RESEARCH ARTICLE

Assessment of Correlation Between MRI and Arthroscopic Pathologic Findings in the Shoulder Joint

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Abstract

Background: The objective of this study was to determine the diagnostic value of magnetic resonance imaging for shoulder joint pathologies and then compare the results with arthroscopy, the standard for joint diagnosis.

Methods: In this cross-sectional study, 80 patients with shoulder joint disorders, who underwent final arthroscopy, were studied. Based on patients' medical history and physical examinations, shoulder MRI was requested if paraclinical investigations were. If non-surgical therapies failed, arthroscopy of the affected shoulder was done and the same structures were inspected. Subsequently, sensitivity, specificity, and positive and negative predictive values (PPV) and (NPV) of MRI were determined by arthroscopy comparisons.

Results: The highest sensitivity, specificity, PPV and NPV were found in MRI pathology reports that included: Hill-Sach lesion (0.910), infraspinatus tendon (0.985), supraspinatus tendon (0.930), and biceps tendon (0.954), respectively. Rotator interval (0.250), biceps labrum complex (0.805), subscapularis tendon (0.538) and anterior labrum lesions (0.604) had the lowest sensitivity, specificity, PPV and NPV, respectively.

Conclusion: The results showed that MRI can be a useful tool in ruling out possible abnormalities in the shoulder and to give clues to the most probable diagnosis. Although knowing some practical skills in order to successfully perform the procedure and experience of the radiologist with suitable feedback by surgeon is necessary.

Keywords: Arthroscopy, MRI, Sensitivity, Shoulder, Specificity

Introduction

Despite the initial challenging interpretation of normal and pathological findings to evaluate the shoulder joint, remarkable and impressive developments of arthroscopy and magnetic resonance imaging (MRI) accomplished over the past three decades have resulted in higher accuracy of diagnoses (1). This outcome has been achieved by the interaction of radiologists and arthroscopic shoulder surgeons who have shared their clinical experiences and provided feedback of mutual patients. However, the opinion of radiologists and surgeons regarding MR images of the shoulder still has undeniable inconsistencies to this date (2,3).

The advent of shoulder arthroscopy, in addition to the progress made in understanding the shoulder anatomy and biomechanics, has provided clinicians with special assistance to detect previously undiagnosed soft tissue lesions and injuries (4). Although it would be unfair to underestimate the importance of patience history and physical examination despite the diversity in performance and interpretation, as well as imaging modalities, like magnetic resonance arthrography (MRA), because these tools still provide limited support (5-8). Thus, diagnostic arthroscopy remains the gold standard in obtaining a definite diagnosis of abnormalities and is useful in planning suitable treatments (4).

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Shoulder complaints such as pain, a common symptom, might be attributable to disorders of rotator cuff tendons, joint capsule, labrum, cartilage or muscles, as a result of wear and tear, trauma or other acute or chronic insults (9,10). Shoulder pathologic manifestations are investigated paraclinically by the use of MRI, MRA and ultrasound (US) (10). Although MRI has been considered the most useful imaging study to assess the shoulder (9, 11), it is still not fully clear whether any of the established imaging methods is superior to the others for different abnormalities (10).

Considering imaging modalities like MRI play a decisive role in planning the treatment protocols for patients (12), it is vital to know to what extent these operator-dependent imaging reports are valid, reliable and informative. Therefore, we studied the sensitivity, specificity, and positive and negative predictive values of MRI for diagnostic evaluation of shoulder disorders and compared the results with arthroscopy, which is the standard reference for interaarticular and subacromial shoulder pathologies.

