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Efficacy of high frequency ultrasound in grading rotator cuff tear in correlation with conventional MRI

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Abstract:
Background: *The shoulder joint being an unstable ball and socket joint without any fixed axis of rotation, which has a wide range of motion in multiple planes. Rotator cuff disease is one of the most common causes of shoulder pain. Hence , needs radiological assessment of the rotator cuff with a diagnostic test such as high resolution ultrasonography or MRI. High resolution ultrasound is used as a screening modality for detecting rotator cuff tear as it is non-invasive, less expensive and non - ionizing modality with good sensitivity*
***Aims* :**
1. Role of high frequency ultrasound in grading rotator cuff tears.
2. Comparing its efficacy with the conventional MRI.
Materials and methods :
Sample size : 56 , prospective cross sectional study in duration of 2 years
1. 1.5 T MRI system (Magnetom Siemens Avanto,8-channel)
2. High frequency ultrasound probe (6-15 MHz -LOGIQ S-7, VOLUSION)
Statistical analysis used :
-Chi-square test or Fischer's exact test (for 2x2 tables only) was used as test of significance for qualitative data.
- Kappa statistics.
Results: *Most commonly affected tendon being the supraspinatus followed by sub-scapuaris with Teres minor being the least affected . Sensitivity for supraspinatus tendon injuries (97.83%) and specificity was 90% with diagnostic accuracy of 96.4% . Sensitivity of subscapularis tendon is 75% with diagnostic accuracy of 96.43%. The agreement between USG and MRI findings was measured by Kappa and highest agreement was observed for Supraspinatus (0.878)*
Conclusion: *USG is a reliable diagnostic technique in detecting tendon injuries with high sensitivity and specificity of full thickness tear as compared to partial thickness tears and most commonly involved tendon is supraspinatus. Partial tears are more common than the full thickness tears. Among the partial tears most common are articular surface tears.*
Therefore , the study recommends for effective use of USG as a reliable diagnostic test in rotator cuff tendon injuries especially in settings of non availability of MRI scan.
Key words: *Ultrasound , MRI , Musculoskeletal , Sports , Medicine , rotator cuff , tears , tendinosis*

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I. Introduction

The aim of the study is to bring out the efficacy of high frequency ultrasound in grading Rotator cuff tears and comparing with the conventional MRI

Shoulder joint is an incongruous ball and socket joint without any fixed axis of rotation and hence subjected to wear and tear during the day to day activities. 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. Rotator cuff disease is one of the most common causes of shoulder pain. Inaddition to history and physical examination, evaluation of a patient with shoulder pain often involves assessment of the rotator cuff with a diagnostic test such as high resolution ultrasonography or MRI[1]

High resolution ultrasound is non invasive, less expensive and non - ionizing modality with good sensitivity in detecting both rotator cuff and non rotator cuff disorder.[2]

MRI has become the "gold standard" for detecting both subtle and obviousinternal derangement and assessing overall jointstructure.[2]Although non-invasive, MRI is considerably more expensive and time consuming than ultrasonography and will probably not replace it as a screening procedure for those trained in its use[3]

Arthrography appears to be more accurate in diagnosing rotator cuff injuries than either MRI or

