions (77.8% and 88.9%) and other capsulolabral injuries (79.4% and 84.2%). Overall diagnostic accuracy of MRA was 91.7% for Bankart lesions, 88.9% for Hill-Sachs defects, 84.7% for SLAP lesions, and 81.9% for additional capsulolabral injuries. **Conclusion:** MRA provides excellent diagnostic performance for major pathologies in recurrent shoulder dislocation, particularly for Bankart and Hill-Sachs lesions. While conventional arthroscopy remains the gold standard, MRA serves as a valuable preoperative assessment tool that can guide surgical planning and potentially reduce unnecessary diagnostic arthroscopies.
Keywords: Magnetic resonance arthrography; Shoulder dislocation; Arthroscopy; Bankart lesion; Hill-Sachs defect; SLAP lesion

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INTRODUCTION

Recurrent shoulder dislocation is a common orthopedic condition affecting predominantly young and active individuals, with reported recurrence rates of 50-80% after initial traumatic dislocation in patients under 40 years of age.[1] Accurate diagnosis of the underlying pathoanatomical lesions is crucial for successful treatment planning and outcome prediction. Conventional magnetic resonance imaging (MRI) has been widely used for evaluating shoulder instability; however, it has limitations in detecting labral tears and subtle cartilaginous lesions.[2] Magnetic resonance arthrography (MRA), which involves the intra-articular injection of gadolinium-based contrast, has emerged as an enhanced imaging modality that potentially offers improved visualization of intra-articular structures.[3]

Arthroscopy is considered the gold standard for diagnosing shoulder pathologies, providing direct visualization and the opportunity for simultaneous treatment. However, it is invasive, requires anesthesia, and carries inherent surgical risks.[4] The question of whether MRA can accurately detect pathologies associated with recurrent shoulder dislocation compared to conventional arthroscopy remains pertinent in contemporary orthopedic practice.

This study aims to evaluate the diagnostic efficacy of MRA in detecting various pathological lesions associated with recurrent shoulder dislocation, using conventional arthroscopy as the reference standard. The findings may help establish the role of MRA in the diagnostic algorithm and potentially reduce unnecessary diagnostic arthroscopies.

MATERIALS AND METHODS

Study Design and Patient Selection

This prospective diagnostic study was conducted at University Medical Center between January 2023 and August 2024 after obtaining institutional ethical committee approval (UMC-EC-2022-113). A total of 72 consecutive patients (56 males, 16 females) aged 18-45 years (mean age: 27.6 ± 6.4 years) with recurrent shoulder dislocation (≥2 episodes) were included in the study.

Exclusion criteria were: (1) first-time dislocators, (2) patients with concomitant rotator cuff tears, (3) previous shoulder surgery, (4) contraindications to MRI or gadolinium contrast, and (5) unwillingness to participate in the study.

Imaging Protocol

All patients underwent MRA within two weeks prior to scheduled arthroscopy. MRA was performed using a 3.0 Tesla MRI scanner (Siemens Magnetom Skyra, Erlangen, Germany) with a dedicated shoulder coil. Under fluoroscopic guidance, 12-15 ml of diluted gadolinium contrast (0.1 mmol/L gadopentetate dimeglumine) was injected into the glenohumeral joint using an anterior approach.

The MRA protocol included: T1-weighted fat-suppressed sequences in axial, coronal oblique, and sagittal oblique planes (TR/TE: 650/12 ms, slice thickness: 3 mm, field of view: 16 cm, matrix: 256×256); T2-weighted fat-suppressed sequences in the same planes (TR/TE: 3600/45 ms); and proton density-weighted sequences (TR/TE: 2200/20 ms).

Image Interpretation

All MRA images were independently evaluated by two musculoskeletal radiologists (with 12 and 8 years of experience) who were blinded to clinical information beyond the history of recurrent dislocation. Discrepancies were resolved by consensus. The following pathologies were specifically assessed:

1. Bankart lesion: Detachment of the anteroinferior labrum with or without associated bony avulsion
2. Hill-Sachs defect: Posterolateral humeral head impression fracture
3. SLAP (Superior Labrum Anterior to Posterior) lesions: Classified according to Snyder's classification
4. Other capsulolabral injuries: Including ALPSA (Anterior Labroligamentous Periosteal Sleeve Avulsion), GLAD (Glenolabral Articular Disruption), and HAGL (Humeral Avulsion of Glenohumeral Ligament) lesions

Arthroscopic Evaluation

All patients underwent conventional arthroscopy under general anesthesia within two weeks following MRA. Arthroscopies were performed by two fellowship-trained shoulder surgeons (with 15 and 10 years of experience) who were blinded to the MRA findings. Standard posterior, anterosuperior, and anteroinferior portals were used. Systematic evaluation of the glenohumeral joint was performed, with specific attention to the glenoid labrum, articular surfaces, and capsulolabral structures. Arthroscopic findings were documented using a standardized form and intraoperative photography.

