ORIGINAL RESEARCH ARTICLE

Role of Ultrasonography and Magnetic Resonance Imaging in Patients Presenting with Shoulder Pain

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ABSTRACT

Introduction: Shoulder pain is the third most common presenting complaint in Orthopedics OPD and is associated with significant morbidity and disability. The plan of management depends on an accurate diagnosis. Though clinical examination is a corner stone in diagnosis, in many situations imaging helps to understand the extent and degree of the involved pathology. Accuracy, availability, cost effectiveness and expertise are some of the important parameters that guide the process of making a decision on the best modality. Objectives: To evaluate the efficacy of USG in detecting rotator cuff tears in comparison to MRI, which has been considered as gold standard.

Material and methods: 100 shoulders from 95 patients who came with history of shoulder pain and on clinical examination were being suggested radiographic imaging were compared for their USG and MRI findings. The diagnostic accuracy of USG when compared with MRI was expressed with Specificity, Sensitivity, Positive Predictive value and Negative Predictive value.

Results: The diagnostic accuracy was higher for Rotator cuff injury, moderate for Biceps pathologies and poor for instability related shoulder injuries.

Conclusion: As ultrasonography is less expensive, noninvasive, patient compliant and more widely available than MRI, it may be the first line investigation (screening).

Keywords: Shoulder Pain, Rotator Cuff Injury, Diagnostic Accuracy

INTRODUCTION

Shoulder pain is the third most common presenting complaint in Orthopedics OPD after low back pain and knee pain. It is associated with significant morbidity and disability.[1] Restricted shoulder movement because of pain, stiffness, or weakness can affect a person's ability to perform their daily activities (eating, dressing, personal hygiene) and professional work.[2] The functional limitations resulting due to shoulder disability increase with age.[1]

Overall prevalence of self-reported shoulder pain is around 16% in the United Kingdom and increases to 26% in the elderly populaiton.[3] Although community prevalence of shoulder pain is limited in our country, the prevalence among urban and rural population of India has been reported to be 2% and 7.4%, respectively.[4,5]

The most common causes of shoulder pain in primary care are reported to be disorders affecting the rotator cuff, acromioclavicular joint disease and glenohumeral joint disorders.[2] The major pathologies that can cause shoulder pain include soft tissue disorders, articular injury or instability, and arthritis. Rotator cuff (RC) pathology contributes to 30%-70% of shoulder pain.[3]

The plan for management (whether conservative or surgical treatment) depends on the diagnosis. The type of the surgical intervention (open or arthroscopic) would also vary according to the diagnosis. Also, the extent of tendon retraction and the condition of the ruptured edges, as well as the quality of the muscle itself influences the management policy.[6] Though history taking and clinical examination are the cornerstones of the diagnosis of shoulder disorders, the value of history taking and clinical examination alone are limited with regard to making a decision for further management with certainty. Making a differential diagnosis in place of a confirmatory diagnosis will lead to difficultly in treating the patient appropriately.[3]

The role of imaging in such conditions is to identify the causal factors as well as to detect the involvement of tendon injuries and its extension, as tears of the cuff muscles is difficult to be identified clinically.[6] The most important criterion for the assessment of different imaging modalities is their ability to distinguish individual pathologies of the shoulder joint, either alone or in combination.[3]

Accuracy, availability, cost effectiveness and expertise are some of the important parameters that guide the process of making a decision on the best modality.[7]

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To evaluate the painful shoulder, a variety of imaging tests have been used; yet, for diagnosing a rotator cuff tear the standard imaging modalities such as unenhanced MRI, indirect and direct MR arthrography, and ultrasound are used. Ultrasound of the shoulder is utilized increasingly in healthcare settings to assess the integrity of the rotator cuff. It is a non-invasive examination with practically no side effects. It is beneficial in the dynamic examination of the tendons during movement of the shoulder. Yet being operator dependent with a long learning curve is frequently considered to be its limitation, especially in cases of partial thickness tears for which a high interobserver variability is noted.[6]

