RESEARCH ARTICLE

MRI-Arthroscopic Correlation in Rotator Cuff Tendon Pathologies; A Comparison between Various Centers

Sepideh Sefidbakht, MD; Omid Reza Momenzadeh, MD; Sakineh Dehghani, MD; Hadi Gerami, MD

Research performed at Shiraz University of Medical Sciences , Shiraz, Iran

Received: 25 April 2015 *Accepted: 27 December 2015*

Abstract

Background: Magnetic resonance imaging (MRI) has long been considered a perfect imaging study for evaluation of shoulder pathologies despite occasional discrepancies between MR reports and arthroscopic findings. In this study we aim to evaluate impact of imaging center as an indicator of image quality on accuracy of MRI reports in diagnosis of rotator cuff tendon pathologies.

Methods: We reviewed MR reports of 64 patients who underwent arthroscopy in university center hospital. MRIs were done in various centers including both university-affiliated and out-centers. All studies were reported by two radiologists in consensus unaware of the arthroscopic results or previous reports. An inter-observer agreement analysis using the kappa statistics was performed to determine consistency among imaging and surgical reports.

Results: Kappa values for out-centers were as follows: 0.785 for biceps, 0.469 for suscapularis, 0.846 for supraspinatus and 0.785 for infraspinatus tendons. In university centers values were 0.799 for biceps, 0.802 for suscapularis, 0.789 for supraspinatus and 0.770 for infraspinatus tendons.

Conclusion: Image reporting in university centers with proficient sequences increased accuracy of diagnosis in 3/4 of evaluated features and showed subtle decreased inter-observer agreement in 1/4 of features. Uniformity of the scanners and protocols as well as evaluation on a workstation rather than hard copies cumulatively resulted in a meaningful increase in the accuracy of the same radiologists in diagnosis of rotator cuff tendon tear.

Keywords: Agreement, Arthroscopy, MRI, Rotator Cuff Tendons, Shoulder joint

Introduction

Magnetic resonance imaging (MRI) has long been considered the diagnostic imaging study of choice to evaluate internal derangement of the shoulder joint thanks to its superior spatial resolution and soft tissue contrast. The diagnostic value of MR studies; however, have been shown to vary considerably with field strength (1-3). Also certain pathologies are better seen in specific sequences and imaging planes, and can easily be missed if the study is substandard in image acquisition and planning (4, 5).

In this study we have compared the accuracy of the same radiologists in the diagnosis of rotator cuff tendon tears in two settings: in university-affiliated hospitals of a certain medical school (in-centers) and in a diverse array of community imaging centers (out-centers).

Materials and Methods

A total of 64 patients who underwent arthroscopy by a single orthopedic surgeon in Chamran University hospital were included in this study. Their available MR images were reviewed by two radiologists who were unaware of the arthroscopic results or previous reports. Magnetic resonance imaging was done in various centers: in two university centers, Chamran and Faghihi Hospital, and 11 centers out of the university. In-center images were reviewed on PACS workstations and out-center images on hard copy. Out-center images were done by the 0.3 Tesla Philips scanner in one center, 1.5 Tesla Philips scanner in three centers, and 1.5 Tesla Siemens Avanto scanner in seven other centers. We confronted different sequences and imaging parameters that have been reported in Table 1. Various combinations of sequences were detected in different patients. Detail of acquisition was not available for images done by the 0.3 Tesla scanner. University centers used the 1.5 Tesla Siemens Avanto and Philips

Corresponding Author: Sakineh Dehghani, Imaging Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
Email: dehghanis90@gmail.com

AB&JS THE ONLINE VERSION OF THIS ARTICLE ABJS.MUMS.AC.IR

Table 1. Divergent mixture of MR sequences with wide range of parameters used in out university centers

Parameters Sequences	TR (msec)	TE (msec)	ST (mm)	Space (mm)	Fov (mm)
Sagittal PD fat sat	2400-3000	33-40	3-4	0.4-0.8	160*160-220*220
Sagittal T2 WI	2360-3000	70-72	3-4	0.76-2.3	160*160-180*180
Axial PD	2800-3000	16-40	3-3.5	0.4-1.2	160*160
Axial T2	2820-4000	74-100	3-3.5	0.6-3.9	164*250
Coronal T2	2600-4000	70-100	3-3.5	0.9-3	160*160-160*250
Coronal T1	280-760	10-27	3-4	0.4-1.7	160*160-220*220

