Int. J. Curr. Res. Med. Sci. (2018). 4(12): 120-129

International Journal of Current Research in Medical Sciences

ISSN: 2454-5716

P-ISJN: A4372-3064, E -ISJN: A4372-3061

www.ijcrims.com

Original Research Article

Volume 4, Issue 12 -2018

DOI: http://dx.doi.org/10.22192/ijcrms.2018.04.12.013

A prospective comparative study of high resolution ultrasound and MRI in the diagnosis of rotator cuff tears

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Abstract

Aim: Comparing the role and finding sensitivity and specificity of ultrasonography with that of conventional MRI techniques in patients presenting with rotator cuff injury.

Methods: 50 patients who presented with shoulder pain and/or disability and clinically suspected rotator cuff tears in orthopedic outpatient department (OPD) of Guru Nanak Dev Hospital, Amritsar, referred to department of Radiodiagnosis and imaging for ultrasonography and magnetic resonance imaging.

Results: USG shows sensitivity of 83.7%, specificity of 100%,positive predictive value of 100% and negative predictive value of 68.4% for partial thickness tear and 100% sensitivity, specificity , positive predictive value and negative predictive value in complete thickness tear. The strength of agreement between USG and MRI for diagnosis of rotator cuff tear was found to be (k= 1.0) for full thickness tears (very good agreement) and good agreement for partial thickness tears.

Conclusion: From our study, USG is proven to be an effective imaging modality with results comparable with MRI in patients presenting with shoulder pain and /or disability and clinically suspected case of rotator cuff tendon tears. Ultrasound by an experienced radiologist should be considered as a primary diagnostic tool for imaging the rotator cuff pathologies. At present, MRI can be reserved for patients with suspicious USG results.

Keywords: Rotator cuff tear, MRI and USG.

Introduction

Rotator cuff pathology is the most frequent (10%) cause of shoulder pain and disability.[1] Not only full-thickness rotator cuff tears but also partial-thickness rotator cuff tears are an important cause of shoulder pain and disability. The prevalence of rotator cuff tears in the general population has been found to range from 5% to 39%.Its frequency depends on patient's age, with or without previous trauma and the practice of activities using the arm up (sports, leisure activities, and work).[2]

Rotator cuff is a group of muscles and their tendons that act to stabilize the shoulder. They are supraspinatus, infraspinatus, teres minor and subscapularis muscles. These muscles arise from the scapula and connect to the humerus forming a cuff at the shoulder joint. They hold the head of humerus in the small and shallow glenoid fossa of the scapula.[3]

Patients with a partial-thickness tear can be managed with conservative treatment, while patients with a full-thickness tear and associated weakness of active shoulder abduction, require surgical repair. The results of the imaging of the shoulder may have clinical consequences as the decision to proceed with surgery or to continue with conservative management depends on the accurate diagnosis of the rotator cuff tear.[4]

Both ultrasound (USG) and magnetic resonance imaging (MRI) can confirm a suspected partial-thickness or full- thickness rotator cuff tear. Both techniques have their advantages and disadvantages, and can be competitive and complementary at the same time. The question, which test constitutes the most accurate, cost effective, expedient or least invasive approach to the diagnosis of rotator cuff tears is still controversial. The question as to which is the best test should be answered on the basis of clinical experience, availability, and the expected sensitivity and specificity of the tests.[5]

Aims and Objectives

Aims:

1. To compare the role of ultrasonography with that of conventional MRI techniques in patients presenting with rotator cuff injury.
2. To compare the sensitivity and specificity of ultrasonography and MR Imaging in rotator cuff injury.

Objectives of the study

- Evaluation of role of high resolution ultrasound in rotator cuff injuries.
- Evaluation of role of MRI in rotator cuff injuries.
- Correlation of high resolution ultrasound findings with MRI findings.

Materials and Methods

A prospective study was conducted on the patients who present with shoulder pain and / or disability suspected with rotator cuff tendon tear in orthopedic outpatient department (OPD) of Guru Nanak Dev Hospital, Amritsar, referred to department of Radiodiagnosis and imaging for ultrasonography and magnetic resonance imaging.

