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MR Arthrography and Arthroscopic Correlation in the Evaluation of Shoulder Pathologies

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Abstact

Background: Shoulder is a complex joint. Shoulder patologies effect young and active people. It causes to loss of manpower and it is common situation. It is important to accurately determine the etiological causes in patients presenting with pain and recurrent shoulder dislocation.

Aim: The aim of the study to evaluate the sensitivity and specificity of conventional magnetic resonance (MR) imaging and MR arthrography in the diagnosis of shoulder pathologies, and to compare with arthroscopic results.

Methods: Twenty-five patients (16 male and nine female) who were refered because of clinically suspected shoulder pathologies were examined using conventional MR imaging and MR arthrography. In 21 of these patients, imaging findings were compared with those at arthroscopy, which performed by an experienced orthopedic surgeon.

Results: In 21 patients there were 30 pathologic shoulder lesions on arthroscopy. Conventional MR imaging detected 26 of them (%86.6sensitivity), whereas 29 lesions were detected by MR arthrograpy (% 96.6sensitivity).

Conclusions: MR arthrography is a more sensitive and specific modality than conventional MR imaging to evaluate of shoulder pathologies. Our sensitivity and specificity values obtained with both conventional MR and MR arthrography were found to be similar to the results of studies with larger patient groups. No statistically significant difference was found between the imaging methods used in our study($p>0,05$). But it was seen that the results obtained by MR arthrography were closer to the results obtained arthroscopically. In fact, It was concluded that MR arthrography is a reliable imaging method to be designed for accurate and detailed evaluation of shoulder pathologies.

Key words: Shoulder MR, MR artrography, arthroscopy, impingement, instability.

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Orginal Article

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Introduction

Shoulder is a complex joint. Shoulder patologies effect young and active people. It causes to loss of manpower and it is common situation. It is important to accurately determine the etiological causes in patients presenting with pain and recurrent shoulder dislocation. Thus, the right treatment can be selected. Therefore, direct radiography, computed tomoarthrography and magnetic resonance (MR) imaging methods are used for diagnostic purposes (1,2). However, the search for new methods continues because of the disadvantages of these methods and their technical deficiencies in helping the diagnosis.

Magnetic resonance imaging has become a reliable diagnostic method in the evaluation of musculoskeletal pathologies due to its high soft tissue contrast. Conventional MR imaging is insufficient in evaluating and diagnosing pathologies seen in the ligament, tendon, labrum and other anatomical structures of the shoulder joint. Also, the articular surface of the rotator cuff is difficult to evaluate in the absence of joint effusion (3,4). In recent years, MR arthrography, which is performed by obtaining MR images after the administration of contrast material into the joint space, has been seen as a promising method in the evaluation of shoulder pathologies (5).

The contrast material given in MR arthrography causes the joint capsule to expand, making the intra-articular structures better visible and increasing the accuracy of conventional MR. (6,7). It is a method that can be preferred to conventional MR imaging especially in the suspicion of rotator cuff tear, recurrent shoulder dislocations, evaluation of labral pathologies and glenohumeral ligaments. (6,8).

In this study, it was aimed to evaluate the arthroscopic correlation of conventional MR and MR arthrography and to ensure the routine use of MR arthrography in our hospital.

Material and Methods

This study was conducted as a prospective study between October 2002 and February 2004 within the Department of Radiodiagnostic, Erciyes University Faculty of Medicine. Patients who underwent shoulder surgery for any reason before, or those with systemic diseases that could not tolerate arthroscopic procedure were excluded from the study. A total of 25 patients who presented to our faculty orthopedics outpatient clinic due to shoulder pain, limitation of shoulder movements, anterior, posterior and multidirectional shoulder dislocation were included in the study. Written information was given to the participants about the study. Informed consent was obtained after all participants signed a standardized consent form. Sixteen of the patients included in the study were male and nine were female, and the mean age was 42.8 ± 13.9 (21-68). Sixteen patients had right shoulder pathology, nine patients had left shoulder pathology.

Conventional MR imaging was performed to the patients before performing the MR arthrography examination. The images were obtained with the patient in the supine position and the arm in external rotation. The matrix was 256x256. Conventional MR imaging protocol is shown in Table 1. Conventional MR imaging time was about half an hour.

Intra-articular contrast agent injection was applied to each patient before MR arthrography imaging was obtained. For this purpose, an average of 12-16 ml of 1/120 diluted isotonic Gd-DTPA (Gadolinium Diethylenetriamine Pentaacetic acid, Omniscan, Nycomed) solution was

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Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

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injected into the joint space from the posterior while the patient was sitting, using an 18-Gauge intracet mandrel (Becton- Dickinson). None of the patients developed early or late complications.

