

Role of ultrasound and MRI in patients with shoulder pathologies: A correlation study

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Abstract:

Introduction: *The rotator cuff disorders constitute the most common cause of shoulder pathologies. Ultrasonography and MRI are widely used in evaluating various shoulder pathologies. USG of shoulder is simple, cheap, fast and non-invasive imaging technology for detection of rotator cuff and non-rotator cuff abnormalities. In this study we have assessed the usefulness of USG in diagnosing the shoulder pathologies and have correlated with the MRI.*

Aim: *Evaluation of a patient with shoulder pathology with ultrasonography as the initial line of imaging technique as compared to MRI, assessing the accuracy of ultrasonography in diagnosing shoulder joint pathologies, especially rotator cuff abnormalities, using MRI as a reference standard and correlating findings wherever possible.*

Materials and Methods: *Hundred patients were studied prospectively over a period of two years. Study subjects included both men and women in all age groups with suspected shoulder pathology, suspected to have musculo-tendinous origin. All patients underwent USG evaluation of the shoulder joint followed by MRI of the affected shoulder.*

Results: *USG showed a sensitivity of 85%, specificity of 100%, PPV of 100% and NPV of 97% in diagnosing full thickness tear of rotator cuff using MRI as reference. For partial thickness tears, it showed a sensitivity of 71%, specificity of 69%, PPV of 82% and NPV of 54%. Overall accuracy of USG in detection of any tear of rotator cuff with MRI as reference was 82%. The strength of agreement between USG and MRI for the diagnosis of any tear of rotator cuff is considered to be 'substantial' in our study (Kappa=0.635).*

Conclusion: *USG showed comparable results to MRI in assessment of rotator cuff abnormality and should be used as first line of investigation in patients presenting with shoulder pathologies. It proved to have high sensitivity and specificity for full thickness tears with relatively less sensitivity and specificity in detection of partial thickness tear.*

Keywords: *Shoulder, MRI, USG, Rotator cuff, Tendinopathy*

INTRODUCTION

Shoulder pain is one of the most common presenting complaints due to which a person visits Orthopedic clinic [1]. Tendon inflammation, tendon tear, joint instability, arthritis, fracture are the most common shoulder pathologies seen in patients. Other less common causes include infections and nerve related conditions. The rotator cuff disorders constitute the most common cause of painful shoulder [2]. Continuous active and passive forces make the rotator cuff tendons prone to degeneration causing swelling of tendon with sub-luxation [3]. Ultrasonography and MRI are widely used in evaluating various shoulder pathologies. Shoulder joint is the commonest joint to undergo musculoskeletal (MSK) USG examination [4]. USG of shoulder is simple, cheap, fast and non-invasive imaging technology for the detection of rotator cuff and non-rotator cuff abnormalities [5,6]. 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). 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. 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.

MATERIAL AND METHODS

A prospective study was undertaken in Department of Radiology in Government Medical College Amritsar Punjab, India, for a period of 1 year from February 2020 to February 2021 in which 100 patients referred for MRI for evaluation of shoulder pathologies were taken. After clinical evaluation, once a patient satisfied the inclusion and exclusion criteria for this study, he or she underwent sonographic evaluation of the shoulder joint followed by MRI of the affected shoulder. Ethical committee approval was obtained. Patient consent was taken.

Inclusion Criteria

- History of pain in either of the shoulder.
- History of restricted movements in either shoulder.
- Clinically suspected to have internal derangements like rotator cuff injury, biceps tendon injury, calcific tendinitis, etc.

Exclusion Criteria

- Patients with instability disorders.
- Patients with any electrically, magnetically or mechanically activated implants (pacemaker, biostimulators, neurostimulators and cochlear implants).
- Patients having claustrophobia.

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

MRI imaging was done with 1.5 Tesla Siemens magnetom machine using shoulder coil.

USG and MRI findings were statistically analysed and interpreted.

RESULTS

Study design: Total 100 patients with shoulder joint pain were studied and USG findings were correlated with MRI findings.

Spectrum of pathology: Of the patients with shoulder complaints referred to our department, rotator cuff pathologies were the most common finding and were seen in 93 patients.

USG findings: Among the subjects studied for painful shoulder, on USG majority had pathology involving supraspinatus tendon (85%). This was followed by subscapularis tendon pathologies seen in 54% patients.