Sample size: Fifty subjects.

Patient inclusion criteria:

Patients with age group of 15-75 years of either gender who presented with pain / or disability involving the shoulder were included in the study.

Exclusion criteria:

- Patients who had undergone shoulder surgery for any reason
- Patients with known or diagnosed fracture/ dislocation on plain radiograph involving the shoulder.
- Patients with contraindication to MR imaging which are as follows:

Absolute:

- Ferromagnetic or electronically operated stapedial implants.
- Electronically, magnetically and mechanically activated implant e.g. cardiac pacemaker.

Relative:

- Electronically, magnetically and mechanically activated implant e.g. other pacemakers like for carotid sinus, insulin pumps, nerve stimulators, lead wires or similar wires.
- Non-ferromagneticstapedial implants.
- Cochlear implants.
- Prosthetic heart valves.
- Hemostatic clips (body).

Methods:

After taking the informed, written consent of each patient, detailed clinical history were recorded and general physical and local examination was done.

MRI-Scanning protocol:

SEQUENCES	FOV	THK	TR (ms)	TE (ms)
T1W-TSE/SAG	160mm	3.0	400-700	10-20
T2W-ATSE/COR/TSE	160mm	3.0	3500-6500	80-100
PDW-SPAIR/COR/TSE	160mm	3.0	3500-6500	20-40
PDW-SPAIR/AXIAL/TSE	160mm	3.0	3500-6500	20-40
PDW-ATSE/COR	160mm	3.0	3500-6500	20-40
STIR-LONG TE/SAG	160mm	3.0	2500-5000	40-80
STIR-LONG TE/COR	160mm	3.0	2500-5000	40-80

Field of view 14-16 cm, slice thickness 2-3 mm and matrix 512 x 512.

Method of Collection of Data (including sampling procedure if any):

Additional MRI sequences were used whenever required.

Radiography:

Radiograph of shoulder was done to rule out any fracture/dislocation.

Ultrasonography technique and patient position:

USG:

Imaging will be done with MINDRAY DC-8 machine using linear high frequency probe. High resolution real time ultrasound examination of involved shoulder was done with examination of the contralateral normal shoulder for comparison.

USG Examination:

All patients were examined in the sitting position on a rotating seat.

MRI:

Imaging will be done with 1.5 Tesla Siemens magnetom machine using shoulder coil the following sequences will be selected as required

- USG and MRI findings were correlated statistically

Statistical analysis:

All the findings of the cases studied were tabulated using Microsoft Excel. This is depicted in the master chart which has been added in the Annexure. After obtaining the full data, various statically test were applied for data.

Observations and Results

Table I: Age distribution

Age Group (in years)	Number of patients	Percentage
15-25	5	10%
26-35	3	6%
36-45	6	12%
46-55	17	34%
56-65	16	32%
66-75	3	6%
Total	50	100%

The ages of all the patients ranged from 15-65 years. Out of these patients, 3 (6%) were in 15-25 years age, 5 (10%) were in 26-35 years age, 9 (18%) were in 36-45 years age, 15 (30%) were in 46-55 years age and 18 (36%) were in 56-65 years age. This suggested that there is increase in the prevalence of shoulder pain and rotator cuff tear with advancing age.

Table II: Sex distribution

Sex	Number of patients	Percentage
Males	33	66%
Females	17	34%
Total	50	100%

Out of the 50 patients which were included in the study 33 patients (66%) were males and 17 patients (34%) were females. Thus male: female ratio is 1.9: 1.