Table 1: Conventional MR protocol

Sequence	TE (msn)	TR (msn)	FOV (mm)	Slice Thickness (mm)	Cross Section Range (mm)
Proton TSE axial	1496	17	180	3	0,3
T2 Weighted FFE axial	550	14	180	3	0,3
T1 Weighted oblique coronal	500	17	220	4	0,4
T2 Weighted oblique coronal	2799	90	200	4	0,4
T2 Weighted SPIR coronal	2537	70	210	4	0,4
T2 Weighted oblique sagittal	2799	90	180	4	0,4

Philips Gyroscan ACS-NT model 1.5 T MR device (Made in Netherlands) was used for conventional MR and MR arthrography. Intra-articular injection of contrast material and MR imaging took approximately 45 minutes. After the injection, MR arthrography was performed using the shoulder coil, with the patients in the supine position, with their arms and hands in external rotation. The matrix was 256x256. In the last 2 sequences, the patients were placed in the abduction external rotation (ABER) position to better evaluate the inferior glenohumeral ligament and its pathologies. Table 2 shows the MR arthrography protocol.

Rotator cuff tendons and glenohumeral ligaments, glenoid labrum, Hill-Sachs deformity, acromion morphology (acromion type 1-3) and joint capsule (type 1-3) were evaluated in the images obtained. Partial tear was diagnosed by observing the extension of the contrast material into the tendon. It was emphasized that there was a full-thickness tear in the tendon by showing the transition of the contrast material to the subacromial, subdeltoid bursa by crossing the tendon.

Table 2: MR arthrography protocol

Sequence	TE (msn)	TR (msn)	FOV (mm)	Slice Thickness (mm)	Cross Section Range (mm)
T1 Weighted fat supressed sequence	20	500	180	4	1,5
T1 Weighted axial	20	500	180	4	1,5
T1 Weighted oblique coronal	20	500	180	4	1,5
T1 Weighted oblique sagittal	20	500	180	4	1,5
T2 Weighted TSE oblique coronal	90	2791	180	4	1,1
T1 Weighted coronal (ABER)	17	500	220	4	1,4
T1 Weighted axial (ABER)	17	500	220	4	1,4

IJBCS ISSN: 2147-1428

Orginal Article

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In the evaluation of glenoid labrums; it was stated that the tears detected in the axial sections were in the anterior and posterior labrum, and the tears detected in the oblique coronal sections were in the superior and inferior labrum.

The typing of the acromion was made by looking at the shape of its lower surface in oblique sagittal images. It was named type 1 if it had a flat bottom surface, type 2 if it had a sloping bottom surface, and type 3 if it was hooking forward. Type 3 acromion was considered pathological because it caused impingement and acromioplasty was performed with arthroscopic intervention.

In capsule typing; capsular adhesion type 1 in the labrum; If it is adjacent to the junction of the glenoid and labrum, close to the middle part of the neck of the scapula, type 2; The most medial part of the neck of the scapula was named type 3 capsule.

Arthroscopy of all patients was performed within one month after MR arthrography by an experienced orthopedist (F.D.). Arthroscopic procedure was performed with Linvatek brand Swiss made arthroscopy device. Following the application of interscalene or general anesthesia, the joint space was accessed with a posterior approach. Joint distension was achieved by first injecting 50 ml of isotonic or arthroscopic glycine fluid into the joint space.. When the joint was entered, the biceps tendon and its origin, humeral head and glenoid joint surface, glenoid labrum and ligaments, and intra-articular surface of the rotator cuff were evaluated. Then, the bursal surface of the rotator cuff, synovial status and the morphology of the acromion were evaluated from the subacromial space. The detected pathologies were repaired using appropriate techniques.

Findings obtained from arthroscopic examination were accepted as "gold standard". It was compared with conventional MR and MR arthrography results. In our study, because we wanted to measure the strength of methods to detect lesions rather than patients; nine different lesions obtained from 21 patients were evaluated in three main groups. For this purpose, lesions were divided into three groups as impingement group, instability group, and others. Partial and full thickness rotator sheath tendon tears (partial and full-thickness tears of the supraspinatus tendon and full-thickness tears of the infraspinatus tendon) constituted the impingement group. Glenoid labrum tears (Bankart and SLAP-superior labrum anterior posterior- lesions) and Hill-Sachs deformity lesions were included in the instability group. Other pathologies identified (biceps tendon rupture, intraarticular free body) and type 3 acromion were considered as the third group. In the impingement and instability group; Conventional MR, MR arthrography and arthroscopy results were compared and evaluated. Thus, three lesions in both the impingement and instability groups were evaluated separately for each patient (21 patients). As a result, 63 data were obtained for these two groups and statistical analysis was made. In the third group; since the same number of lesions were detected in all three methods, no statistical evaluation was required.

Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 57-67 Tutus S. Et all.

Statistical Analysis

Since the data are qualitative and in a dichotom; Cochran Q test was used to compare the three methods, and Mc Nemar test was used to compare arthroscopy with conventional MR and MR arthrography. Sensitivity and specificity of conventional MR and MR arthrography methods compared to arthroscopy were calculated. SPSS 11.5 statistical package program was used for statistical calculations. In all comparisons, α error level was taken as 0.05.

Results

Arthroscopic intervention was performed in 21 of 25 patients who underwent conventional MR and MR arthrography. Bankart lesion was suspected on MRI in one of the remaining four patients. However, as a result of the MR arthrography, it was determined that the patient did not have an anterosuperal labrum and that the middle glenohumeral ligament (MGHL) extended quite thickly, and the lesion was evaluated as the Buford complex. Therefore, the patient did not need arthroscopy. In one case; Bankart lesion was again suspected on MR imaging. In MR arthrography; since the anterosupior labrum was observed separately from the adjacent glenoid, it was reported as a sublabral foramen and arthroscopy was not performed. In a patient with shoulder pain in the right arm abduction, arthroscopy was not required due to normal MR and MR arthrography results. Conventional MR and MR arthrography revealed dislocation in the biceps tendon, complete rupture in the supraspinatus tendon, intraarticular free body and acromioclavicular joint degeneration in another patient with marked limitation of motion and pain in the right shoulder. However, the patient did not accept arthroscopy.

All cases were evaluated for glenoid labrum tears [Bankart lesion, SLAP, ALPSA (anterior labroligamentous peristeal sleave avulsion) lesion etc.], Hill-Sachs deformity, glenohumeral ligament tears, rotator cuff tears (partial and full thickness tears of the supraspinatus, infraspinatus, subscapularis and teres minor tendons), type 3 acromion, intraarticular free body and biceps tendon tears by conventional MR, MR arthrography and arthroscopy. According to the arthroscopic findings, 30 pathological lesions were detected, and conventional MR and MR arthrography results are shown in Table-3.

Full thickness tears in the infraspinatus tendon were observed together with full thickness tears in the supraspinatus tendon. All partial tears were associated with the articular surface. All Hill-Sachs deformities were associated with Bankart lesion. Intraarticular free body was present with Bankart lesion and Hill-Sachs deformity, and the same patient had type 3 capsular insertion in the anterior region. The biceps tendon rupture observed in only one case was associated with Bankart lesion and partial tear of the supraspinatus tendon. In the same case, there were type 3 capsules in the anterior and type 2 capsules in the posterior. In a patient who had clinical complaints of impingement and whose conventional MR and MR arthrography was reported to be normal, type 2 acromion findings were detected arthroscopically. Acromioplasty was performed due to clinical complaints.

IJBCS ISSN: 2147-1428

Orginal Article

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Table-3: Comparison of conventional MR and MR arthrography results according to arthroscopic findings. (Values in parentheses indicate true positives, and the other number indicates the number of lesions evaluated as positive by that method.)

Lesion	Conventional MR	MR Arthrograhy	Arthroscopy
Supraspinatus full thickness tear	4 (4/5)	5 (5/5)	5
Supraspinatus partial tear	5 (3/3)	4 (3/3)	3
Infraspinatus full thickness tear	2 (2/2)	2 (2/2)	2
Bankart lesion	9 (5/6)	6 (6/6)	6
Hill-Sachs deformity	6 (5/5)	5 (5/5)	5
SLAP lesion	- (0/2)	1 (1/2)	2
Type 3 acromion	5 (5/5)	5 (5/5)	5
Intraarticular free body	1(1/1)	1(1/1)	1
Biceps tendon tears	1(1/1)	1(1/1)	1
TOTAL	**33 (26/30) (%86.66)**	**30 (29/30) (%96.66)**	**30 (%100)**

Acromion typing in impingement syndrome was performed in MR arthrography. Accordingly, type 1 acromion was detected in seven of 25 patients, type 2 in 13 and type 3 in five patients.

Capsule types that play a role in instability were evaluated in MR arthrography. In the anterior leads, seven of the 25 patients had type 1, eleven patients had type 2 and seven patients had type 3 capsules. In the posterior, fifteen patients had type 1, nine patients had type 2, and only one patient had type 3 capsules.