Materials and Methods

Eighty consecutive patients who underwent shoulder arthroscopic surgery during April-August 2014 in the Shoulder Surgery Branch of the Orthopaedics Department, Chamran Hospital, Shiraz University of Medical Sciences, Shiraz, Iran, participated in this cross-sectional study. These patients were selected from the population with shoulder joint disorders. They were examined according to medical history and paraclinical studies were requested if necessary, especially MRI. After confirming the diagnosis with clinical and paraclinical clues including MRI findings, treatment was initiated with suitable non-surgical modalities, such as drugs, physiotherapy and joint injection for an adequate period of time. In case of treatment failure, or in some patients with conditions necessitating early surgical intervention such as acute rotator cuff tearing, shoulder arthroscopy was performed. Patients with contradictory conditions for general anesthesia and surgery and those who showed acceptable responses to non-surgical treatments were excluded. All processes of this study were approved by Ethics Committee of the Shiraz University of Medical Sciences.

Pre-operative MRI was obtained in various centers in university or out of university. Out-center images were done by a 0.5 or 1.5 tesla PHILIPS or 1.5 tesla magnet SIEMENS AVANTO device with sequences including: axial T2WI & PD, sagittal GRE, T1WI, T2WI, PD fat saturation and coronal T2WI & T1WI with a wide range of MRI indices. In the university center, 1/5 TESLA magnet SIMENS AVANTO and PHILIPS device with almost uniform sequences and MRI indices were used including: coronal, sagittal and axial T2WI & PD fat sat. Images were reported by a single expert radiologist from the radiology department of the Shiraz University of Medical Sciences in order to omit inter-observer factors interfering with the reliability of the test. The radiologist checked all the structures that could be evaluated in arthroscopy according to a checklist provided by the arthroscopist. They were bíceps tendon, biceps labral complex, labrum, rotator interval, subscapularis tendon, ligaments, head and glenoid cartilages, sub-acromial bursa, and supa- and infraspinatus tendons. This helped to reduce the chance of missing positive findings in the MRI, which could be missed due to lack of adequate attention to the desired structures.

Patients underwent shoulder arthroscopy at a maximum four weeks after reviewing the MRI findings under general anesthesia in the lateral decubitus position after applying a special shoulder traction device, with standard posterior and mid-glenoid portals and a 30 degree arthroscopic lens. All previously mentioned structures were inspected and probed. With the same prepared checklist, pathologies were saved in detail for future comparison with the radiologist's MRI report. Then surgical intervention of found pathologies was done as needed.

Finally, MRI findings (sensitivity, specificity, and positive and negative predictive values) were compared to arthroscopy findings.

Results

This study was done on 80 patients with shoulder joint disorders who were candidates for shoulder arthroscopy in their clinical course of management. After definite diagnosis through arthroscopy, as the standard reference, MRI reports were assessed and the four analytical features of the MRI test (sensitivity, specificity, and positive and negative predictive values) were calculated for biceps labrum complex, biceps tendon, labrum, subscapularis tendon, rotator interval and synovitis, supraspinatus tendon, infraspinatus tendon and glenoid and head cartilage and subacromial bursa.

Sensitivity of MRI proved to be highest for Hill-Sachs lesion size and location (0.910) and lowest for rotator interval pathologies (0.250). Highest specificity was in tears of infraspinatus tendon (0.985), whereas it was lowest for biceps-labrum complex (0.805). We detected 36 cases with SLAP I, three cases with SLAP II and 16 cases with synovial hypertrophy grade I & II and three cases with type III. MRI reports were shown to have the most positive predictive value for supraspinatus tendon tears (0.930), while this factor ranked the lowest for subscapularis tendon tears (0.538). The highest negative predictive value was found to be 0.954, which was recorded for biceps tendon pathologies (tendinosis and tear). However, detection of anterior labrum lesions possessed the lowest negative predictive value in MRI reports (0.604). In general, specificity of MRI had the highest values, compared to the other three characteristics of this diagnostic test and specifically for five out of eight evaluated areas. All calculated data are shown in [Table 1].