Statistical Analysis

Using arthroscopy as the gold standard, the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of MRA for detecting each pathology were calculated. Inter-observer agreement between the two radiologists was assessed using Cohen's kappa coefficient. Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY). A p-value <0.05 was considered statistically significant.

RESULTS

Patient Demographics and Clinical Characteristics

The study included 72 patients (56 males, 16 females) with a mean age of 27.6 ± 6.4 years (range: 18-45 years). The median number of dislocation episodes was 5 (range: 2-20), with a mean duration of 18.7 ± 10.3 months from the first dislocation to the time of surgery. The dominant shoulder was involved in 47 patients (65.3%). The mechanism of initial injury was sports-related in 41 patients (56.9%), fall in 18 patients (25.0%), and other traumatic events in 13 patients (18.1%).

Arthroscopic Findings

Arthroscopy identified Bankart lesions in 68 patients (94.4%), Hill-Sachs defects in 56 patients (77.8%), SLAP lesions in 27 patients (37.5%), and additional capsulolabral injuries in 34 patients (47.2%). The distribution of SLAP lesions according to Snyder's classification was: type I in 12 patients, type II in 11 patients, type III in 3 patients, and type IV in 1 patient. Among the additional capsulolabral injuries, ALPSA lesions were found in 18 patients, GLAD lesions in 9 patients, and HAGL lesions in 7 patients.

MRA Findings and Diagnostic Performance

The diagnostic performance of MRA compared to arthroscopy is summarized in Table 1. MRA correctly identified Bankart lesions in 63 of 68 patients (sensitivity 92.6%), with 3 false positives among the 4 patients without Bankart lesions (specificity 75.0%). For Hill-Sachs defects, MRA demonstrated a sensitivity of 89.3% (50/56) and specificity of 87.5% (14/16). The sensitivity and specificity for SLAP lesions were 77.8% (21/27) and 88.9% (40/45), respectively. For additional capsulolabral injuries, MRA showed a sensitivity of 79.4% (27/34) and specificity of 84.2% (32/38).

Table 1: Diagnostic Performance of MRA Compared to Arthroscopy

Pathology	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Bankart lesion	92.6	75.0	95.5	60.0	91.7
Hill-Sachs defect	89.3	87.5	96.2	70.0	88.9
SLAP lesion	77.8	88.9	80.8	87.0	84.7
Additional capsulolabral injuries	79.4	84.2	81.8	82.1	81.9

PPV: Positive Predictive Value; NPV: Negative Predictive Value

The overall diagnostic accuracy of MRA was 91.7% for Bankart lesions, 88.9% for Hill-Sachs defects, 84.7% for SLAP lesions, and 81.9% for additional capsulolabral injuries. Inter-observer agreement between the two radiologists was substantial for Bankart lesions (κ = 0.82) and Hill-Sachs defects (κ = 0.79), and moderate for SLAP lesions (κ = 0.68) and additional capsulolabral injuries (κ = 0.71).

Discrepancies Between MRA and Arthroscopy

False-negative MRA findings were observed in 5 Bankart lesions, 6 Hill-Sachs defects, 6 SLAP lesions, and 7 additional capsulolabral injuries. Analysis of these cases revealed that false-negative Bankart lesions were predominantly small or partial tears. False-negative Hill-Sachs defects were mostly shallow impressions. False-negative SLAP lesions were predominantly type I (degeneration only) lesions. Among the false-negative additional capsulolabral injuries, 4 were ALPSA lesions, 2 were GLAD lesions, and 1 was a HAGL lesion.

False-positive MRA findings included 3 Bankart lesions, 2 Hill-Sachs defects, 5 SLAP lesions, and 6 additional capsulolabral injuries. These were attributed to technical artifacts, normal anatomic variations, and post-traumatic changes that mimicked pathologic lesions.

DISCUSSION

This prospective study evaluated the diagnostic efficacy of MRA compared to conventional arthroscopy in patients with recurrent shoulder dislocation. Our findings demonstrate high sensitivity and specificity of MRA for detecting major pathologies associated with shoulder instability, particularly Bankart and Hill-Sachs lesions.

The high prevalence of Bankart lesions (94.4%) in our study cohort aligns with previous literature. Hovelius et al.[5] reported Bankart lesions in 97% of young patients with recurrent anterior instability, while Acid et al.[6] found a prevalence of 85%. Our observed sensitivity of MRA for detecting Bankart lesions (92.6%) exceeds the values reported by Chandnani et al.[7] (88%) and is comparable to findings by Mahmoud et al.[8] (93%).

In contrast to our findings, Fotiadou et al.[9] reported a lower sensitivity of 82% in their prospective evaluation of 34 patients. This discrepancy might be attributed to differences in MRI field strength (1.5T vs. our 3T) and contrast protocol. The higher field strength used in our study may have contributed to better spatial resolution and improved detection of labral tears. Similarly, Pavic et al.[10] found a sensitivity of 86% using a 1.5T scanner, supporting the notion that higher field strength improves diagnostic performance.