TABLE 1: Detailed correlation of pathological findings on USG and MRI

Tendons	USG /MRI	Partial thick-ness tear	Full thick-ness tear	Tendinosis	Intra substance tear	Normal
Subs-capularis	USG	8 (8%)	2 (2%)	42 (42%)	2 (2%)	46 (46%)
	MRI	6 (6%)	2 (2%)	45 (45%)	2 (2%)	45 (45%)
Supra-spinatus	USG	51 (51%)	12 (12%)	20 (20%)	2 (2%)	15 (15%)
	MRI	63 (63%)	13 (13%)	15 (15%)	2 (2%)	7 (7%)
Infra-spinatus	USG	7(7%)	0	7 (7%)	0	86 (86%)
	MRI	7(7%)	2 (2%)	10 (10%)	0	81 (81%)
Teres Minor	USG	-	-	-	-	100 (100%)
	MRI	-	-	-	-	100 (100%)
Biceps tendon	USG	-	-	2 (2%)	-	90 (90%)
	MRI	-	-	2 (2%)	-	90 (90%)

Among the non rotator cuff disorders, acromio-clavicular joint arthropathy was the most common pathology detected on USG.

TABLE 2: Correlation of USG and MRI in detection of non rotator cuff related pathologies.

Pathology	MRI	USG
ACJ arthropathy	60	48
SASD bursa effusion	27	40
SC bursa effusion	16	24

Biceps tendinosis	2	2
Biceps dislocation	7	7
Peribicipital tendon fluid	50	49

MRI findings: On MRI, 93 patients showed supraspinatus tendon pathologies. Among the non rotator cuff disorders acromioclavicular joint arthropathy was most common pathology seen in 60(60%) patients on MRI. Other pathologies that were seen are subacromial-subdeltoid bursa effusion, subcoracoid bursa effusion, acromio-clavicular joint arthropathies, biceps tendinosis and dislocation.

Correlation of USG and MRI findings: In our study, MRI was used as reference standard and out of 100 patients, 81(81%) patients showed either partial thickness, full thickness or combined partial and full thickness rotator cuff tears whereas on ultrasonography examination out of 100 patients 70 (70%) patients showed either isolated or combined rotator cuff tears.

Rotator cuff tears: Tear in any tendon, whether in isolation or in combination with other tendons was considered a rotator cuff tear. Overall, MRI showed rotator cuff tears in 81 patients.

USG showed good sensitivity in diagnosing full thickness tears and correctly identified eight out of nine cases of full thickness tears.

TABLE 3: USG in evaluation of rotator cuff tears.

Findings	TP	FP	TN	FN	Sensitivity	Specificity	PPV	NPV
Partial Thickness Tear	48	10	23	19	71.06%	69.67%	82.7%	54.70%
Full Thickness Tear	12	0	86	2	85.70%	100%	100%	97.70%

TABLE 4: Agreement between USG and MRI in diagnosing rotator cuff tears

	DIAGNOSIS	MRI			TOTAL
		NO TEAR	PTT	FTT	
USG	No Tear	15	15	0	30
	PTT	4	50	4	58
	FTT	0	0	12	12
		19	65	16	100
Agreement	Expected Agreement	Kappa	Standard Error	Z	p-value
80.00%	45.28%	0.63	0.0945	6.73	<0.001

The agreement between the two methods was assessed using kappa coefficient (Kappa=0.63). The strength of agreement between USG and MRI for the diagnosis of any tear of rotator cuff is considered to be 'substantial' in our study.



Figure 1: USG of supraspinatus tendon showing full thickness tear on longitudinal view. USG of supraspinatus tendon showing signs of partial thickness tear at the articular aspect.