MRI initially became more popular than Ultrasound for preoperative diagnosis of partial and full-thickness RC tears, with high sensitivity and accuracy results. On the long run though, when considering accuracy, cost, availability, safety, and efficiency of management when used at the point of care, Ultrasound is likely the best option in most settings for the diagnosis. MRA is a mildly invasive imaging technique, and use of contrast medium, gadolinium is required to be introduced in the joint. Evaluations of plain X-ray and computed tomographic arthrography (CTA) are usually excluded from this kind of investigations as these techniques are recognized to have limited value in the diagnosis of soft tissue lesions.[3]

Thus, even though more accurate than USG, MRI cannot become the screening modality of choice for rotator cuff pathologies in a country like India where cost and availability are major patient concerns. The present study aims at evaluating the efficacy of USG in detecting rotator cuff tears in comparison to MRI, which we have taken as Gold standard.

MATERIAL AND METHODS

This cross sectional study was done on 100 shoulders from 95 patients who came with history of shoulder pain and who on clinical examination were been suggested radiographic imaging in a tertiary care medical college in Kannur, Kerala. Prior Institutional ethical committee permission was obtained. The patients were briefed about the need and purpose of the study, confidentiality of information and participant's rights in this study. Those who were willing to participate in the study were requested to give a written informed consent. Patients with claustrophobia,metallic implants/pacemaker and those who had a past history of surgical procedure on the shoulder were excluded from the study. A Pretested semi-structured questionnaire was used for data collection. The questionnaire consisted of two parts. First part elicited the sociodemographic details of the patient and their clinical history. The second part included the radiographic findings of USG and MRI. USG was done performed while the patient was made to sit on a rotating stool without arm rest using a high resolution ultrasound with GE 9L transducer probe of GE logiq S8 machine. MRI Shoulder was done using 1.5 Tesla GE 16 channel machine.The following sequences were acquired in planes orthogonal to the shoulder joint:

T1W (T1 weighted) in coronal and sagittal planes.
T2W (T2 weighted) in axial, coronal and sagittal planes.
PD-FAT SAT (Proton Density – Fat Saturated) in axial, coronal and sagittal planes.

T2 MERGE (Gradient Echo) in axial plane.

The ultrasound Procedure and MRI interpretation was done by a single radiology resident and the findings were confirmed and corrected if any by a senior radiologist. USG was done first and then MRI was done to avoid bias. The results were entered in Microsoft excel sheet. The socio demographic variables and clinical history were expressed in percentages. The ultrasound findings were compares with the MRI findings(which we considered as gold standard) and True positives, True negatives, False Positives and False Negatives were tabulated. The diagnostic accuracy of USG when compared with MRI was expressed with Specificity, Sensitivity, Positive Predictive value and Negative Predictive value.

RESULTS

A total of 95 patients who fulfilled were included in the study. 90 had unilateral pain in the shoulder while 5 patients had bilateral shoulder pain which contributed to 100 shoulder. There were totally 60 shoulders from male patients(60%) and 40 shoulders from female patients(40%). Around 62% had right shoulder involvement and rest 38% had left shoulder involvement.

The age of the patients varied from 20 – 84 years. Maximum number of shoulders were from those who were in the age group of 51-60 years (28%), followed by 31-40 years (18%) (Fig 1).

Pain was present in 63% of study population, limitation of movement was present in 57% of the study population. 10%(10 participants) of the study population had dislocation of shoulder of which 7 (70% of those who had dislocation) had recurrent dislocation.(Fig 2)

Around 66% of study population had duration of symptoms less than 6 months, 23% between 6 months to one year. 11% had symptoms more than one year. 5% of study population had symptoms more than 5 years and one patient was suffering for more than 16 years.(Fig 3) Trauma was the cause of 61% of study population of which 12% had sports Injury.(Fig 4) 76% of the study population had Rotator cuff pathology followed by biceps pathology(15%), instability(12%). (Fig 5)