*ST,Slice thickness ; TR,Time to repetition; TE,Time to echo;PD,Prpton density ; Sat,Saturated ; WI,Weighted image

scanner. Similar sequences were used in both centers as follows: FOV=220*220 and 180*180 in images from the Siemens and Philips scanner, respectively. Coronal T2WI with TR=2250, TE=83, ST=3.8, SP=0.5. Coronal PD fat sat with TR=2700, TE=10, ST=3, SP=0.5. Sagittal T2WI with TR=3400, TE=64, ST=3.5, SP=0.7. Sagittal PD fat sat with TR=2500, TE=43, ST=3.2, SP=0.7. Axial T2WI with TR=4200, TE=75, ST=4.5, SP=4. Axial PD fat sat with TR=3000, TE=38, ST=4, SP=4.8.

We considered shoulder arthroscopy as the standard of reference and aimed to seek inter-observer agreement between the findings of the radiologists and orthopedic surgeon using the kappa test analyzed by SPSS for Windows version 6 (SPSS Inc., Chicago IL). Kappa values were interpreted as less than chance agreement (K<0), slight agreement (K=0.01-0.2), fair agreement (K=0.21-0.40), moderate agreement (K=0.41-0.60), substantial agreement (K=0.61-0.80) and almost perfect agreement (K=0.81-0.90) (6).

Results

Sixty-four patients entered the study (19 females and 45 males). Percentages of correct diagnosis of MRI reports have been listed in Table 2. Interobserver agreements between the radiologists' MRI reports and orthopedic surgeon's arthroscopic findings have been summarized in Table 3. Subscapularis tendon lesions showed significant change in amount of agreement from fair to substantial agreement. Agreement slightly increased in detection of biceps and infraspinatus tendon pathologies, but still remained in substantial agreement range. For supraspinatus tendon out-center images were more in agreement with arthroscopy.

Table 2. Percentage of correctly diagnosed lesions on MR examinations confirmed by arthroscopy

Evaluated Features	Out-center	in-center
Biceps tear	$^{24}/_{26}$ (92.30)	$^{35}/_{38}$ (92.10)
Subscapularis tendon tear	$^{24}/_{26}$ (92.30)	$^{36}/_{38}$ (94.73)
Supraspinatus tendon tear	$^{24}/_{26}$ (92.30)	$^{34}/_{38}$ (89.47)
infraspinatus tendon tear	$^{24}/_{26}$ (92.30)	$^{36}/_{38}$ (94.73)

numbers given are the data used to calculate percentage
*percents are shown in parenthesis

Discussion

Magnetic resonance imaging has served as a highly diagnostic means in evaluating shoulder girdle pathologies. It provides a good diagnosis of pathologies and preoperative concept of shoulder anatomy, and is a valuable follow up imaging tool. Arthroscopy allows direct visualization of intra articular structures as well as offering a minimally invasive therapeutic method (7). Proper diagnosis of pathologies is essential to select medical versus surgical treatment as well as specific surgical procedure planning. Preoperative imaging can also reduce duration of arthroscopy (8).

Efforts have been done to find the superiority of different diagnostic routes in the determination of various shoulder pathologies. In this regard, MRI has proved to be superior to other imaging modalities. However technical issues can dramatically influence the diagnosis. Techniques proposed to reduce motion artifacts could increase the image quality for detection of shoulder pathologies (9). High-field-strength units have improved spatial and contrast resolution that may result in more accurate interpretation of full-thickness supraspinatus tendon tears and labral tears in some patients than would be possible with low-field-strength scanners (1-3). On the other hand, optimal detection of cartilage injuries needs different MR parameters than for detection of rotator cuff tendons or labrum (10). Nevertheless, it is not possible to obtain all useful planes and parameters because of time and cost limitations. Think that what would happen when even these limited protocols are not well obeyed by some imaging centers.

Table 3. Inter-observer agreement among radiologists' MRI records and orthopedic surgeon's arthroscopic findings

Evaluated features	Out-center			In-center		
	kappa	St.Er	*P*	kappa	St.Er	*P*
Biceps tear	0.785	0.143	0.000	0.799	0.137	0.000
Subscapularis tendon tear	0.469	0.306	0.005	0.802	0.135	0.000
supraspinatus	0.846	0.103	0.000	0.789	0.100	0.000
infraspinatus	0.785	0.143	0.000	0.770	0.156	0.000

In this study we compared the agreement of imaging and arthroscopy reports of rotator cuff tendon pathologies between images performed in a group of university affiliated in-centers and out-centers not affiliated with a university.