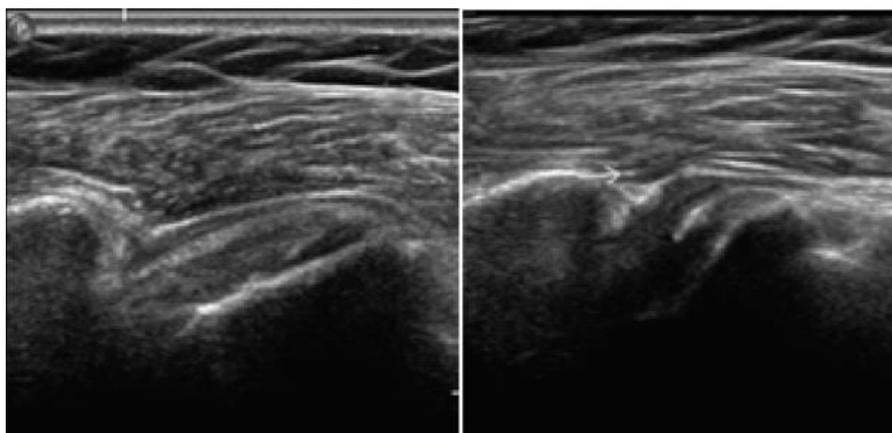


Figure 2 : Longitudinal USG of supraspinatus tendon showing calcifications. Longitudinal USG of subscapularis tendon showing signs of tendinosis.

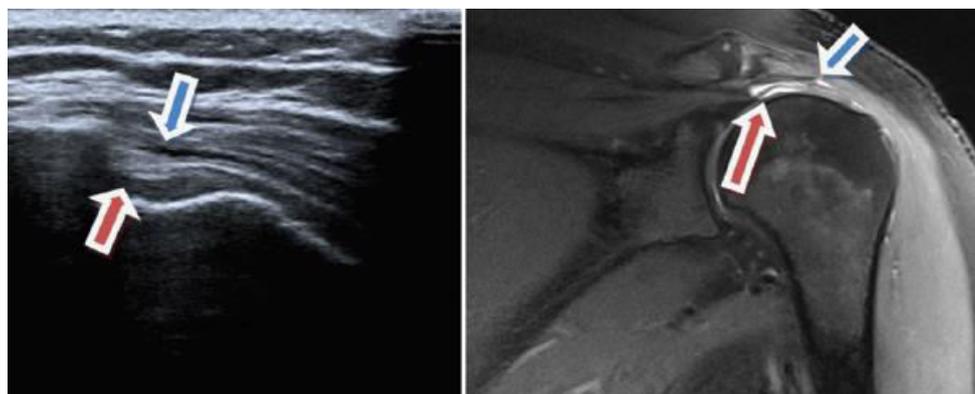


Figure 3 : On ultrasonography thinned out supraspinatus tendon (red arrow) with reduced acromiohumeral distance and minimal fluid in subdeltoid bursa (blue arrow), Magnetic resonance imaging proton density weighted coronal oblique image with fat saturation - supraspinatus tendon tear with few spared fibers and reduced acromiohumeral distance with minimal subdeltoid fluid (blue arrow)



Figure 4 : MRI PD- FSE coronal image depicting full thickness tear of supraspinatus tendon with minimal free fluid in subdeltoid and subacromial bursae.