Discussion

Nowadays MRI is one of the powerful modalities in evaluation of soft tissue and bony pathologies of the shoulder joint. In this study we were interested in evaluating the reports of shoulder MRIs, submitted by

Table 1. Sensitivity, specify, positive predictive value (PPV) and negative predictive value (NPV) of MRI studies for each of the particularly evaluated cartilage and soft tissue site of abnormalities

Structures	Arthroscopy (n)	MRI (n)	Sensitivity	Specificity	PPV	NPV
Biceps labrum complex	39	37	0.744	0.805	0.784	0.767
Biceps tendon	15	14	0.800	0.969	0.857	0.954
Labrum	42	28	0.500	0.842	0.778	0.604
Subscapularis tendon	11	13	0.636	0.913	0.538	0.940
Rotator interval & Synovium	19	6	0.250	0.983	0.833	0.797
Supra-spinatous tendon	44	43	0.909	0.917	0.930	0.892
Infra-spinatous tendon	12	9	0.667	0.985	0.889	0.944
Humeral head & Glenoid Cartilage	32	44	0.910	0.910	0.660	0.980

radiologists in our center. Advanced shoulder surgeries such as shoulder arthroscopic reconstructions and shoulder arthroplasties in the orthopedic department of the Shiraz University of Medical Sciences, started in year 2010. To date we are one of the fewest in the south of Iran to perform complicated and advanced shoulder surgeries. After years of acceptable experience in these surgeries, now the time has come to evaluate shoulder MRI reports submitted by the radiologists and compare them with arthroscopic findings for feedback in order to become better readers of preoperative MRI's and to have a better connection with radiologists and improve the accuracy of their reports. We divided pathologies of the shoulder into two groups: intra-articular and sub-acromial. We asked the responsible radiologist of this study, who is studying fellowship in MRI and experienced in the shoulder, to precisely inspect the shoulder MRI's of the 80 patients for all the structures predetermined in our checklist. Several interesting conclusions were made upon which the results of our study are based. Rotator interval pathologies have the highest chance to be missed by the reader, and reports of subscapularis tendon tears are false with a greater probability, as they have the lowest PPV. On the other hand, supraspinatus tendon tears had the greatest PPV, which means their diagnosis in MRI can be reliable and definitive. Furthermore, sensitivity and specificity of detection of this lesion in MRI were both higher than 90%.

Biceps-labrum complex and Biceps tendon

Kaplan et al, in their study, showed that fluid around the long head of the biceps is abnormal only if it completely surrounds the tendon in the absence of joint effusion (12). Therefore, mere attention to the tendon may result in false-positive detection of tendonitis. Also, considering that complete biceps tendon rupture not only occurs in the extra-articular part in the biceps grove, but also possibly in the intra-articular part, it is essential to pay attention to MRI in order not to miss intra-articular ruptures (13). Biceps tendon dislocation could be detected in MRI easily, but usually it is accompanied by subscapularis tendon and/or coraco-humeral ligament rupture. Hence, in this way if we are suspicious of these tendon and ligament ruptures, kinematic shoulder MRI in full external rotation position would be more helpful (14). Also, detecting SLAP lesions is also difficult with conventional MRI. In a study by Cortland, taking the coronal oblique view and external rotation position were helpful in detecting SLAP lesion (15). Diagnosis of superior labrum anterior-posterior (SLAP) tears in patients undergoing arthroscopy showed an overall sensitivity of 66%, specificity of 77%, PPV of 24%, and NPV of 95% for MRI. These values were all lower than those mentioned in previous literatures, and so MRI cannot be considered accurate as a single diagnostic tool, except for an acceptable SLAP lesion exclusion rate, due to its high NPV percentage (13). The results of another similar study on SLAP lesions found 43% sensitivity and 96% specificity for conventional MRI (14). MR arthrography has higher sensitivity and specificity than non-contrast MRI in detection of SLAP lesion, but it is not accurate in the differentiation of complete and partial biceps-labral detachment; and limb traction during the MRI procedure improves this differentiation (16). Jee et al. reported sensitivity of 92% and specificity of 82% with MR arthrography compared to arthroscopy (17).