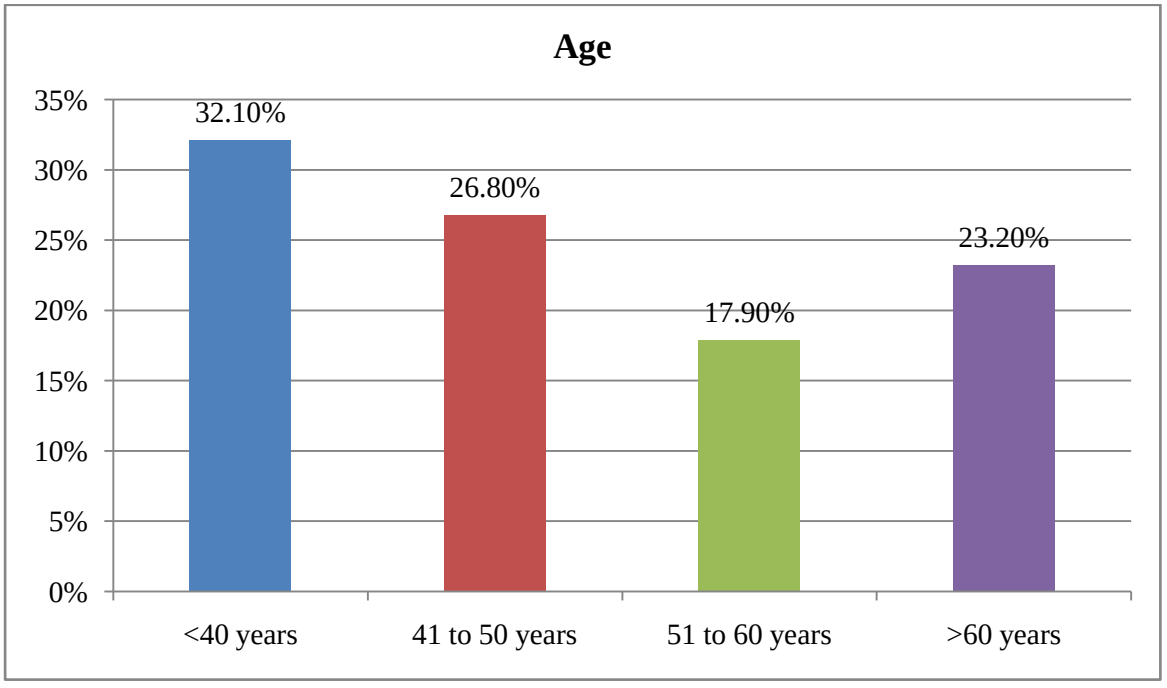
ultrasound but that benefit must be set against the invasiveness and potential discomfort to patients. Ultrasonography is as accurate as MRI for both full thickness and partial thickness tears, these results combined with low cost for ultrasound suggests that ultrasound may be the most cost effective imaging method of screening for rotator cuff injuries provided that the examiner is trained in this operator dependent technique[4]

II. Subjects and Methods

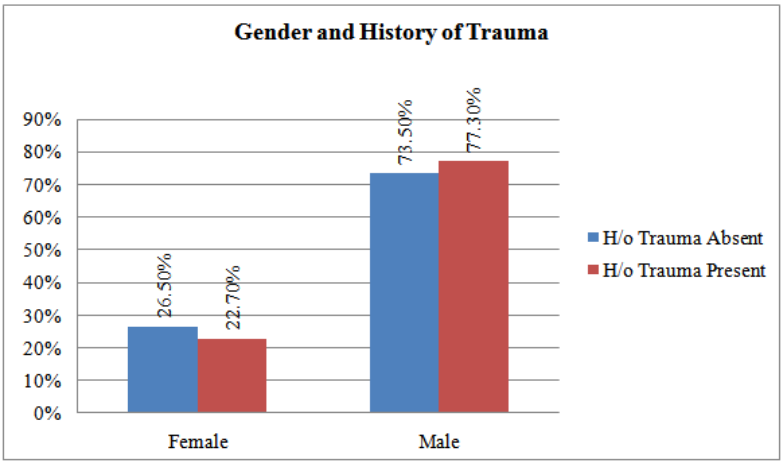
1.1.5 T MRI system – Magnetom Siemens Avanto ,8-channel
• MRI sequences:
Saggital : T1 , T2 with PDFS
Coronal : T1 , T2 , T1 and T2 with PDFS
Axial: T2 with PDFS
• FOV : 16 cm ,18x18mm ; Matrix size :256x256
• Slice thickness: 3-4 mm
2.USG:
LOGIQ S-7 Expert machine , VOLUSION (6-15 MHz , 6-12 MHz probes) ,Special view : panoramic view
Sample size : 56 (n)
Confidence interval: 95%
Study type: prospective cross sectional
Study duration: 2 years