In cases of subscapularis tendon pathologies, we observed increased agreement from fair to substantially good state with in-center reports. Fat saturated MR sequences are superior to conventional MR imaging for detection of rotator cuff lesions (4). In addition, patients with subscapularis tears may not be able to keep their shoulder in supine or neutral position, which is necessary for identification of tears in this tendon (5,10). Also, an appropriately arranged coronal oblique and sagittal plane is preferred in many centers to investigate the anatomical position and pathology of rotator cuff tendons (4, 5).

Moreover, it has been reported that the position of the tear in the subscapularis tendon may cause them to be overlooked (5). Tears of this tendon usually begin from the superior portion of the articular side. Intact inferior bundles on axial images may lead to false negative reports. This can be another cause of low accuracy in reports of centers that do not include the sagittal oblique plane in their protocol. In this study, although sagittal oblique images were present in all out-center images, in many of them the images were suboptimally planned and none of the studies were performed on 0.3T scanners to include fat-saturated proton density images.

On the other hand, an orthopedic surgeon has the advantage of freely changing the patient's shoulder posture during arthroscopy to detect a lesion in contrast to the single static position of the shoulder in the MRI that is reported by radiologists. This may be another source of disagreement.

Pathologies related to biceps and infraspinatus tendons showed substantially good agreement in both groups and in cases of supraspinatus, almost perfect agreement was achieved in the out-center group. These tendons are well depicted in all coronal, axial, and sagittal planes and all performed sequences can guide radiologists to the pathology even if some planes or sequences are missing. Also, it is not challenging for orthopedic surgeons to seek out their pathologies during arthroscopy, so, although in-center images had better achievements, out-center images yielded almost the same results. Momenzadeh et al. also detected high positive predictive values for MRI in detecting tears in these tendons (11). However, it should not be forgotten that partial thickness tears of rotator cuff muscles is detected more often when using MR arthrography, especially in the abduction external rotation (ABER) position (7, 10, 12, 13). MR arthrograhy is not carried out on all the patients in either centers unless directly requested by the referring physician. It can be expected that both groups could reveal better inter-observer agreement if they had the assistance of MR arthrography in selected cases.

In this study there is less than perfect agreement in infraspinatus tendon tears in both groups and supraspinatus tendon in university centers. This was in agreement with previous studies that reported a low sensitivity for MRI in depicting bursal side partial thickness tears (14). On the other hand, a lower detection rate of supraspinatus tendon pathologies in university centers, unlike standard protocols of MRI, may be due to a false sense of assurance that makes radiologists overlook small pathologies. In cases of biceps tendon pathology; however, results were similar in university-affiliated and out-center studies. This low sensitivity is in concordance with previous reports and is apparently related to inherent shortcomings of the modality (15, 16). The oblique course of the biceps tendon leads to partial volume averaging of the tendon with adjacent structures and fluid (10). That is why we had no significant change in biceps pathology agreement among the two study groups.

The increased accuracy in detection of pathologies related to two of four evaluated tendons can be attributed to a variety of factors including a mixed array of scanners in the out-center group, some of which were performed on 0.3T scanners. Superiority of higher field scanners in diagnosis of shoulder pathologies has been emphasized before (3). In addition to the magnet strength; however, we believe that the increased accuracy can partly be due to the fact that university-affiliated imaging centers tend to have standard protocols. Moreover, studies have been evaluated either on a workstation or on PACS in both participating university affiliated hospitals, while the radiologists had to interpret hard copies for the out-center studies in this study. In this study we evaluated our accuracies in both settings as an indicator of standard image acquisition and interpretation in radiologist accuracy. Since the same radiologists interpreted both sets of images, effect of radiologist training and expertise was eliminated.

Although we considered arthroscopy the reference diagnostic method in this study, this should be considered a limitation. Pitfalls and misdiagnosis during arthroscopy can thus be partly responsible for the disagreement between imaging and surgical reports. For example, contained interstitial tears of rotator cuff tendons without communication with either surface of the tendons cannot be seen during arthroscopy (17). We did not enter the interstitial tears detected by MRI in our statistical analysis to achieve a better agreement; however, practitioners should consider this as a cause of disagreement that is sometimes perceived in clinical practice. Also, because we did not evaluate the agreement of different types of tears (partial versus complete) this can be considered a further limitation. Determining inter-observer variability among different radiologists, which was not conducted in this study, can also add to the statistical strength of such investigations. Disagreement of reports can be attributed to other reasons we did not concentrated on in this investigation. Inherent shortcomings of MRI

in detecting some lesions and different definitions of same pathologies between radiologists and surgeons are other disturbing factors that were not evaluated here.

