Indian Journal of Basic and Applied Medical Research; September 2020: Vol.-9, Issue- 4, P. 159 - 167
DOI: 10.36848/IJBAMR/2020/18215.56015

Original article:

Study of correlation between clinical and high-resolution ultrasound findings with MRI findings

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Abstract:

Introduction: Arthrography appears to be more accurate in diagnosing rotator cuff injuries than either MRI or ultrasound but that benefit must be set against the invasiveness and potential discomfort to patients. Ultrasonography is as accurate as MRI for both full thickness and partial thickness tears, these results combined with low cost for ultrasound suggests that ultrasound may be the most cost effective imaging method of screening for rotator cuff injuries provided that the examiner is trained in this operator dependent technique.

Material and methods: 30 patients referred to the department of Radio diagnosis, Adesh Medical College and Hospital, Kurukshetra, Haryana with clinically suspected rotator cuff injuries were subjected to undergo USG and MRI after thorough history taking and clinical examination. After clinical evaluation, once a patient satisfied the inclusion and exclusion criteria for this study, he or she would undergo MRI examination after giving consent.

Results: In our study it was observed that USG had 66.67%, Sensitivity, 100% Specificity, 100% PPV, 42.86% NPV and 73.33% Diagnostic accuracy in diagnosing Rotator cuff injuries. Kappa Agreement between USG and MRI was 0.44 i.e. fair agreement.

Conclusion: MRI is more sensitive than USG for detecting peribicipital tendon fluid, joint effusion, SA-SD and S-C bursal fluid and SA impingement. MRI is equivalent to USG in detecting calcification of the rotator cuff tendon, acromio-clavicular joint hypertrophy and S-C impingement. Labral tears, acromion type and adjacent bone changes were detected only by MRI.

Keywords: MRI, USG , Shoulder pain

Introduction:

Patients presenting for imaging fall broadly into one of the following categories: Specific pain and restricted movements on abducting the arm and symptoms of instability.Several radiological techniques have been used to detect tears of the rotator cuff. [1]Each has limitations and no clear consensus on the optimum diagnostic study has emerged[1]. MRI has become the "gold standard" for detecting both subtle and obvious internal derangement and assessing overall joint structure.[2]

MRI can provide information about rotator cuff tears such as tear dimensions, tear depth or thickness and tear shape, involvement of adjacent structures (eg, rotator interval, long head of biceps brachii tendon etc) and muscle atrophy, all of which have implications for rotator cuff treatment and prognosis. Information about coracoacromial arch and impingement as it relates to rotator cuff tears can also be obtained with MRI[3].Arthrography is quite accurate in detecting complete tears but it is an invasive procedure with some associated risk and discomfort, in addition it is insensitive to partial tears involving superficial surface or substance of the cuff. The diagnosis of partial tears, however, is important because many orthopedic surgeons will operate to relieve impingement of supraspinatus tendon before it progresses to full thickness tear. The relative ease with which they are seen on MRI suggests that MRI may have a role in their diagnosis[2].

Although non-invasive, MRI is considerably more expensive than ultrasonography and will probably not replace it as a screening procedure for those trained in its use. For those cases in which the sonogram yields indeterminate results or in those institutions in which no one is trained to do sonography of the shoulder, MRI may be a useful screening test[2]. The major disadvantages of MRI are the long examination time, expense and that the study may be unsuccessful in very large or claustrophobic patients.[4]

Arthrography appears to be more accurate in diagnosing rotator cuff injuries than either MRI or ultrasound but that benefit must be set against the invasiveness and potential discomfort to patients. Ultrasonography is as accurate as MRI for both full thickness and partial thickness tears, these results combined with low cost for ultrasound suggests that ultrasound may be the most cost effective imaging method of screening for rotator cuff injuries provided that the examiner is trained in this operator dependent technique. For practitioners without ultrasound expertise, MRI can be used. Arthrography can be performed in those cases in which ultrasound and MRI are not definitive[5].