In the impingement group, the number of lesions detected by arthroscopy with conventional MR and MR arthrography methods were compared with Cochran's Q test. (Cocheran’s Q: 0,667, p>0,05). There was no significant difference in this test result. Later, conventional MR and MR arthrography methods were compared with arthroscopy method using Mc Nemar test. In the Impingenent group, it was found that both specificity and sensitivity of MR arthrography were higher than conventional MR. The results are shown in Table 4 and Table 5.

Table-4: Comparison of conventional MR and arthroscopy results in the detection of rotator cuff pathologies in the impingement group.

Convantional MR	Arthroscopy (+)	Arthroscopy (-)
Pozitive	9	2
Negative	1	51
Total	**10**	**53**

(Mc. Nemar, p>0,05) (Sensitivity %90, Specificity %96,2)

IJBCS ISSN: 2147-1428

Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 57-67 Tutus S. Et all.

Tablo-5: Comparison of MR arthrography and arthroscopy results in the detection of rotator cuff pathologies in the impingement group.

MR Arthrography	Arthroscopy (+)	Arthroscopy (-)
Pozitive	10	1
Negative	0	52
Total	**10**	**53**

(Mc. Nemar, p>0,05) (Sensitivity %100, Specificity %98,1)

In the instability group, the number of lesions detected by arthroscopy with conventional MR and MR arthrography methods were compared with Cochran's Q test. There was no significant difference in this test result (Cocheran's Q: 1.750, p>0.05). Then, conventional MR and MR arthrography methods were compared with arthroscopy method using Mc Nemar test. According to these results, it was determined that both specificity and sensitivity of MR arthrography in the instability group were higher than conventional MR. The results are shown in Table 6 and Table 7.

Table-6: Comparison of conventional MR and arthroscopy results in the instability group.

Convantional MR	Arthroscopy (+)	Arthroscopy (-)
Pozitive	10	5
Negative	3	45
Total	**13**	**50**

(Mc. Nemar, p>0,05) (Sensitivity %76.9, Specificity %90,2)

Table-7: Comparison of MR arthrography and arthroscopy results in instability group.

MR Arthrography	Arthroscopy (+)	Arthroscopy (-)
Pozitive	12	0
Negative	1	50
Toplam	**13**	**50**

(Mc. Nemar, p>0,05) (Sensitivity %92.3, Specificity %100)

Discussion

MR arthrography is seen as a promising method in the evaluation of shoulder pathologies (5). Of the 30 lesions evaluated in the study, 26 were correctly detected by conventional MR (sensitivity 86.66%) and 29 were detected by MR arthrography (sensitivity 96.66%), (Tablo-3).

Labral capsular ligamentous complex is an important component of shoulder stability. (9). There are many normal variations of this complex. It has been reported in the literature that these normal variations in conventional MR imaging can be confused with pathological appearances (10,11). Therefore, MR arthrography has become an important imaging technique used in the evaluation of the labral capsular ligamentous complex of the shoulder joint in order to increase the sensitivity and accuracy in diagnosis (12,13).

Generally, the glenoid labrum can be successfully evaluated with conventional MR imaging, but there are some technical difficulties during this evaluation (14). Therefore, MR arthrography can be used safely in the evaluation of the glenoid labrum. (15).

It is necessary to know the normal anatomy and anatomic variations of the labral ligamentous complex in order to interpret MR arthrograms correctly in patients with suspected shoulder instability clinically (16). The Buford complex is characterized by cord-like MGHL and the absence of anterior superior portion of the labrum. This structure is a normal anatomical variation and is seen in approximately 1.5% of patients (17). This formation can be mixed with a separated labrum. In case of partial adhesion or non-adhesion of the labrum to the anterosuperior of the glenoid rim line of the epiphysis, a sublabral foramen is formed between the glenoid rim and the labrum. This situation can be confused with anterior labrum tear. In a conventional MR study evaluating two transverse sections in the T2 W fat suppressed FSE sequence taken below the midpoint of the glenoid fossa; 94% sensitivity and 80% specificity were found in the diagnosis of sublabral foramen and Buford complex (18). In this study, there were two cases that were understood to have Buford complex and sublabral foramen variations in MR arthrography, although they were diagnosed with Bankart lesion in conventional MR imaging. Arthroscopy was not performed because these findings were accepted as variation.

In an unstable patient, four anatomical areas should be evaluated at the time of imaging: the humeral head, joint capsule, glenohumeral ligaments, and glenoid labrum and adjacent bone. (19).