Standardization of scanners and image acquisition protocols can improve the radiologists' performance in the diagnosis of rotator cuff injuries. National legislation for standardization and quality assurance of MR studies can help improve accuracy and prevent unnecessary costs due to study repetitions and imprecise diagnoses.

Authors have no conflict of interest to disclose.

Sepideh Sefidbakht MD
Sakineh Dehghani MD
Imaging Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

Omid Reza Momenzadeh MD
Hadi Gerami MD
Bone and Joint Diseases Research Center, Shiraz University of MedicalSciences, Shiraz, Iran

References

1. Magee T, Shapiro M, Williams D. Comparison of high-field-strength versus low-field-strength MRI of the shoulder. AJR Am J Roentgenol. 2003; 181(5):1211–5.
2. Lee CS, Davis S., McGroder C, Kouk S, Sung RM, Stetson WB, et al. Analysis of low-field MRI scanners for evaluation of shoulder pathology based on arthroscopy. Orthop J Sports Med. 2014; 2(7):1-7.
3. Loew R, Kreitner KF, Runkel M, Zoellner J, Thelen M. MR arthrography of the shoulder: comparison of low-field (0.2 T) vs high-field (1.5 T) imaging. Eur Radiol. 2000; 10(6):989-96.
4. Pfirrmann CW, Zanetti M, Weishaupt D, Gerber C, Hodler J. Subscapularis tendon tears: detection and grading at MR arthrography. Radiology. 1999; 213(3):709-14.
5. Chingkoe CM, White JH, Louis LJ, Andrews G, Forster BB. Rotator cuff troublemakers: pitfalls of MRI and ultrasound. Open Access J Sports Med. 2009; 2010(1):1–9.
6. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med. 2005; 37(5):360-3.
7. Joshi UP, Puri S. Clinical, MRI and arthroscopic correlation in anterior and posterior shoulder instability. Int J Res Med Sci. 2014; 2(3):857-60.
8. Jana M, Srivastava DN, Sharma R, Gamanagatti S, Nag HL, Mittal R, et al. Magnetic resonance arthrography for assessing severity of glenohumeral labroligamentous lesions. J Orthop Surg. 2012; 20(2):230-5.
9. Dietrich TJ, Ulbrich EJ, Zanetti M, Fucentese SF, Pfirrmann CW. PROPELLER technique to improve image quality of MRI of the shoulder. AJR Am Roentgenol. 2011; 197(6):W1093–100.
10. Polster JM, Schickendantz MS. Shoulder MRI: what do we miss? AJR Am J Roentgenol. 2010; 195(3):577–84.
11. Momenzadeh OR, Gerami MH, Sefidbakht S, Dehghani S. Assessment of correlation between MRI and arthroscopic pathologic findings in the shoulder joint. Arch Bone Jt Surg. 2015; 3(4):286-90.
12. de Jesus JO, Parker L, Frangos AJ, Nazarian LN. Accuracy of MRI, MR arthrography and ultrasound in the diagnosis of rotator cuff tears: a meta analysis. AJR Am J Roentgenol. 2009; 192(6):1701–7.
13. Choi JH, Suh S, Kim BH, Cha SH, Kim MG, Lee KY, et al. Comparison between conventional MR artgrography and abduction and external rotation MR arthrography in revealing tears of the antero-inferior glenoid labrum. Korean J Radiol. 2001; 2(4):216-21.
14. Chun KA, Kim MS, Kim YJ. Comparisons of the various partial-thickness rotator cuff tears on MR arthrography and arthroscopic correlation. Korean J Radiol. 2010; 11(5):528-35.
15. Halma JJ, Eshuis R, Krebbers YM, WeitsT, Gast A. Interdisciplinary inter-observer Agreement and accuracy of MR imaging of the shoulder with arthroscopic correlation. Arch Orthop Trauma Surg. 2012; 132(3):311–20.
16. Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders: a systematic review. Health Technol Assess. 2003; 7(29):1-166.
17. Hodgson RJ, O'Connor PJ, Grainger AJ. Tendon and ligament imaging. Br J Radiol. 2012; 85(1016):1157–72.