Section: Radiology

Original Research Article

PARTIAL THICKNESS ROTATOR CUFF TEARS: THE HITS AND MISSES WITH SHOULDER ULTRASONOGRAPHY

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Abstract

Background: Shoulder ultrasonography is a well reckoned modality for evaluation of rotator cuff tears. Though the role of ultrasonography for evaluation of full thickness tears is well established albeit its performance with regards to partial thickness rotator cuff tears has always been a matter of debate. Partial tears are difficult to identify and presence of pitfalls caused due technique, anatomic variations and artifacts further lowers the confidence. Accurate identification of partial thickness tear and its complete description has important surgical implications. **Aim:** To evaluate the diagnostic performance of shoulder ultrasonography in the detection and characterisation of partial thickness rotator cuff tears in comparison with MRI. **Material and Methods:** Prospective observational study was conducted at our institute over a period of 2 years which included a total of 112 patients.Patients of varying age groups referred by orthopedic surgeon with clinical suspicion of rotator cuff tears were included in the study. Shoulder ultrasonography(USG) was performed by a general radiologist using a standard protocol. Ultrasonography findings were compared with Magnetic Resonance Imaging(MRI) which is considered a standard of reference. **Results:** Of the total of 112 patients included in our study 93(83%) had partial tears of rotator cuff on MRI and 96(85%) on ultrasonography. Partial rotator cuff tears were most often seen in supraspinatus tendon 55(49.1%)on MRI as well as ultrasonography 57 (50.9%). The most common type of partial tears were articular surface tears seen in 68(73%) patients on MRI and 60(64.5%) on ultrasonography. Majority of patients partial tears involved less than 50% of the fibres. The validity of ultrasonography findings for evaluation of partial thickness tears was estimated by calculating sensitivity, specificity, and diagnostic accuracy. **Conclusion:** A good congruence was noted in our study between the two modalities reiterating shoulder ultrasonography as efficient tool for evaluation of partial thickness tears of rotator cuff.

INTRODUCTION

Partial thickness tears have for long been a bone of contention for radiologist and surgeons alike. While the diagnosis and treatment strategies for full thickness tears are quite forthright, those for partial thickness tears are still evolving. The pathogenesis, grading, progression and treatment of partial thickness tears has always been contested time and again in literature. The significance of reviewing this literature and analysing the data from our study emanates from the fact that missing diagnosis of rotator cuff tear leads to progression and increase in size of the tear with irreversible fatty degeneration of shoulder musculature making surgical repair more challenging and less rewarding.

MATERIALS AND METHODS

A prospective observational study including 112 patients was conducted at our institution over a period of 2 years from November 2018 to November 2020 after getting approval from institutional Ethical & Scientific committee. Informed consent was taken from patients participating in the study.

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Inclusion Criteria: Patients of varying age groups referred to our department by orthopedic surgeon with clinical suspicion of rotator cuff tears were included in the study.

Exclusion Criteria: Patients with previous surgical intervention and patients who have contraindications for MRI (pacemakers, metal implants, aneurysmal clips) were excluded in the study.

***MRI* Technique:** MRI imaging was performed with 1.5 Tesla MRI machine (Siemens Magnetom Avanto) using a dedicated shoulder coil. The field of view was between 14 to 16 cm, matrix size (pixels) 240 to 256 and slice thickness as 3mm. Imaging of the shoulder joint was performed in all three planes (axial, coronal and sagitta) using oblique axis as follows.

Sequences	Slice Thickness	TR/TE (msec)	FOV (cm)	Matrix size
Oblique coronal T1	3mm	533/9	14-16	256x320
Oblique sagittal T1	4mm	533/9	14-1	256x320
Oblique coronal T2 FSE FAT SAT	3mm	3017/50	14-1	224x320
Oblique sagittal T2 FSE	3mm	3800/98	14-16	224x320
Oblique coronal PD with FAT SAT	3mm	2650/23	14-16	230x384
Oblique sagittal PD with FAT SAT	3mm	2650/23	14-16	230x384
Axial PD with FAT SAT	3mm	2650/23	14-16	230x384

Images were reviewed by consultant radiologists in our department. Rotator cuff tears were identified and categorized according to classification available in literature.