Hill-Sachs deformity is checked while evaluating the humeral head. A true Hill-Sachs deformity is above the coracoid level. Anterior dislocation of the humeral head causes notching and flattening of the posterolateral part of the head. It is seen in approximately 75% of patients with anterior instability. (20). The lower part of the coracoid level of the proximal humerus is normally straight in the posterolateral segment. This appearance should not be confused with Hill-Sachs deformity (21). Hill-Sachs deformity is a direct indicator of dislocation. In the presence of a major deformity, open surgery should be performed rather than arthroscopic repair. (22). Our five cases had recurrent shoulder dislocations, and conventional MR and MR arthrography had Hill-Sachs deformity. A false positive diagnosis was made in one patient in conventional MR. In all other cases, Hill-Sachs deformities were confirmed by arthroscopy. All of them were associated with an anterosuperior labrum tear.

Glenohumeral ligaments strengthen the shoulder joint capsule. Inferior glenohumeral ligament (IGHL) is one of the three most important parts of joint stability (23). In this study, none of the patients had damage to the gleohumeral ligament. The reason for the absence of cases with glenohumeral ligament damage among our cases was thought to be due to the low number of our cases.

Evaluation of glenoid labrums is also important for instability. In unidirectional dislocation towards the anterior, the damage to the anterior inferior labroligamentous structures is called Bankart lesion, and if the underlying scapular periosteum is involved in the rupture, it is called Perthes lesion, which is a variant of Bankart lesion. (24). Another lesion that can be easily overlooked arthroscopically, especially in chronic injuries, is ALPSA lesion. In the neck of the glenoid, a medial displacement of the adjacent periosteum and labrum is observed. Like Perthes lesion, ALPSA lesion is another cause of anterior instability (21). Superior labrum tears are known as SLAP tears.

In the study of Parmar H et al. (25) in the diagnosis of anterior instability; They reported that MR arthrography had high sensitivity (95%) and specificity (100%) values. In our study, there were a total of 13 lesions in the instability group. While 12 of these lesions were detected correctly by MR arthrography, only one lesion was evaluated as incorrect. The sensitivity of MR arthrography in the instability group was 92.3%, and the specificity was 100%. These results were evaluated in accordance with the study conducted by Parmar H et al. (25).

Wortler K et al. (26) showed that MR arthrography has a significantly higher sensitivity in the evaluation of SLAP lesions in the shoulder compared to the conventional MR technique. There were only two SLAP lesions in our study. While none could be detected by conventional MR, only one was detected correctly by MR arthrography.

Although rotator cuff pathologies can be seen especially in young athletes, even in postmortem studies, the incidence of complete tear was reported to be 6-19%, and partial tear was reported to be 6-33% (27). In our study, 10 of the 30 lesions (33.33%) were in the impingement group. While all of these 10 lesions were detected correctly in MR arthrography (sensitivity: 100%), one lesion was interpreted as false positive in favor of a partial tear. It was thought that the reason why this rate was slightly higher than the rates they obtained from cadaver data was due to the fact that the cases that came to our hospital were selected cases and all of them had shoulder pathology.

Palmer WE et al. (28) used fat suppressed MR arthrography in the evaluation of the rotator cuff and compared it with arthroscopy and open surgery. They reported 100% sensitivity and specificity in the evaluation of fat suppressed images, while 90% sensitivity and 75% specificity in the evaluation of non-fat suppressed images. In their studies, the sensitivity values of MR arthrography obtained with fat suppression are similar to our results. In the impingement group (Table 4,5); with conventional MR, sensitivity is 90.0%, specificity is 96.2%; The sensitivity was 100.0% and specificity 98.1% by MR arthrography. Lee SY and Lee JK (29) evaluated the horizontal component in partial tears of the rotator cuff in oblique coronal images in ABER position. Accordingly, they stated that the ABER position can provide additional information in grading partial tears and evaluating horizontal components. In our study, there were a total of three partial tears in the supraspinatus tendon. All tears were facing the articular surface. Fat suppressed T1 W coronal images were evaluated in MR arthrography. However, optimal quality images could not be obtained since the patients could not tolerate due to the excessive pain in the ABER position. Therefore, images with ABER position were not taken into consideration in the evaluation of pathologies.

Although there was no statistically significant difference between the imaging methods used in our study ($p > 0.05$), it was observed that the results obtained with MR arthrography were closer to the results obtained by arthroscopy. Therefore, it was concluded that MR arthrography is a reliable imaging method that can be used in the accurate and detailed evaluation of shoulder pathologies.

Increasing the number of patients and determining the accuracy rates and advantages of MR arthrography for each lesion will help to use the method more widely in our clinic.

IJBCS ISSN: 2147-1428

Orginal Article

International Journal of Basic and Clinical Studies (IJBCS)

2020; 9(2): 57-67 Tutus S. Et all.

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