Material and methods:

The main source of data for the study were patients from the following teaching Hospital attached to Adesh group of institutions, Adesh Medical College and Hospital, Kurukshetra, Haryana

30 patients referred to the department of Radio diagnosis, Adesh Medical College and Hospital, Kurukshetra, Haryana with clinically suspected rotator cuff injuries were subjected to undergo USG and MRI after thorough history taking and clinical examination.

Study Period: Two years

Study Design: Proportion study

Inclusion criteria:

The study includes

- All patients with clinical suspicious of rotator cuff injuries.
- Cases of all age groups irrespective of sex

Exclusion criteria:

The study will exclude

- Patient having history of claustrophobia.
- Patient having history of metallic implants insertion, cardiac pacemakers and metallic foreign body insitu.

After clinical evaluation, once a patient satisfied the inclusion and exclusion criteria for this study, he or she would undergo MRI and USG examination after giving consent.

Data was entered into Microsoft excel sheet and was analyzed using EPI Info 7 version software.

Results:

The age of the patients with rotator cuff pathologies studied ranged from 23 to 76 years, with a mean of 46.6 +/- 2.08.

The patients involved in the study were divided into 3 age groups viz. <40 years, 41-50 years, >50 years. Majority of Rotator cuff injures were observed after 50 yrs of age in 40% of subjects. 30% at < 40 yrs and 41 to 50 yrs.

Of the 30 patients studied, 5(16.7%) were females and 25 (83.3%) were males. The mean age among females was 54 + /-1.98 and the mean age among males was 45.12+/- 2.2.

In our study majority of the patients were right handed i.e 86.6% and 13.4 % were left handed .

All the 4 left handers (100%) had Rotator cuff injuries on left side and 80.7% of right handers had injuries on right side. This association was statistically significant.

Table 1: Validity of USG findings with MRI findings in Tendon Injuries

	Sensitivity	**Specificity**	**Positive Predictive value**	**Negative Predictive value**	**Diagnostic Accuracy**	**Kappa Degree of agreement**
SS	59.09%	100%	100%	47.06%	70%	0.43
IP	50%	100%	100%	96.55%	96.67%	0.65
SUB	66.67%	100%	100%	92.31%	93.33%	0.76
TM	-	100%	-	100%	100%	-
BT	-	100%	-	100%	100%	-

USG findings in comparison to MRI findings showed that Sensitivity of USG was low in detecting the Tendon injuries at all the sites. Highest sensitivity was observed for Sub scapular tendon injuries. Specificity was 100% at all the sites. Diagnostic accuracy was low in Supraspinatus tears and Highest for Teres minor and Biceps tendon injuries. The agreement between USG and MRI findings was measured by Kappa and highest agreement was observed for subscapular tears.

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Table 2: Validity of USG findings with MRI findings in detecting Calcification

	Sensitivity	Specificity	Positive Predictive value	Negative Predictive value	Diagnostic Accuracy	Kappa Degree of agreement
SS	100%	100%	100%	100%	100%	1
IP	-	100%	-	100%	100%	-
SUB	-	100%	-	100%	100%	-
TM	-	100%	-	100%	100%	-
BT	-	100%	-	100%	100%	-

USG had similar Sensitivity, specificity, positive predictive value, Negative predictive value and Diagnostic accuracy as MRI in identifying calcifications in Rotator cuff injuries.

Table 3: Association between USG findings and MRI findings in Peribicipital tendon fluid (PTF)

		PTF in MRI		Total	χ 2 , df, p value
		Absent	**Present**		
PTF in USG	**Absent**	14	1	15	26.25, 1, 0.0001**
	Present	0	15	15	
Total		**14**	**16**	**30**	

MRI showed 16 patients positive for PTF out of 30 whereas USG detected 15 out of 30 cases and did not detect PTF in one case. There was significant association between USG and MRI findings. i.e. MRI was better in detecting PTF than USG.