USG technique: Ultrasonography was subsequently performed by a consultant radiologist who was blinded to the MRI findings. Ultrasonography was performed using Siemens ACUSON S 2000 machine with a 7.5–14 MHz linear array transducer using a standard protocol. [1,2,3,4,5]

The long head of biceps tendon was used as a guide while evaluating the rotator cuff with ultrasonography. The sequence of cuff scanning was as follows-subscapularis, supraspinatus, infraspinatus and finally teres minor.

The patient was made to sit on a stool. The patient's hand was placed on their lap with elbow flexed at 90 degree, the transducer was placed over the anterior shoulder in the transverse plane to visualize the bicipital tendon in the groove. The probe was then positioned over the lesser tuberosity at the medial aspect of the bicipital groove. The subscapularis tendon was seen in long axis coursing anterior toward the lesser tuberosity. The patient was then made to externally rotate the shoulder pulling the subscapularis located inferior to the coracoid laterally for better delineation.

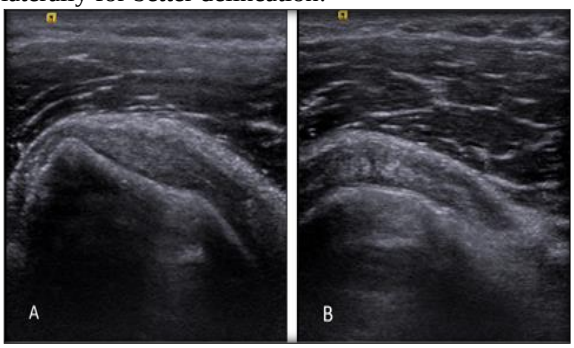

Figure 1: Subscapularis Tendon; (A) long axis view with shoulder externally rotated shows hyperechoic and fibrillar subscapularis tendon (B) short axis views shows hyperechoic and fibrillar subscapularis tendon

The supraspinatus tendon was evaluated in Crass position (2) with the dorsal aspect of the ipsilateral hand placed behind the back effectively causing hyperextension and internal rotation position pulling the supraspinatus tendon from under the acromion.

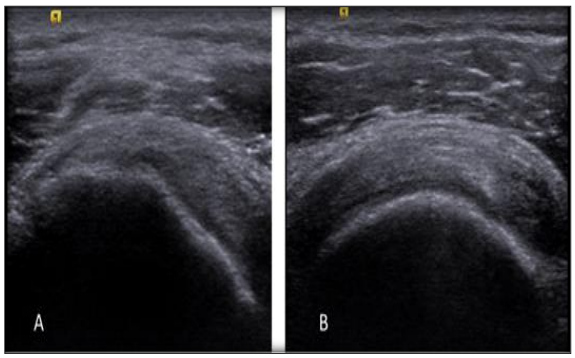

Figure 6: Supraspinatus tendon (A) Long axis view over superior facet of greater tuberosity shows hyperechoic and fibrillar supraspinatus tendon. (B) corresponding short axis view

With the hand positioned on the contralateral shoulder with palm facing down the transducer was placed just below the scapular spine over the posterior shoulder in a slightly oblique axial plane that parallels the orientation of the scapular spine. This position produced a long-axis view of the infraspinatus tendon, which was assessed at its insertion on the posterior aspect of the greater tuberosity.

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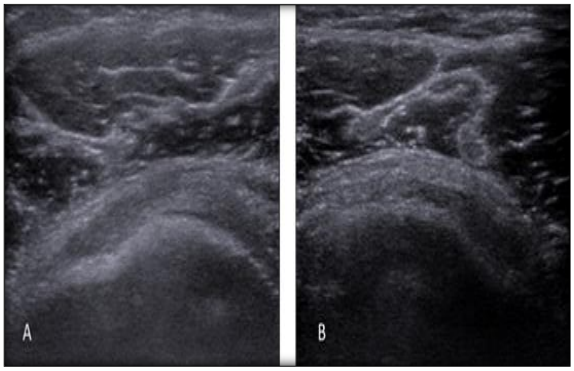

Figure 7 Infraspinatus (A) Transducer placement over posterior aspect of the shoulder in neutral position. shows characteristic contours of the humeral head with adjacent infraspinatus tendon. (B) short axis view in the same region

The teres minor inserting just below was identified in a similar fashion.