Table III: Side of shoulder involved

Side	Number of patients	Percentage
Right shoulder	33	66%
Left shoulder	17	34%
Total	50	100%

Table IV: Dominant vs non-dominant arm (handedness)

		Rotator Cuff Tears On MRI		Total
		Right shoulder	Left shoulder	
Handedness	Right shoulder	31	10	41
	Left shoulder	0	0	0

Table V: Pathologies of rotator cuff on USG

Tendon	Partial tear	Complete tear	Tendinosis
Subscapularis	5	3	3
Supraspinatous	25	5	8
Infraspinatous	1	0	0
Teres minor	0	0	0
Total	31	8	11

Out of 50 patients , 9(18%) patients showed no abnormality in USG and rest 41(82%) patients showed 31 partial tears, 8 complete tears and 11tendinosis. 5 (10%) patients were diagnosed with partial tears,3 (6%)patients with complete tears and 3 (6%) patients with tendinosis of subscapularis tendon. 25 (50%) patients with partial tears, 5 (10%) patients with complete tears and 8 (16%)patients with tendinosis of supraspinatus tendon.1 (2%) patient with partial infraspinatus tendon tear.

Table VI: Pathologies of rotator cuff on MRI

Tendon	Partial tear	Complete tear	Tendinosis
Subscapularis	8	3	0
Supraspinatous	28	5	5
Infraspinatous	1	0	0
Teres minor	0	0	0
Total	37	8	5

Out of 50 patients, 9(18%) patients showed no abnormality in MRI and rest 41(82%) patients showed 37 partial tears,8 complete tears and 5 tendinosis . 8 (16%) patients were diagnosed with partial tear and 3(6%) patients with complete tear of subscapularis tendon. 28(56%) patients with partial tear ,5(10%) with complete tear of supraspinatus tendon and 5(10%) patients with tendinosis. 1(2%) patient with partial infraspinatus tendon tear.

Out of 50 patients,41 patients were found to have pathology in MRI and 9 patients were found to be normal. Out of 41 patients 25 patients had isolated partial tears,5 patients had isolated tendinosis, rest of 11 patients had combined injury of several tendons. USG evaluation showed 31 partial tear,8 complete tear and 11 tendinosis in 41 patients . MRI evaluations showed 37 partial tears,8 complete tears and 5 tendinosis in 41 patients . Thus USG false positively diagnosed 6 partial tears as tendinosis. Whereas, USG was able to correctly detect partial supraspinatus tendon tears in 31 of these 37 cases.

Table VII: USG in evaluation of rotator cuff tears

Findings	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Thickness tear Partial	31	0	13	6	83.7%	100%	100%	68.4%
Full thickness tear	8	0	42	0	100%	100%	100%	100%