III. Results

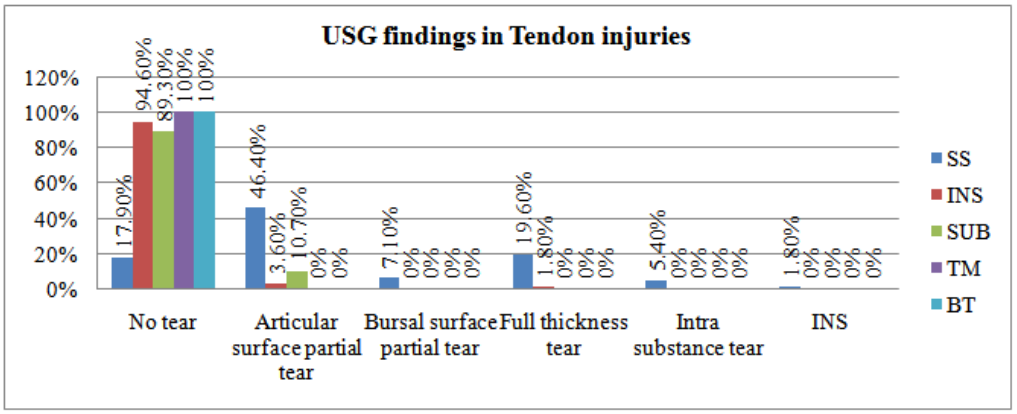
-Chi-square test or Fischer's exact test (for 2x2 tables only) was used as test of significance for qualitative data.
- **Kappa Statistics:** Agreement between two or more observers/ between two or more methods or instruments and equipments was assessed by using Kappa statistics.
- **p value** (Probability that the result is true) of <0.05 was considered as statistically significant after assuming all the rules of statistical tests.



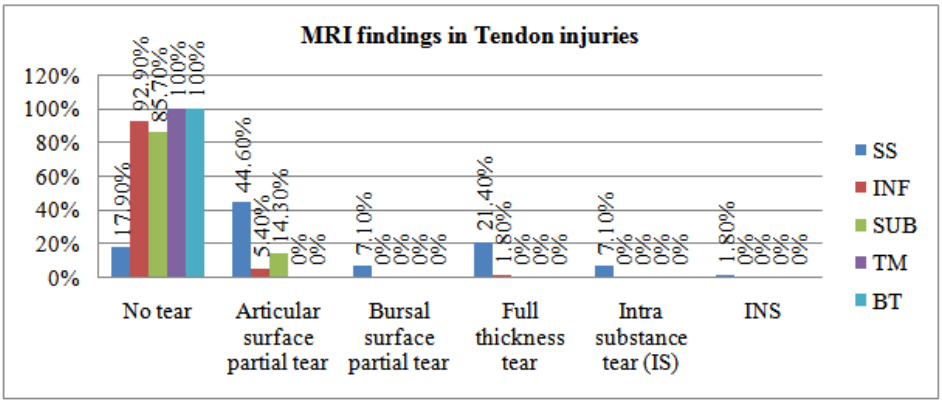
In the study majority of subjects were in the age group <40 years (32.1%), 26.8% were aged b/w 41 to 50 years, 23.2% were aged >60 years and 17.9% were in the age group 51 to 60 years.
Mean age of subjects was 48.2 ± 13.42 years.



In the study among those who had History of trauma, 22.7% were females and 77.3% were males. There was no significant association between Gender and History of Trauma.



On USG, in Supraspinatus tendon, 46.4% had articular surface partial tear, 7.1% had Bursal surface partial tear, 19.6% had Full thickness tear, 5.4% had Intra substance tear and 1.8% had INS.
In Infraspinatus tendon, 3.6% had articular surface partial tear and 1.8% had Full thickness tear.
In Subscapularis tendon, 10.7% had articular surface partial tear. In Teres minor and Biceps tendon, none of them had tear.