Tendons appear hyperechoic on ultrasonography with fibrillar pattern and were assessed in short and long axis by rotating the transducer 90 degrees.

Interpretation: Partial-thickness rotator cuff tears were diagnosed on usg if there was focal discontinuity (i.e., a focal hypoechoic area or mixed hyper- and hypoechoic zone) involving the articular or bursal side or located within the tendon, or focal thinning of the rotator cuff or loss of convexity of the outer border (bursal surface) of the rotator cuff.(6,7,8)We followed the widely accepted classification RCT by Codman et al in our study categorizing the partial tears into bursal surface, articular surface and intra-tendinous.[6,7,8] Partial tears were further assessed to know whether 50% or more of the tendon thickness was involved.

Analysis: Data was entered into Microsoft excel data sheet and was analysed using SPSS 22 version software. Categorical data was represented in the form of frequencies and proportions. Chi-square was used as test of significance. Continuous data was represented as mean and standard deviation. p value <0.05 was considered as statistically significant. Validity of USG with MRI was estimated by calculating sensitivity, specificity, NPV, PPV and diagnostic accuracy.

RESULTS

Of the total of 112 patients included in our study 93(83%)had partial tears of rotator cuff.

Partial rotator cuff tears were found to be most common between 50-60 years of age (27.7%). The extremes of age group being least commonly affected.

A definite increased incidence of partial rotator cuff tears were noted in the dominant hand with 71% patients having partial thickness tears affecting the right hand.

The following observations were made in our study.

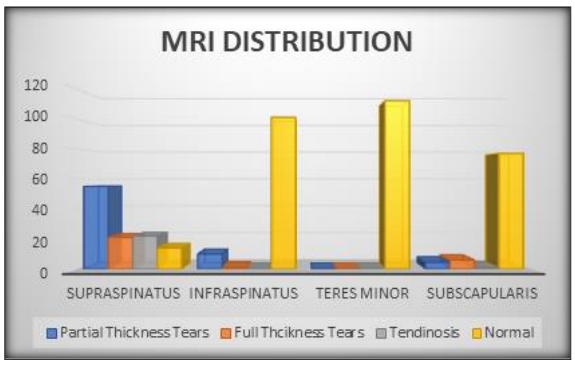

Chart 4: Distribution of cases according to Rotator Cuff injuries on MRI

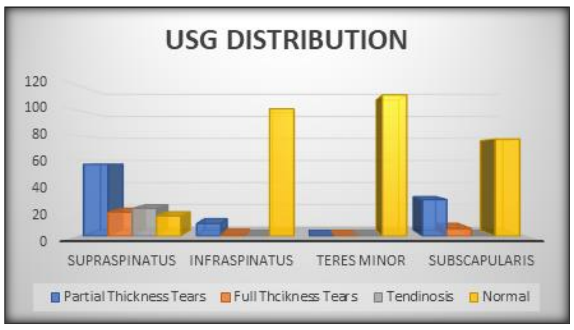

Chart 5: Distribution of cases according to Rotator Cuff injuries on USG

No tears of teres minor were identified on ultrasonography/MRI. Among the partial thickness tears 68 (73%) were articular surface tears on MRI and 60(64%) were articular surface tears on usg. There were total of 25(26%) bursal tears identified on MRI and 20(21.5%)bursal surface tears on ultrasonography. In 78(83%) patients partial thickness tears involved less than 50% of the fibres.