The sensitivity of the USG findings compared with MRI findings are more than 60 except for Infraspinatous partial thickness tear and teres minor partial thickness tear. The specificity is more than 95 in all the findings. the PPV is also more than 60 in all the measures except teres minor partial thickness tear. The negative predictive value is more than 90% in all the findings. (Table 1)

The sensitivity of the USG findings compared with MRI findings for Biceps pathology is 100% in all the conditions except for partial tear where it is 66.7%. The specificity is more than 90 in all the findings except for displacement where it is 88.9. The PPV is also more than 66 in all the measures except Vertical split/Bifurcation. The negative predictive value is more than 90% in all the findings. (Table 2)

Findings		TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	kappa
Full Thickness Tear	Supraspinatus	29	1	4	40	87.9	97.6	96.7	91.9	0.932
	Infraspinatus	4	1	2	69	66.7	98.6	80	97.2	0.865
	Subscapularis	3	2	0	71	100	97.3	60	100	0.899
Partial Thickness Tear	Supraspinatus	30	2	4	40	88.2	95.2	93.8	90.9	0.92
	Infraspinatus	6	2	5	63	54.5	96.9	75	92.6	0.907
	Subscapularis	13	2	6	55	68.4	96.5	86.7	90.2	0.894
	Teres minor	0	1	1	74	0	98.7	0	98.7	0.973
Tendinosis	Supraspinatus	29	2	2	43	93.5	95.6	93.5	95.6	0.947
	Infraspinatus	5	1	1	69	83.3	98.6	83.3	98.6	0.973
	Subscapularis	9	1	1	65	90	98.5	90	98.5	0.973
	Teres minor	1	0	1	74	50	100	100	98.7	0.986

Table 1: Diagnostic accuracy of USG compared to MRI in Rotator cuff Pathologies

	TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	kappa
Rupture/FTT With retraction	3	0	0	12	100	100	100	100	1
Partial Tear	2	1	1	11	66.7	91.7	66.7	91.7	0.866
Tendinosis	4	1	0	10	100	90.9	80	100	0.933
Subluxation	2	1	0	12	100	92.3	66.7	100	0.933
Displacement	6	1	0	8	100	88.9	85.7	100	0.933
Vertical split/Bifurcation	1	1	0	13	100	92.9	50	100	0.933

Table-2: Diagnostic accuracy of USG compared to MRI in Biceps Pathologies

	TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	kappa
Hill Sachs	0	1	7	4	0	80	0	36.4	0.333
Reverse Hill sachs	0	0	1	11	0	100	0	91.7	0.916
Bankart Lesions	0	0	4	8	0	100	0	66.7	0.667
Soft tissue Bankart	0	0	9	3	1	100	0	25	0.25
POLPSA	0	0	1	11	0	100	0	91.7	0.916
GAGL	0	0	1	11	0	100	0	91.7	0.916
SLAP	0	0	2	10	0	100	0	83.3	0.833
PLC	1	1	2	8	33.3	88.9	50	80	0.75
Marrow Edema	0	0	3	9	0	100	0	75	0.75
SupraspinatousTendinosis/Tears	3	2	2	5	60	71.4	60	71.4	0.615
Glenohemeral joint subluxation/dislocation	0	0	4	8	0	100	0	66.7	0.667
Fracture proximal humerus	3	1	0	8	100	88.9	75	100	0.916