Labrum

Different labrum pathologies in anterior instability like degeneration, tear, erosion and MRI finding were described in detail in different studies. According to Goss's study, MRI sensitivity and specificity for labrum pathologies of degeneration, tear and erosion were reported at 90.6% and 68.8% (18). Studies showed MR arthrography in diagnosis of labrum pathologies is better than conventional MRI. Labral defect, frying and detachment are diagnosed more accurately with dye infiltration (18). In a study by Cvitanic, axial MR arthrography in the ABER position has had the most sensitivity and specificity in detection of labrum pathologies (19).

Subscapularis tendon

Diagnosed subscapularis tendon tears using radial-

slice MRI with arthroscopy was assessed in radial, transverse and oblique sagittal images by Furukawa et al. Sensitivities and specifies were 94.7% and 82.4%, 57.9% and 100% and finally 60.5% and 100% for radial, transverse and oblique sagittal images, respectively (15).

Shoulder joint cartilage

Sensitivity and specificity of diagnostic non-contrast MRI in detecting glenohumeral cartilage lesions were 43% and 91% for humeral and 53% and 93% for glenoid lesions (20). Although the authors considered MRI overall a good tool, they mentioned reduced accuracy in low-grade lesions. Also MRI being reader-dependent is disadvantageous to this modality (20).

Rotator cuff tendons

Review of the literature yields studies with variable results in this field. Concordance of MRI and arthroscopy to diagnosis rotator cuff tear in a study by Frei et al., showed a sensitivity of 0.92 and specificity of 1.0, with the authors claiming MRI to be one of the most effective ways for rotator cuff tear diagnosis (21). A systematic study by Lenza et al., which reviewed correlation of rotator cuff tears in MRI and arthroscopy, suggested that MRI has good diagnostic accuracy for identification of full-thickness tears. However, it has a poor sensitivity regarding partial-thickness tears (9). Symptomatic partial rotator cuff tears were evaluated by Vlychou in patients with impingement syndrome of the shoulder through MRI, before arthroscopic or mini-open surgical interventions. MRI imaging had a sensitivity of 97.7%, a specificity of 63.6% and PPV of 91.7% (11). In a study by Robertson et al., MRI inter-observer and intra-observer reliability for rotator cuff full thickness tears had an accuracy of about 90%, but they did not obtain this result in partial thickness tears (22). MR arthrography increases the ability of MRI to detect rotator cuff tears particularly on articular side partial thickness tears, although this is not the case for MRI in detecting full thickness tears and bursal-side partial thickness tears (16). Kirkley et al. analyzed correlation of MRI and arthroscopy for multiple disorders (23). Correlations were fair for rotator cuff tear and joint capsule lesions, moderate for superior labral lesions, sensitive for Hill-Sachs lesions and perfect for Bankart lesions (24). The authors concluded that MRI can be considered a valuable tool for Bankart and Hill-Sachs lesions associated with primary traumatic anterior dislocations; however, it has limited efficiency to detect other pathologic lesions. In a double-blind study comparing MRI and arthroscopy results with patients with shoulder pain, MRI proved to be highly accurate in diagnosing full-thickness supraspinatus tears, yet had a poor concordance for biceps tendon. The overall conclusion of the authors, was that MRI was a useful tool in the identification of shoulder pathology (20). Non-contrast MRI reports of three radiologists for non-dislocating shoulder trauma in a study by Banerjee et al. showed a moderate sensitivity for most intra-articular pathologies. It was concluded that accuracy depends on observers rather than the assessed qualities (17). In general, it is clear that MRI findings are highly dependent on readers' subjective assessments and reports vary in different clinical conditions and settings. With that in mind, clinical decision-making should be based on a full understanding of the report's validity and reliablity.

The results indicate that MRI can be a useful tool in ruling out possible abnormalities in the shoulder and giving clues to the best diagnosis. Some practical skills in its performance and the experience of radiologists along with suitable feedback by surgeons are necessary to increase sensitivity and specificity in medical centers with high activities in shoulder surgeries. Our limitation in this study was the differences between quality of MRI (0.5 tesla in 10 cases) and presently more investigations about these differences are in progress in another study.

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