Bar diagram - I: USG in evaluation of rotator cuff tears

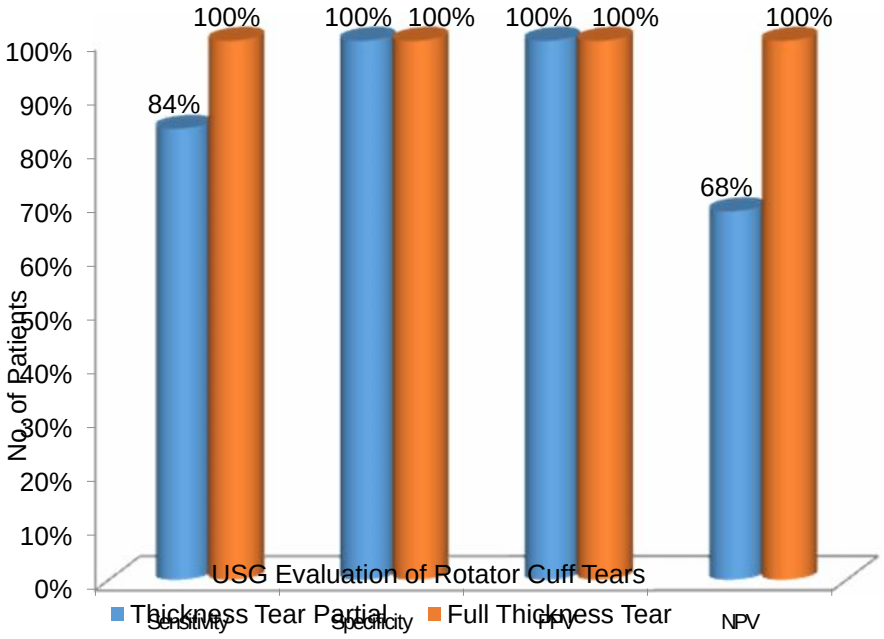

Table VIII: Tendon wise analysis of USG and MRI results

Tendons	USG/MRI	Partial thickness tear	Full thickness tear	Tendinosis	Normal
Subscapularis (n=50)	USG	5(10%)	3(6%)	3(6%)	39(78%)
	MRI	8(16%)	3(6%)	0(0%)	39(78%)
Supraspinatus (n=50)	USG	25(50%)	5(10%)	8(16%)	12(24%)
	MRI	28(56%)	5(10%)	5(10%)	12(24%)
Infraspinatus (n=50)	USG	1(2%)	0(0%)	0(0%)	49(98%)
	MRI	1(2%)	0(0%)	0(0%)	49(98%)
Teres Minor (n=50)	USG	0(0%)	0(0%)	0(0%)	50(100%)
	MRI	0(0%)	0(0%)	0(0%)	50(100%)

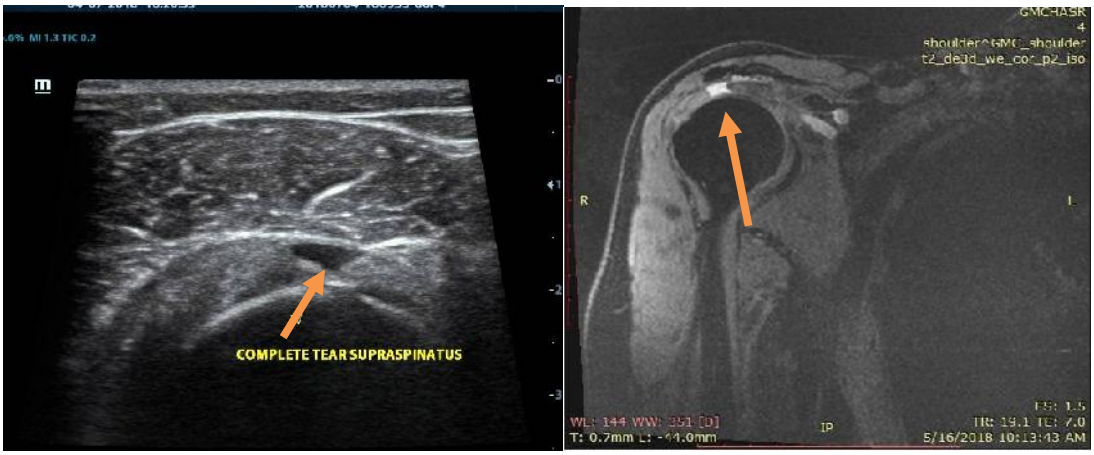

Figure: 1- USG image showing complete tear of supraspinatus tendon with minimal free fluid in subdeltoid and subacromial bursae.

Figure: 2 MRI PD- FSE coronal image depicting full thickness tear of supraspinatus tendon with minimal free fluid in subdeltoid and subacromial bursae.