Table 1: Correlation of USG and MRI findings with respect to Supraspinatus, infraspinatus and subscapularis partial thickness tears

Site of partial thickness tear	Sensitivity	Specificity	PPV	NPV	Chi square	P Value	Kappa value
Supraspinatus	98%	88.89	92.7%	96.9%	69.555	<0.0001	0.882
Infraspinatus	90%	99%	90%	99%	87.943	<0.0001	0.890
Subscapularis	93.1%	98.7%	96.4%	97.4%	91.342	<0.0001	0.928

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DISCUSSION

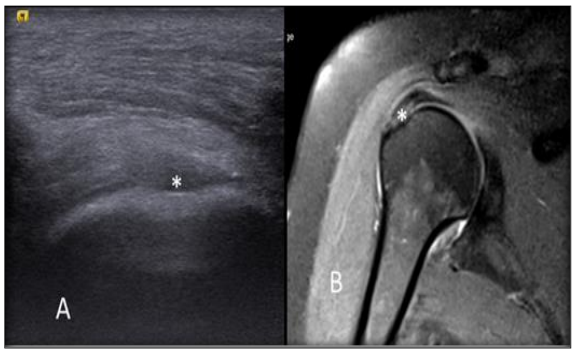
Shoulder pain is a frequent cause of patient visit to an orthopedic clinic and most often than not it is related to a rotator cuff pathology. Rotator cuff disease is a spectrum of pathologies progressing from rotator cuff tendinopathy with no definite tear to partial thickness rotator cuff tear and finally a full-thickness rotator cuff tear. Full thickness tear if left untreated leads to rotator cuff tear arthropathy.[3,4] Early diagnosis of rotator cuff disease and prompt treatment can arrest disease progression and improve outcome for the patient and orthopaedic surgeon. Literature is replete with studies describing full thickness rotator cuff tears their MRI and ultrasonography appearances and associated findings like tendon retraction, fatty infiltration and muscle atrophy. In this article we have tried to analyse the less discussed and more intriguing partial thickness tears and their quick and reliable diagnosis with help of ultrasonography.

The majority of patients having partial thickness rotator cuff tears in our study belonged to middle age (50 to 60 years) age group. This is in keeping with the fact that intrinsic factors which include age related pathological changes which occurring in the tendons like thinning, disorientation of collagen fibers, myxoid degeneration, hyaline degeneration, chondroid metaplasia, calcification, vascular proliferation, and fatty infiltration play a major role as compared to extrinsic factors like subacromial impingement, acute traumatic events, and repetitive microtrauma. This finding has been confirmed by Hashimoto et al in their study of histopathological analysis of degeneration of rotator cuff tendons.[9,10]

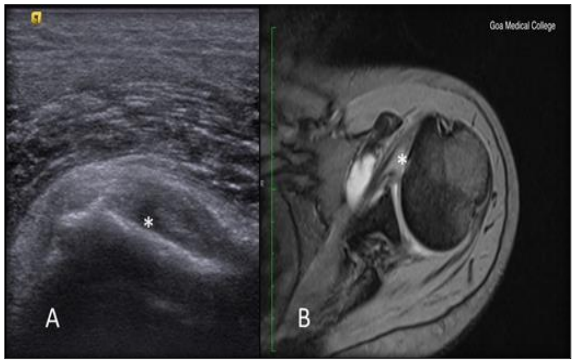
We also observed that the partial thickness tears were more common in the dominant/right side seen in 61(71%) patients than otherwise. Sayampanathan and Tan 7et al in their study suggested the plausible cause for this observations was the increased apoptotic activities. The dominant hand is utilized more than the non-dominant hand and hence tends to be placed under higher stress which increases apoptosis at these sites resulting in increased incidence of tears.

Rotator cuff tears were identified on ultrasonography with help of primary/secondary signs described in literature.[5] The most reliable primary sign finding is hypoechoic/ anechoic areas within the otherwise hyperechoic tendon due to fluid accumulation with the area of the torn tendon, with characteristic increased through transmission of fluid. The secondary signs of rotator cuff tears include “double cortex” or “cartilage interface” sign -refers to the sonographic presence of a thin markedly hyperechoic line at the interface between the normally hypoechoic hyaline articular cartilage of the humeral head and an abnormally hypoechoic supraspinatus tendon. This arises due to the marked difference in acoustic impedances of the two tissues at the interface. Other signs are bursal effusions and fluid along the biceps tendon and cortical irregularity of the greater tuberosity.