Table-3: Diagnostic accuracy of USG compared to MRI in Instability Pathologies

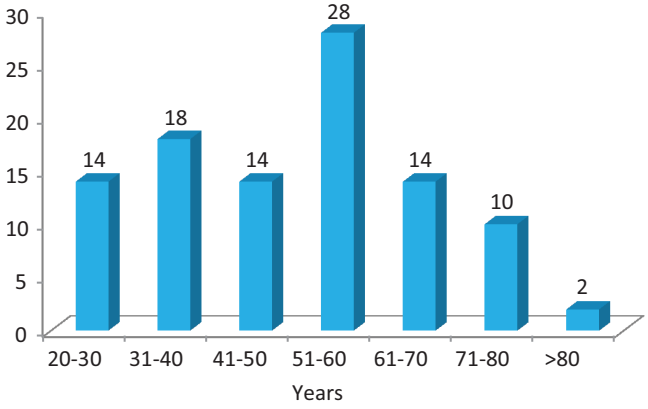

Figure-1: Distribution of study population according to age group

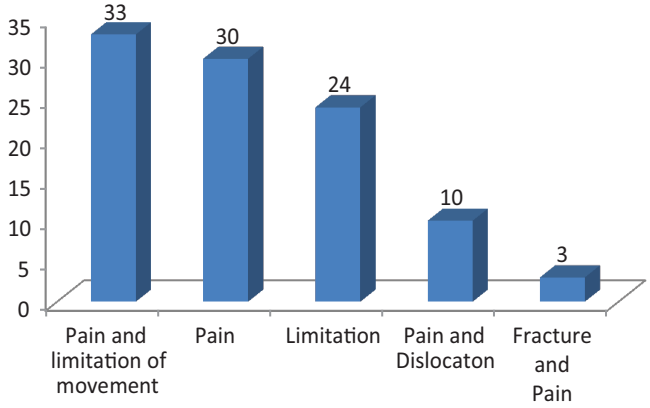

Figure-2: Distribution of study population according to symptoms

The sensitivity and PPV is very very poor for diagnosing instability related shoulder pathology. The specificity and NPV of USG in ruling out instability related shoulder pathology is better.(Table 3)

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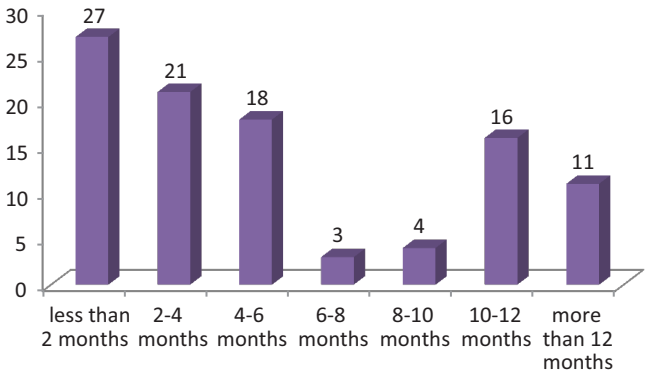

Figure-3: Distribution of study population according to duration of symptoms

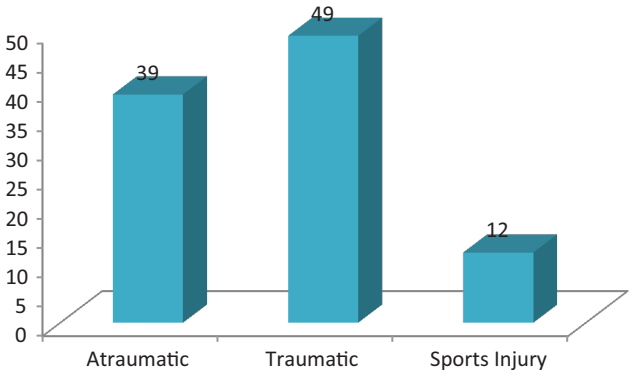

Figure-4: Distribution of study population according to nature of the cause

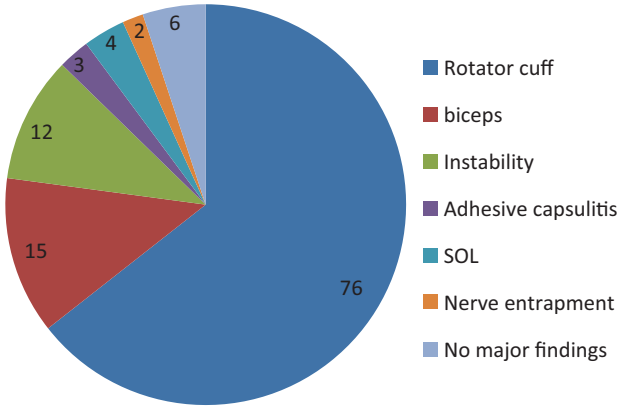

Figure-5: Distribution of study population according to shoulder pathology

DISCUSSION

Shoulder pain being one of the commonest causes of musculoskeletal pain and morbidity among general adult population. Immediate and accurate diagnostic results will help in inititating prompt and accurate treatment. Even though MRI is already established to be a highly accurate imaging modality, it is essential to demark the efficacy of USG in a developing country like India where cost and availability are major limitations of MRI.(1)