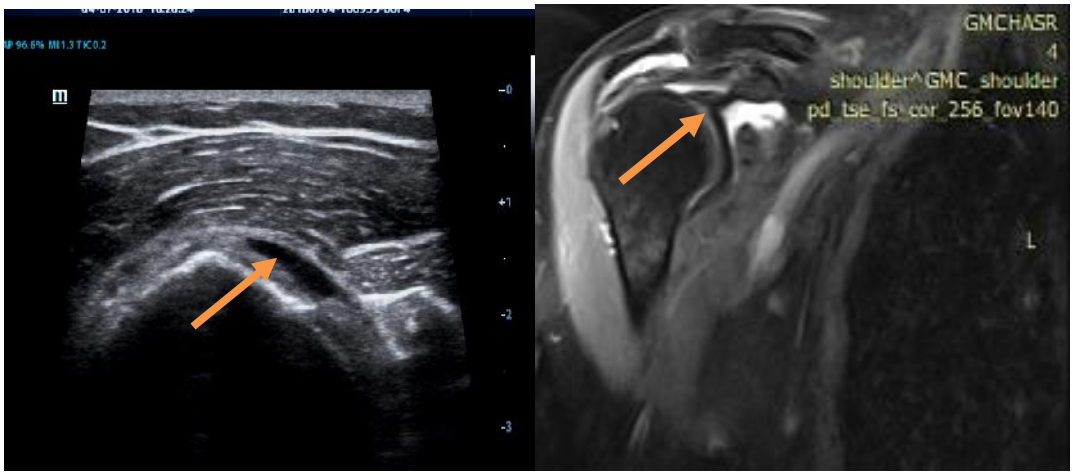

Figure: 1 USG image depicting partial thickness tear of supraspinatus tendon with minimal freefluid in subdeltoid and subacromial bursae.
Figure: 2 MRI PD FSE coronal image depicting partial tear of supraspinatus tendon with minimal freefluid in subdeltoid and subacromial bursae (arrow marked).

Figure: 1 USG of partial tear of subscapularis tendon
Figure 2: MRI T2W image of partial tear of subscapularis tendon

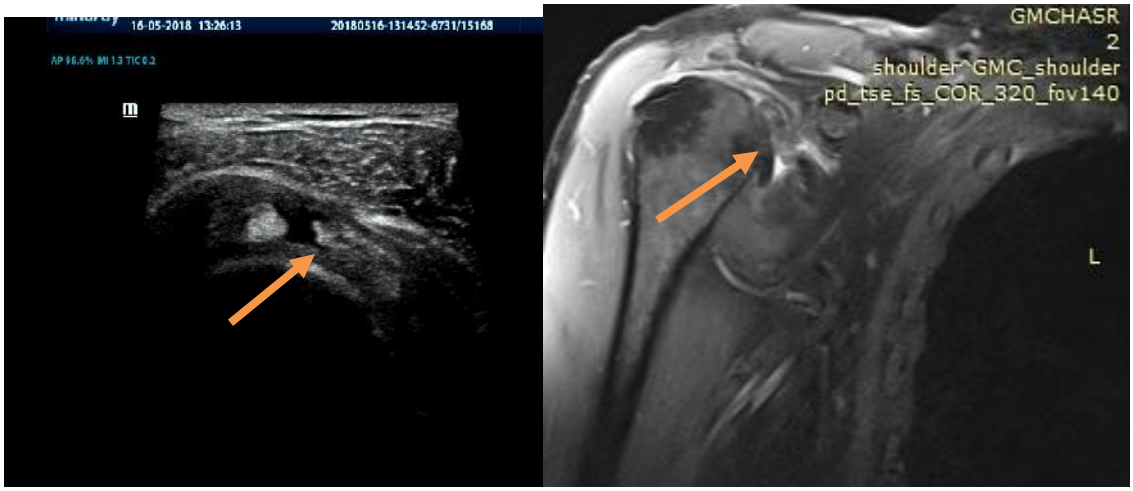

Figure 1: USG of complete subscapularis tendon tear.
Figure 2: MRI coronal PD FSE image of complete subscapularis tendon tear.