Similarly for identifying partial thickness tear on MRI, focal area of fluid signal intensity is identified in the tendon on PD FAT SAT and T2W sqeuences.[8]



Case 2: Partial thickness supraspinatus tear. (A) longitudinal USG of the supraspinatus tendon, shows presence of hypoechoic area (asterisk) along the articular surface of the supraspinatus tendon near its insertion measuring approximately 6 mm in length, suggestive of articular surface partial tear and (B) Coronal PD FS image, confirms the findings of USG with hyperintense signal (asterisk) noted along the articular surface of the supraspinatus tendon near its insertion.



Case 4: Partial thickness tear of the subscapularis. (A) longitudinal USG of the subscapularis tendon shows presence of hypoechoic area (asterisk) along the articular surface of the subscapularis for a length of 5 mm and (B) axial PD FS image, confirms the findings of USG with hyperintense signal (asterisk) noted along the articular surface of the subscapularis tendon.

Once diagnosed, tear size is ascertained via measurements in both orthogonal planes, allowing for both the width and the length of the tear.

Our study used the standard classification stated by Ellman et al,[8] which categorises partial thickness tears based on their position into articular, bursal and intra-tendinous tears. In our study articular surface partial tears were more common than bursal surface tears.M. Vlychou et al,[12] in their study found the articular surface tears to be two to three times common as bursal surface tears. According to them this finding is likely due to the complex

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composition (tendon, ligament and capsule) the articular layers of the cuff are more prone to tearing than bursal layers that comprise of tendon only and have elongation potential.

Though Ellman et al also graded the partial tears based on the size as grade I (<3mm), grade II (3mm to 6mm) and grade III (>6mm) we classified tears based on involvement of > 50% or less than 50% of the tendon thickness as this information is most important for planning the treatment of the patient.[13] In our study 78(83%) patients partial thickness tears involved less than 50% of the fibres.

In present study maximum percentage of patients had partial tear of supraspinatus tendon 88.3%, followed by subscapularis tear which was 39.5%, thereafter by infraspinatus tear (1.2%). 12.Lohr and Ekthoff et al,[14] in their study of histological sections of rotator cuff found the undersurface of the supraspinatus tendon had a uniformly hypovascular pattern predisposing it to degeneration and increase risk of tear. Similar results were also noted in various other studies.[15,16]

Several authors in the past have investigated the utility of USG for diagnosis of partial thickness tears however have obtained heterogenous results.[17,18,19] We obtained good corroboration between Ultrasonography and MRI findings with sensitivity, specificity and accuracy hitting the bull's eye on most occasion with scarcely any misses. Following factors possibly have contributed to the good outcome in our study-USG performed by single radiologist reduced interobserver bias. The radiologist had thorough knowledge of anatomy and ultrasonography appearances of the RCT as well as the potential pitfalls like anisotropy, rotator interval and musculotendinous junction. A fixed standard protocol for ultrasonography examination and predetermined criteria for tear helped in achieving excellent concurrence between the two modalities.

Pitfalls: Anatomical factors include shape of the acromion, os acromiole, acromial spurs, fractures and acromioclavicular osteoarthritis which a major role in the development of rotator cuff tears through direct traction on the underlying tendon cannot be assessed by ultrasonography

CONCLUSION

Because of its easy availability, lack of ionising radiation, quick scan time, real time imaging, dynamic imaging with patient interaction and competitive pricing ultrasonography has remained a reigning favourite among radiologist and referring fellow clinicians. With our study we conclude that ultrasonography can confidently diagnose partial thickness tears which can help to initiate necessary treatment. MRI although the standard of reference has long waiting periods, longer scan times and pricey could be used only in patients in alternative structures like capsule, glenoidal labrum and cartilage needs to be assessed.

Scope for Improvement: Use of templates for ultrasonography can further reduce scan time and provide standardization.

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