Male to female ratio was 1.5:1in our study. Similar results were observed in studies done by Thakker et al[1], Khanduri[2] et al and Ramesh et al.[8] In a study done by Ahmed et al[10] the male to female ratio was 1.2:1.

62% had right sided pathology. Similar results were observed in studies done by Ramesh et al[8] and okoraha et al[9] in his study observed that 66% had right sided injury. There were more than 80% with right sided pathology in studies done by Thakker et al[1], Ahmed et al[10] and Patidar et al.[11]

Maximum number of shoulders were from those who were in the age group of 51-60 years (28%), followed by 31-40 years (18%). Similar results were observed in studies done by Ramesh et al.[8] Majority of the cases were younger 54% between 20 – 39 in a study done by Thakker et al.[1] In a study done by Ahmed et al[10] majority of the study population were more than 60 years.

Pain and limitation was the major complaint in most of the study participants. Similar results were reported by studies done by Thakker et al[1], Khanduri et al[2] and Saraya and Bakry.[6]

Trauma was the cause of 61% of study population of which 12% had sports Injury. Trauma was the predominant reason for shoulder pathology in studies done by Thakker et al[1] and Khanduri et al.[2] Trauma accounted for only 27% of shoulder pathology in a study done by Ahmed et al[10]

76% of the study population had Rotator cuff pathology followed by biceps pathology (15%) and instability(12%). Rotator cuff pathology was the predominant diagnosis observed in majority of the studies.[2,7,12,13]

USG has a better diagnostic accuracy in diagnosing rotator cuff injuries. In the rotator cuff pathologies, there was a very good agreement for complete tear and tendinosis and a good agreement for partial thickness tear. Similar results were obtained by other studies.[8,14-21]

According to Saraya and Bakry[6], ultrasound was as accurate as MRI for assessment of tears of the rotator cuff, both full- or partial-thickness tears. They also concluded that due to its lower cost, it may be a useful imaging modality which is cost-effective, provided the examiner has adequate expertise or training.

Roy et al[22] in their meta-analysis, confirmed a similar and high diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of full-thickness rotator cuff tears in individuals with shoulder pain.

Elfaal et al[23] in their study have observed that Full-thickness rotator cuff tears can be identified using ultrasonography and MRI with similar accuracy. However, as ultrasonography is less expensive, less time-consuming, more dynamic and less demanding for patients, it should be used as the first line of investigation for rotator cuff tears, when appropriate skills are available.[23]

There is a moderate agreement between USG and MRI in diagnosing Biceps pathology. Similar results were obtained in many studies done by Saraya and Bakry[6], Ahmed et al[10], Alasaarela et al[24], Wengert et al[25] and El-Shewi et al.[26] Chen et al[27] in his study observed a better diagnostic accuracy for biceps pathology.

The diagnostic accuracy in diagnosing instability is quite poor. Wengert et al[25] and El-Shewi et al[26] found a moderate agreement for USG and MRI.

CONCLUSION

Ultrasonography has a high accuracy with respect to MRI in

the diagnosis of rotator cuff tears. However, ultrasonography shows consistently low reliability in detecting subtle, but clinically important, degeneration of the soft-tissue envelope. As ultrasonography is less expensive, noninvasive, patient compliant and more widely available than MRI, it may be the first line investigation (screening). It could be considered as the most appropriate method when rotator cuff integrity is the main question. If any other clinical condition is suspected other than rotator cuff pathology, MRI can be considered. However, MRI is superior in surgical planning for larger tears and provides much more information about the prognostic factors.

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