Table 4: Association between USG findings and MRI findings in detecting Bursal fluid

		MRI Findings		Total	χ 2 , df, p value
		Absent	**Present**		
Subacromial-subdeltoid bursal fluid (SA-SD) in USG	**Absent**	15	1	16	26.25, 1, 0.0001**
	Present	0	14	14	
Total		15	15	30	
Subcoracoid bursal fluid (S-C) in USG	**Absent**	20	2	22	21.81, 1, 0.0001**
	Present	0	8	8	
Total		**20**	**10**	**30**	

MRI showed 15 positive for SA-SD bursal fluid out of 30 whereas USG detected 14 cases and did not detect SA-SD in one case. There was significant association between USG and MRI findings. I.e. MRI was better in detecting SA-SD bursal fluid than USG. Similarly MRI showed 10 positive for SC bursal fluid out of 30 whereas USG detected 8 cases and did not SC in two cases. There was significant association between USG and MRI findings. I.e. MRI was better in detecting SC bursal fluid than USG.

Table 5: Association between USG findings and MRI findings in detecting Joint Effusion

		Joint Effusion in MRI		Total	χ 2 , df, p value
		Absent	**Present**		
Joint Effusion in USG	**Absent**	14	3	17	20..7, 1, 0.0001**
	Present	0	13	13	
Total		14	16	30	

MRI showed 16 positive for joint effusion out of 30 whereas USG detected in 13 cases and did not detect joint effusion in three cases. There was significant association between USG and MRI findings. i.e. MRI was better in detecting joint effusion than USG.

Table 6: Association between USG findings and MRI findings in detecting Acromio - clavicular joint hypertrophy (ACJH)

		ACJH in MRI		Total	χ 2 , df, p value
		Absent	**Present**		
ACJH in USG	**Absent**	21	0	21	30.0, 1, 0.0001**
	Present	0	9	9	
Total		**21**	**9**	**30**	

MRI showed 9 positive for ACJH out of 30, USG also detected all the 9 cases of ACJH. There was significant association between USG and MRI findings. I.e. USG was equivalent to MRI in detecting ACJH.

Table 7: Association between USG findings and MRI findings in detecting Impingement lesions

		MRI Findings		Total	χ 2 , df, p value
		Absent	**Present**		
Subacromial impingement (SA) in USG	**Absent**	25	2	27	16.67, 1, 0.0001**
	Present	0	3	3	
Total		**25**	**5**	**30**	

Subcoracoid impingement (SC) in USG	**Absent**	29	0	29	30.0, 1, 0.003**
	Present	0	1	1	
Total		**29**	**1**	**30**	

MRI showed 5 positive for SA impingement out of 30 whereas USG detected 3 cases and did not detect SA impingement in two cases. There was significant association between USG and MRI findings. I.e. MRI was better in detecting SA impingement than USG. Similarly MRI showed 1 positive for SC impingement out of 30, USG also detected 1 case of SC impingement. There was significant association between USG and MRI findings. I.e. USG was equivalent to MRI in detecting SC impingement.

Table 8: Comparison of MRI Diagnosis with USG and Clinical diagnosis

	Sensitivity	**Specificity**	**Positive Predictive value**	**Negative Predictive value**	**Diagnostic Accuracy**	**Kappa Degree of agreement**
USG vs MRI	66.67%	100%	100%	42.86%	73.33%	0.44
Clinical diagnosis VS MRI	100%	0%	80%	-	80%	0

Discussion:

In our study it was observed that USG had 66.67%, Sensitivity, 100% Specificity, 100% PPV, 42.86% NPV and 73.33% Diagnostic accuracy in diagnosing Rotator cuff injuries. Kappa Agreement between USG and MRI was 0.44 i.e. fair agreement. USG findings in comparison to MRI findings showed that Sensitivity of USG was low in detecting the Tendon injuries of supraspinatus (59.09%), infraspinatus (50%) and subscapularis muscle (66.67%). Highest sensitivity was observed for Sub scapular tendon injuries (66.67%). Specificity was 100% at all the sites. Diagnostic accuracy was low in Supraspinatus tears(70%) and Highest for Teres minor and Biceps tendon injuries(100%). The agreement between USG and MRI findings was measured by Kappa and highest agreement was observed for subscapular tears (0.76).