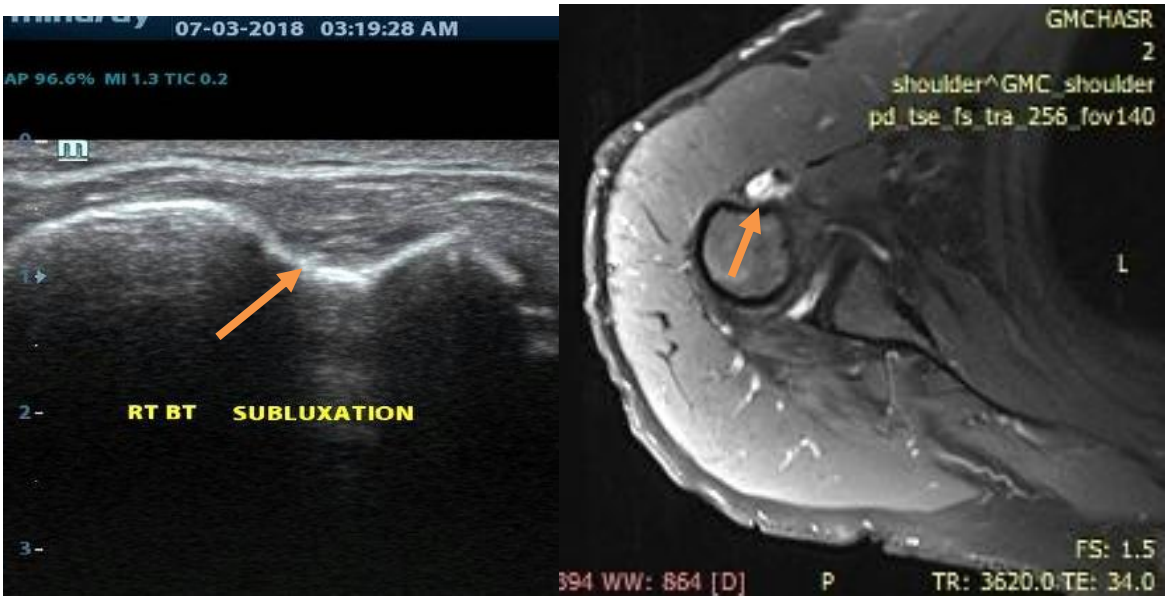

Figure 1: USG shows absence of biceps tendon on bicipital groove suggestive of subluxation of biceps tendon.

Figure 2: MRI T2W axial image of medial subluxation of biceps tendon.

Discussion

Out of 50 patients, maximum number of patients (17) were in the age group of 46-55 years. Thus, there is increase in prevalence of the disease with increasing age.Rotator cuff tears are most commonly found in >45 years age group and incidence increases as age progresses. The similar observation is made in the study done by Brandt T et al.[6]

The present study indicated males more prone for rotator cuff tears , which correlates to the study carried by Yamamoto A et al. [7]

Incidence of tears was more common in the dominant limb as compared to the non-dominant limb. Similar results were obtained by Moosmayer S et al[8.]

USG shows sensitivity of 83.7%, specificity of 100%,PPV of 100% and NPV of 68.4% for partial thickness tear and 100% sensitivity, specificity, PPV and NPV in complete thickness tear. (Table VII,VIII)

The strength of agreement between USG and MRI for diagnosis of rotator cuff tear was found to be (k= 1.0) for full thickness tears (very good agreement) and good agreement for partial thickness tears .Similar results were obtained by Rutten M et al[5], crass J R et al[9], Teefey S A et al[10], Wiener S [11,] Chauhan NS[15] and Aarti Anand[16].

McMonagle JS and Vinson EN (2012) conducted a study on MRI of shoulder concluded that understanding of rotator cuff pathogenesis and the optimal management of rotator cuff pathology is evolving. Shoulder MRI is a valuable tool in evaluating the patient with a painful shoulder, as it accurately depicts rotator cuff tendon pathology and any associated muscle abnormalities[12].

Kamath SU et al (2014) conducted a study on Correlation of Clinical Finding with Ultrasound Diagnosis of Rotator Cuff Pathology. In his prospective study conducted on 60 patients who had presented with shoulder pain due to either traumatic or degenerative cause. Patients with fracture or dislocation of shoulder, previous shoulder or upper limb surgery and malignancy were excluded from the study. All patients underwent a clinical examination followed by ultrasonography of the shoulder. In his study the sensitivity, specificity, a positive predictive value and negative predictive for diagnosing rotator cuff tears using ultrasound is 70.6%, 90.6%, 85.4% and 76.35% respectively for supraspinatus, infraspinatus, teres minor and subscapularis tendon injuries. They concluded that clinical

examination has to be supplemented by imaging modality to plan treatment. Ultrasound is a noninvasive method to confirm the clinical diagnosis and help to diagnosis other potential clinical mimics of this injury[13].