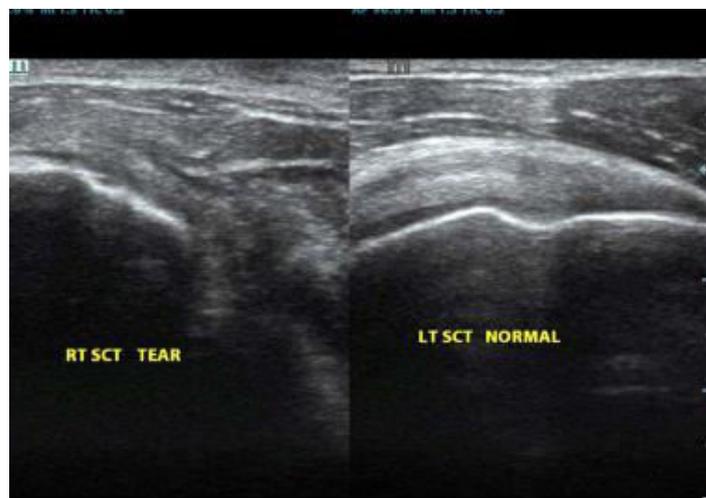


Figure 5 : USG of partial tear of subscapularis tendon

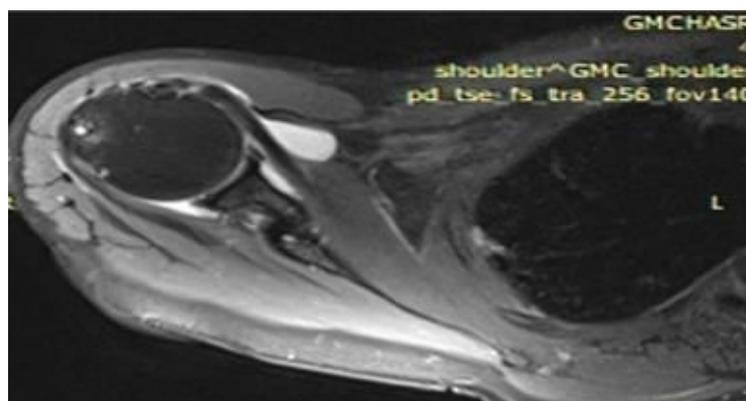


Figure 6 :MRI T2W image of partial tear of subscapularis tendon

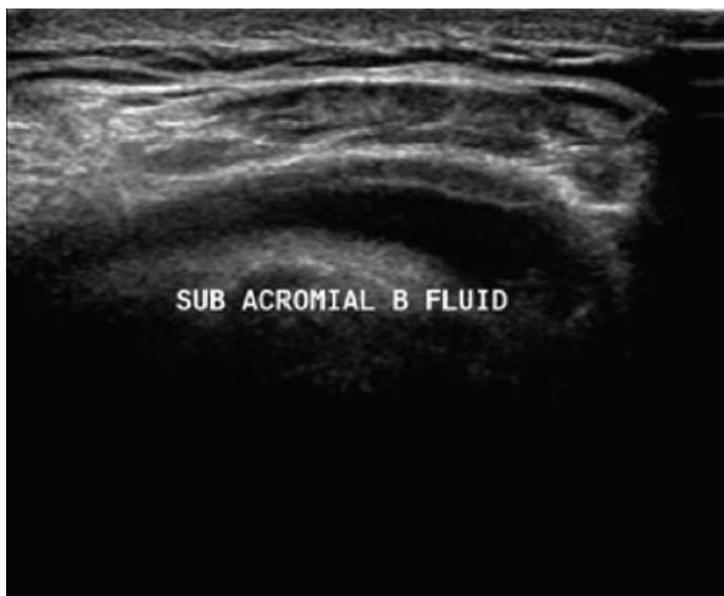


Figure 7 : USG showing sub acromial bursal fluid

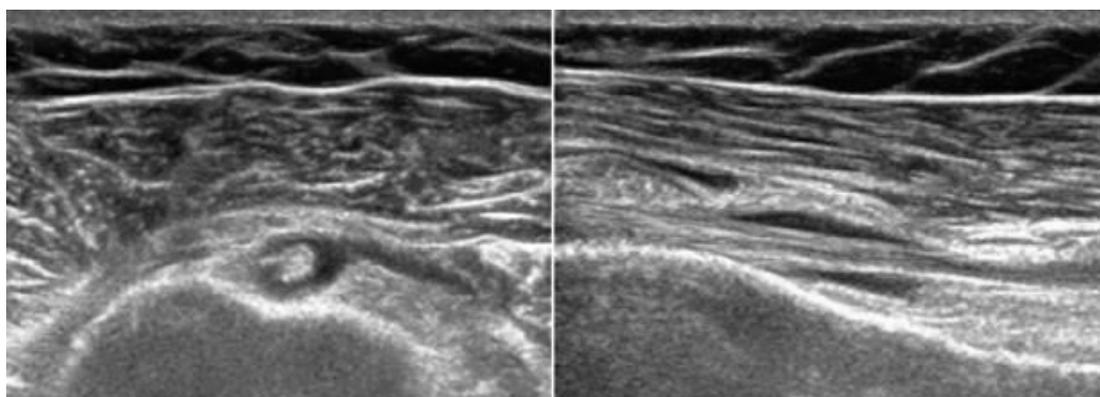


Figure 8: Transverse and Longitudinal USG showing peribicipital tendon fluid.

DISCUSSION

Most commonly encountered shoulder pathologies are tendon inflammation, tendon tear, joint instability, arthritis, fracture and less common ones being infections and nerve related conditions.