This is consistent with study done by Martin Hervas .C and his associates who examined all painful shoulders during 1998 by subjecting them to USG and MRI, have stated that the diagnosis of rotator cuff tears was highly specific on both imaging techniques (100% for USG) but was not as sensitive using USG (67.9%)[5].

In our study 1 out of 30 patients (3.33%) had calcification of supraspinatus tendon which was detected by both USG and MRI indicating that USG and MRI are equivalent to each other for detecting calcification of rotator cuff tendons.

In our study MRI showed 16 positive for PTF out of 30 patients (53.33%) whereas USG detected 15 cases (50%) and did not detect PTF in one case. There was significant association between USG and MRI findings (p value< 0.0001). i.e. MRI was better in detecting PTF than USG.

In our study, peribicipital tendon fluid was found in 16 patients (53.33%). Of these, tear seen in 12(75%), tendinosis was seen in 2(12.5%) and normal tendon seen in 2(12.5%). This was consistent with study done by Doughlas et al in 111 patients with shoulder pain who underwent both MR and surgery, found 73 patients with peribicipital tendon fluid. They concluded peribicipital tendon fluid had a statistically significant association with tears of the supraspinatus and subscapularis components of the rotator cuff[6]. In our study MRI showed 15(50%), positive for SA-SD bursal fluid out of 30 patients whereas USG detected 14 cases (46.67%) and did not detect SA-SD in one case. There was significant association between USG and MRI findings (p value<0.0001). I.e. MRI was better in detecting SA-SD bursal fluid than USG.

Similarly MRI showed 10 positive for S-C bursal fluid out of 30 patients (33.33%) whereas USG detected 8 cases (26.67%) and did not S-C in two cases. There was significant association between USG and MRI findings (p value<0.0001). I.e. MRI was better in detecting S-C bursal fluid than USG.

In our study MRI showed 16 positive for joint effusion out of 30 patients (53.33%) whereas USG detected in 13 cases (43.33%) and did not detect joint effusion in three cases. There was significant association between USG and MRI findings (p value<0.0001). i.e. MRI was better in detecting joint effusion than USG. In a study by Hollister et al done on 97 patients with surgery proven rotator cuff tear 52% had fluid in the joint, bursa or both. It was concluded in this study that fluid in the bursa (subacromial / subdeltoid) / joint effusion had strong association with rotator cuff tears. The specificity and PPV for rotator cuff tears increases when both bursal and joint fluid were present, and careful evaluation of cuff tendons is a warranted to rule out tears in presence of joint effusion or bursal effusion[7].

Similar results were also found in the study by Grainger et al, who reviewed 1831 MRI over 2 years. They suggested subcoracoid bursa effusions is not an incidental finding but may be associated with the rotator cuff and rotator interval tears. In our study joint effusion was found in 16(53.33%) and bursal fluid noted in 20(66.67%).Of the 16 patients with effusion 13(81.25%) had tears and 1 (6.25%) had tendinosis and 2(12.5%) had normal tendon. Of the 20 patients with bursal fluid, 17(85%) showed tear in the cuff tendon and 3 (15%) showed tendinosis in the cuff tendon. Thus presence of joint effusion or bursal effusion is a marker of abnormal cuff tendon especially tears.

In our study MRI showed 9(30%), positive for ACJH out of 30 patients.USG also detected all the 9 cases of ACJH. There was significant association between USG and MRI findings (p value<0.0001). I.e. USG was equivalent to MRI in detecting ACJH.

Out of 9 patients with ACJH 7 had tear (77.77%), 1 had tendinosis (11.11%) and 1 had normal tendon (11.11%).Thus abnormal tendon was common in patients with AC joint hypertrophy and tear being more frequent in these patients. This was consistent with a study by Needel et al in 100 patients in which acromioclavicular joint changes increased with age. More than 80% patients with partial tear and all the patients with full thickness tear showed acromioclavicular joint arthrosis[7].