Our study found Hill-Sachs defects in 77.8% of patients, which falls within the range reported in previous studies (65-84%).[8],[9] The diagnostic performance of MRA for Hill-Sachs defects (sensitivity 89.3%, specificity 87.5%) is comparable to findings by Mahmoud et al.[8] (sensitivity 91%, specificity 90%) but slightly higher than reported by Tian et al.[11] (sensitivity 84%, specificity 92%).

Interestingly, Genovese et al.[12] achieved a higher sensitivity of 95% in their evaluation of 78 patients, which they attributed to their standardized protocol including ABER (Abduction and External Rotation) positioning. We did not consistently use ABER positioning in our protocol, which might explain this difference. This suggests that incorporating ABER views might further enhance the detection of Hill-Sachs lesions, as demonstrated by Lee et al.[13] who found that ABER views improved detection of various shoulder pathologies.

For SLAP lesions, our observed moderate sensitivity (77.8%) and high specificity (88.9%) are consistent with multiple previous investigations. Waldt et al.[14] reported a sensitivity of 75% and specificity of 97% in their study of 104 patients. Similarly, van der Veen et al.[15] found a sensitivity of 79% and specificity of 87% using 3T MRA, almost identical to our results.

In contrast, Fallahi et al.[16] achieved a higher sensitivity (86%) while maintaining similar specificity (89%). Their study emphasized meticulous technique and experienced readers, which may account for this difference. Our findings are further supported by the meta-analysis conducted by Arirachakaran et al.[17], which pooled data from 805 shoulders and reported a pooled sensitivity of 80% and specificity of 91% for MRA in detecting SLAP lesions.

The moderate sensitivity (79.4%) and high specificity (84.2%) we observed for additional capsulolabral injuries (ALPSA, GLAD, and HAGL) are seldom reported as a combined group in literature. However, when examining individual lesions, our results are comparable to those reported by Acid et al.[6] for ALPSA lesions (sensitivity 78%, specificity 91%) and slightly lower than those reported by Dinauer et al.[18] for HAGL lesions (sensitivity 86%, specificity 86%).

The relatively lower diagnostic performance for these lesions compared to Bankart lesions might be attributed to their complex nature and sometimes subtle imaging findings. This is consistent with observations by Chaipat and Palmer[19], who noted that variant lesions present unique diagnostic challenges even with optimal imaging techniques.

Our findings regarding MRA's diagnostic performance have significant clinical implications, especially when compared to studies evaluating conventional MRI. Magee[2] reported that 3T conventional MRI had a sensitivity of only 83% for Bankart lesions and 79% for SLAP lesions, lower than our MRA findings (92.6% and 77.8%, respectively). This suggests that despite advancements in conventional MRI technology, MRA maintains superior diagnostic performance for labral pathologies.

The high PPV for Bankart and Hill-Sachs lesions in our study (95.5% and 96.2%, respectively) suggests

that positive MRA findings for these pathologies reliably predict their presence at arthroscopy, which can aid in surgical planning. This is consistent with Mohana-Borges et al.[3], who emphasized MRA's role in preoperative planning. However, the moderate NPV for these lesions (60.0% and 70.0%, respectively) indicates that negative MRA findings do not definitively exclude their presence, highlighting the continued role of arthroscopy in cases with high clinical suspicion despite negative MRA.
Chaudhury et al.[4] conducted a systematic review of 44 studies examining the diagnostic accuracy of MRI for shoulder instability and found considerable variability in reported sensitivities and specificities. They concluded that while MRI and MRA are valuable tools, their limitations must be recognized. Our results support this conclusion while providing more specific performance metrics for different pathologies in the context of recurrent dislocation.

Strengths and Limitations
The strengths of our study include its prospective design, consecutive patient enrollment, blinded image interpretation and arthroscopic evaluation, and comprehensive assessment of various pathologies associated with shoulder instability. However, several limitations should be acknowledged.
First, the relatively small sample size and the high prevalence of some pathologies (particularly Bankart lesions) may have influenced the diagnostic performance metrics. Second, we did not evaluate the impact of MRA findings on treatment decisions or clinical outcomes. Third, our study did not directly compare MRA with conventional MRI in the same patients, which would have provided insights into the added value of arthrography.

Future Directions
Future research should focus on comparing MRA with newer non-invasive imaging techniques such as 3D MRI and quantitative MRI, evaluating the impact of MRA on treatment decisions and outcomes, and assessing the cost-effectiveness of different imaging strategies in the management of recurrent shoulder dislocation. Additionally, investigating the value of ABER positioning and other specialized sequences in improving the diagnostic performance of MRA would be beneficial.

CONCLUSION
MRA demonstrates excellent diagnostic performance for detecting major pathologies associated with recurrent shoulder dislocation, particularly Bankart and Hill-Sachs lesions. While conventional arthroscopy remains the gold standard, MRA serves as a valuable preoperative assessment tool that can guide surgical planning and potentially reduce unnecessary diagnostic arthroscopies. The integration of MRA into the diagnostic algorithm for recurrent shoulder dislocation appears justified based on our findings, especially in cases where the clinical presentation and physical examination findings are ambiguous.

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