In our study rotator cuff pathologies were found to be the commonest cause for referral to Department of Radio-diagnosis which was found similar to study carried out by Mitchell C et al., [7].

Various techniques are used for evaluating patients with shoulder pathologies including clinical examination, plain radiography, arthrography, USG, CT-scan and MRI. Arthrography traditionally used for diagnosis of rotator cuff tears is invasive technique with many health risks [8]. Hence, Ultrasonography and MRI have widely overtaken this technique. Conventional MRI is sensitive and specific, but cannot be used as a first line of investigation. However, USG is a non-invasive, relatively inexpensive modality that can be used.

Rotator cuff tears have been reported the most common rotator cuff pathology with USG showing high sensitivity and specificity for full-thickness tears, but less for partial thickness tears[9]. In the present study we have compared the findings of ultrasound with MRI, using it

as a reference standard for the detection of rotator cuff and related pathology in patients referred to our department.

Among 100 patients, that underwent sonography and MRI, majority of the subjects, 62(62%) patients (58 males and 42 females) were in the age group of 50 –70 years with mean age 56.67. Rotator cuff tears were seen in 52(52%) patients in age group of 50-70 years. Highest incidence of rotator cuff tears in our study was seen in sixth decade of life, similar to that observed by White et al., [10].

In our study, MRI was used as reference standard and out of 100 patients, 81(81%) patients showed either partial thickness, full thickness or combined partial and full thickness rotator cuff tears whereas on ultrasonography examination 70% patients showed either isolated or combined rotator cuff tears.

USG detected 85% patients and MRI detected 93% patients with supraspinatus tendon pathologies which included tears, tendinosis and calcifications. Zlatkin et al., also found presence of supraspinatus tendon involvement in around 80% of cases in their study [11].

Overall, MRI showed rotator cuff tears in 81 patients. Partial thickness tear was present in 67 patients which included two patients with intrasubstance tear. 15 (15%) patients had full thickness tear or combined partial and full thickness tear. Rest of the 18(18%) patients had intact rotator cuff without any tendon tear. Hence, partial thickness tears were the most common rotator cuff pathology seen in our study.

USG had a sensitivity of 71%, specificity of 69%, PPV of 82% and NPV of 54% in detection of partial thickness tears and a sensitivity of 85%, specificity of 100%, PPV of 100% and NPV of 97% in detection of full thickness tears.

The findings in our study are comparable to studies carried out by Bashir et al., [20] and Rutten et al., [12] where they found substantial agreement between USG and MRI in detection of rotator cuff tears. The level of sensitivity and specificity seen in our study closely resembles to that of Cullen et al., who reported a sensitivity of 89% and specificity of 100% in detection of full thickness tear and sensitivity of 79% and specificity of 94% in detection of partial thickness tears [13].

Non tear related rotator cuff and other related pathologies seen were calcification, tendinosis, tendon impingement, subacromial- subdeltoid fluid and bicipital tendon pathologies. In our study we found that MRI was less accurate in detecting calcific deposits in tendon. Only one patient was diagnosed to have calcific deposits in supraspinatus tendon on MRI. Zubler et al., also found that detection of smaller amounts of calcification may be difficult with MRI, whereas, Hartig and Huth in a study found USG to show 100% sensitivity in detecting calcific deposits in rotator cuff tendon [14,15]. Hence, our findings were in accordance with literature and USG proved to be a better modality in detection of tendon calcification.

ACJ arthropathy was the most commonly observed non rotator cuff related pathology in our study. USG correctly identified acromio-clavicular joint arthropathy in 48(48%) patients with a sensitivity of 80% and specificity of 95%. Iagnocco et al., also found ACJ involvement in 51.5% patients in their study and considered it to be commonly involved in patients with painful shoulder [16].

USG showed 100% sensitivity in detection of biceps tendinosis and dislocation.

Thus, in our study we found USG to have good sensitivity, specificity and accuracy for detection of rotator cuff tears. USG and MRI findings showed good agreement in diagnosis of

partial and full thickness tears. MRI proved to be superior in characterisation of tear with respect to location and extent. It also proved to be superior in detection of certain non rotator cuff related pathologies like subacromial-subdeltoid effusion, subcoracoid effusion and ACJ arthropathy.