In our study MRI showed 5(16.67%) positive for SA impingement out of 30 patients whereas USG detected 3 cases (10%) and did not detect SA impingement in two cases. There was significant association between USG and MRI findings (p value<0.0001).. I.e. MRI was better in detecting SA impingement than USG.

Similarly MRI showed 1(3.33%) positive for SC impingement out of 30, USG also detected 1 case of SC impingement. There was significant association between USG and MRI findings(p value<0.0001).. I.e. USG was equivalent to MRI in detecting SC impingement. In our study sensitivity of dynamic USG for detecting impingement was 66.67% as compared to MRI (100%). This was consistent with the study done by John W et al to determine the accuracy of ultrasound for the preoperative evaluation of impingement syndrome in which dynamic USG correctly diagnosed 25 out of 37 cases(sensitivity 67.56%). They concluded that dynamic USG can help confirm but not exclude a clinical diagnosis of impingement[8].

Final diagnosis was made by arthroscopy/surgery keeping them as gold standard. In our study clinical diagnosis had sensitivity of 100%, specificity of 0%, PPV of 83.33%, NPV of 0%, diagnostic accuracy of 83.33% with kappa degree of agreement 0. This is consistent with a meta-analysis (2012) which suggests that the diagnostic accuracy of orthopedic shoulder exams is overestimated, and that these exams are only rarely useful to differentiate RC tears. While some shoulder examination tests had high sensitivities and others had high specificities, no single test had both a high specificity and a high sensitivity. Further, the lack of precise techniques and subjective interpretation of these exams leads to substantial interobserver variability.[9]

In our study USG had a sensitivity of 64%, specificity of 100%, PPV of 100%, NPV OF 35.71%, diagnostic accuracy of 70% and kappa degree of agreement of 0.37. This is consistent with study done by Cynthia L. Miller et al in which bilateral rotator cuff sonography was performed on 56 patients referred for shoulder arthrography to detect rotator cuff tears and showed that USG had a sensitivity of 58%, specificity of 93% and overall predictive value of 72%. These results suggest that a positive sonographic reading is more reliable than a negative one[10]. Another study done by T D Brandt et al on evaluation of clinical usefulness of rotator cuff sonography demonstrated that USG had a sensitivity of 57% and specificity of 76% depicting that shoulder sonography is less reliable than previously reported[11].

In our study MRI had a sensitivity of 92%, specificity of 80%, PPV of 95.83%, NPV of 66.67%, diagnostic accuracy of 90% and kappa degree of agreement of 0.66. This is consistent with study done by Vlychou M et al. (2009) on 56 patients with symptomatic impingement syndrome, of which all patients underwent USG and MRI scans prior to surgical intervention. MRI showed sensitivity of 97.7%, specificity of 63.6%, PPV of 91.7% and diagnostic accuracy of 91%[44]. Similar results were seen in study done by Zlatkin MB et al who studied diagnostic performance of MRI in rotator cuff tears and reported sensitivity, specificity and accuracy of 91%, 88% and 89% respectively for all rotator cuff tears[12].

Conclusion:

MRI is more sensitive than USG for detecting peribicipital tendon fluid, joint effusion, SA-SD and S-C bursal fluid and SA impingement. MRI is equivalent to USG in detecting calcification of the rotator cuff tendon, acromio-clavicular joint hypertrophy and S-C impingement. Labral tears, acromion type and adjacent bone changes were detected only by MRI.

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Date of Submission: 02 August 2020
Date of Peer Review: 13 August 2020
Date of Acceptance: 2 September 2020
Date of Publishing: 28 September 2020
Author Declaration: Source of support: Nil, Conflict of interest: Nil
Ethics Committee Approval obtained for this study? YES
Was informed consent obtained from the subjects involved in the study? YES
For any images presented appropriate consent has been obtained from the subjects: YES
Plagiarism Checked: YES

DOI: 10.36848/IJBAMR/2020/18215.56015