Bhatnagar S et al (2014) Conducted a study on The role of ultrasound and magnetic resonance imaging in the evaluation of musculotendinous pathologies of the shoulder joint. He founded that USG has sensitivity of 95.2%, specificity of 88.8%, and positive predictive value of 80% for demonstrating full-thickness tears. In case of partial-thickness tears, USG showed overall sensitivity of 94.7%, specificity of 85.7%, and positive predictive value of 90%. Overall accuracy of USG in detecting full-thickness as well as partial-thickness tears was 91%. He concluded that patients with shoulder complaints, USG is a reliable dynamic diagnostic tool. It reveals high diagnostic accuracy in detecting rotator cuff pathologies including cuff tears and tendinopathy. However, MRI has always been successful in overall assessment of joint structure. Its ability to evaluate labrum and various glenohumeral ligaments cannot be superseded by USG[14.]

Chauhan NS (2016), concluded the agreement between USG and MRI for diagnosis of RCTs was statistically excellent; USG showed a sensitivity of 86.7% and a specificity of 100% for full-thickness tears, and a sensitivity of 89.7% and a specificity of 98.8% for partial-thickness tears; observed accuracy for full thickness tears was 98.4% and 95.9% for partial thickness tears. The Kappa coefficient of association was 0.91 for full thickness tears and 0.90 for partial thickness tears. Considering the comparable diagnostic accuracy of USG and MRI, the former modality can be used as a first-line investigation for diagnosis of RCT. MRI should be used secondarily as a problem-solving tool either following an equivocal shoulder USG or for delineation of anatomy in cases where surgical correction is needed[15].

Aarti Anand (2018) concluded that ultrasound has a high sensitivity of 90.90% and specificity of 100.0% for partial thickness tears, and for full thickness tears, sensitivity of 100.0% and a specificity of 99.46%.The observed degree of agreement between ultrasound and MRI for partial thickness tears was 99.0%, with a Kappa coefficient of 0.947. And for full thickness tears, observed degree of agreement was 99.5% with a Kappa coefficient of 0.963. Statistical parameters suggest very good agreement between USG and MRI in detecting rotator cuff injuries[16].

Ultrasonography can be used as a primary method over MRI owing to fast procedure, easy availability , affordable cost, availability in a large scale, portable, quick and much more cost effective imaging method which is also easier tolerated by the patient.

MRI is useful in assessing rotator cuff tears in obese patients and patients with severe restriction of movement due to pain. MRI also provides information about structures that are not visible by USG like acromial anatomical variations, labral injuries and fatty infiltration in muscle atrophy.

Conclusion

From our study, USG is proven to be an effective imaging modality with results comparable with MRI in patients presenting with shoulder pain and /or disability and clinically suspected case of rotator cuff tendon tears. MRI provides excellent soft-tissue detail and has multiplanar capability. There was good agreement between USG and MRI for diagnosis of rotator cuff pathologies. So the results were almost similar to the results for MRI but the ultrasound is significantly cheaper and more available, so the ultrasound by an experienced radiologist should be considered as a primary diagnostic tool for imaging the rotator cuff pathologies. At present, MRI can be reserved for patients with suspicious USG results.

Source of funding: Nil

Conflict of interest: None declared

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How to cite this article:
Ramesh Chander, Madhan Kumar MK, Paramjit Singh, Partap Singh Verka, N.S. Neki. (2018). A prospective comparative study of high resolution ultrasound and MRI in the diagnosis of rotator cuff tears. Int. J. Curr. Res. Med. Sci. 4(12): 120-129.
DOI: http://dx.doi.org/10.22192/ijcrms.2018.04.12.013