CONCLUSION

In our study we concluded that USG can be used as an initial line of investigation for evaluation of all patients with painful shoulder who are clinically suspected to have rotator cuff disorders. Rotator cuff pathologies proved to be the most common cause of shoulder pain and USG showed comparable results to MRI in detection of rotator cuff pathology. Thus, it can be clearly used as a cost effective first line investigation modality in assessment of shoulder pain. It is proved to have high sensitivity and specificity for full thickness tears with relatively less sensitivity and specificity in detection of partial thickness tear.

MRI proved to be superior in estimation of assessment of correct site and extent of tear. It is also proved to be superior in detection of non-rotator cuff related pathologies like subacromial-subdeltoid effusion, subcoracoid effusion, ACJ arthropathies.

REFERENCES

1. Dinnes J, Loveman E, McIntyre L, Waugh N. The effectiveness [1] of diagnostic tests for the assessment of shoulder pain due to soft tissue disorders a systematic review. *Health Technol Assess.* 2003;7(29):iii,1-166.
2. Uthoff HK, Sarkar K. An algorithm for shoulder pain caused [2] by soft-tissue disorders. *ClinOrthopRelat Res.* 1990;(254):121-27.
3. Lambert A, Loffroy R, Guiu B, Mejean N, Lerais JM, Cercueil JP, [3] et al. Rotator cuff tears: value of 3.0T MRI. *J Radiol.* 2009;90(5 Pt 1):583-88.
4. Chaubal NG. Ultrasonography of shoulder [rotator cuff]. *Indian J Radiol Imaging.* 2007;17:209-14.
5. Seibold CJ, Mallisee TA, Erickson SJ, Boynton MD, Raasch WG, [5] Timins ME. Rotator cuff: evaluation with US and MR imaging. *Radiographics.* 1999;19(3):685-705.
6. Martinoli C, Bianchi S, Prato N, Pugliese F, Zamorani MP, [6] Valle M, et al. US of the shoulder: non-rotator cuff disorders. *Radiographics.* 2003;23(2):381-401.
7. Mitchell C, Adebajo A, Hay E, Carr A. Shoulder pain: diagnosis and management in primary care. *BMJ.* 2005;331(7525):1124- 28.
8. Naqvi GA, Jadaan M, Harrington P. Accuracy of ultrasonography [17] and magnetic resonance imaging for detection of full thickness rotator cuff tears. *Int J Shoulder Surg.* 2009;3(4):94-97.
9. Teefey SA, Hasan SA, Middleton WD, Patel M, Wright RW, Yamaguchi K. Ultrasonography of the rotator cuff. A comparison of ultrasonographic and arthroscopic findings in one hundred consecutive cases. *J Bone Joint Surg Am.* 2000;82(4):498- 504.
10. White JJ, Titchener AG, Fakis A, Tambe AA, Hubbard RB, Clark [19] DI. An epidemiological study of rotator cuff pathology using The Health Improvement Network database. *Bone Joint J.* 2014;96- B(3):350-53.

11. Bashir S, Firdose SR, Kamal Y, Khan HA, Arora M, Gul S, Hassan [20] N. Correlation between high resolution ultrasonography and MRI in rotator cuff tear diagnosis. *IJHSR*. 2014; 4(8):103-12.
12. Rutten MJ, Spaargaren GJ, van Loon T, de Waal Malefijt MC, [21] Kiemeney LA, JagerGJ. Detection of rotator cuff tears: the value of MRI following ultrasound. *EurRadiol*. 2010;20(2):450-57.
13. Cullen DM, Breidahl WH, Janes GC. Diagnostic accuracy of [22] shoulder ultrasound performed by a single operator. *AustralasRadiol*. 2007;51(3):226-29.
14. Zubler C, Mengiardi B, Schmid MR, Hodler J, Jost B, [23] Pfirrmann CW. MR arthrography in calcific tendinitis of the shoulder: diagnostic performance and pitfalls. *EurRadiol*. 2007;17(6):1603-10.
15. Hartig A, Huth F. New aspects of the morphology and therapy of [24] calcific tendinitis of the shoulder joints. *Arthroscopy*. 1995;8:117- 22.
16. Iagnocco A, Coari G, Leone A, ValesiniG. Sonographic study of painful shoulder. *ClinExpRheumatol*. 2003;21(3):355-58.