On MRI, in Supraspinatus tendon, 44.6% had articular surface partial tear, 7.1% had Bursal surface partial tear, 21.4% had Full thickness tear, 7.1% had Intra substance tear and 1.8% had INS.
In Infraspinatus tendon, 5.4% had articular surface partial tear and 1.8% had Full thickness tear.
In Subscapularis tendon, 14.3% had articular surface partial tear. In Teres minor none of them had tear and in Biceps tendon 1.8% had **Articular surface partial tear**

Validity of USG in detecting Partial thickness tendon injuries in comparison with MRI

	Sensitivity	Specificity	Positive Predictive value	Negative Predictive value	Diagnostic Accuracy	Kappa Degree of agreement
SS	97.83%	90%	97.83%	90%	96.43%	0.878
INS	75%	100%	100%	98.11%	98.21%	0.847
SUB	75%	100%	100%	96%	96.43%	0.837
TM	0%	100%	0%	100%	100%	-
BT	0%	100%	-	98.21%	98.21%	0

In the study for SS tendon injuries USG had sensitivity of 97.83%, Specificity of 90%, PPV of 97.83%, NPV of 90% and Diagnostic Accuracy of 96.43% and Kappa agreement was 0.878 (Almost perfect agreement).
Similarly for INS tendon injuries USG had sensitivity of 75%, Specificity of 100%, PPV of 100%, NPV of 98.11% and Diagnostic Accuracy of 98.21% and Kappa agreement was 0.847 (Almost perfect agreement).
Similarly for Subscapularis tendon injuries USG had sensitivity of 75%, Specificity of 100%, PPV of 100%, NPV of 96% and Diagnostic Accuracy of 96.43% and Kappa agreement was 0.837 (Almost perfect agreement).
Similarly for TM tendon injuries USG had sensitivity of 0%, Specificity of 100%, PPV of 0%, NPV of 100% and Diagnostic Accuracy of 100%.
Similarly for BT tendon injuries USG had sensitivity of 0%, Specificity of 100%, NPV of 98.21% and Diagnostic Accuracy of 98.21%.

IV. Discussion

Various techniques are used for evaluating patients with rotator cuff tears with each having its own advantage and disadvantages .The gold standard is arthrography but has the disadvantage of being invasive. MRI is sensitive and specific but is expensive and cannot be used as a first line of investigation. However, USG is a non-invasive, relatively inexpensive modality that can be used as a first line of investigation

This was a prospective study in which 56 patients referred to the department of Radio diagnosis, Kasturba Medical College, Mangalore with clinically suspected rotator cuff injuries were subjected to undergo USG and MRI after thorough history taking and clinical examination.

Age-wise distribution of rotator cuff disease :
In our study the age of the patients with rotator cuff disorders ranged from 20 to 70 years with the mean of 48.2 ± 13.42 yrs. Majority of Rotator cuff injures were observed in patients > 40 yrs of age (67.9%).

Gender distribution of rotator cuff disease:

David W.S et al, showed female predominance in case of tendinosis and male predominance among patients with tears [7]. In our study rotator cuff diseases was seen in 25 male patients (75%) and 5 female patients (25%), thus showing male preponderance among the study population correlating with study of David W.S et al.

History of Trauma:

In our study 22 out of 56 patients (39.3%) had history of trauma. H/o of trauma was not significantly associated with gender, although trauma is predisposing factor for rotator cuff tears, it is consistent with literature[5,6.]

USG findings in Tendon injuries:

In our study most commonly involved tendon was supraspinatus, followed by subscapularis, infraspinatus with teres minor and biceps tendon least commonly affected (0%). This is consistent with the study conducted by Jerosch et al. It was a study conducted on the dissected specimen of shoulder joints of 122 patients; it was found that isolated supraspinatus involvement occurred in 78% cases[9].It was also noted no tear occurred without the involvement of supraspinatus tendon. DePalma et al examined 96 cadaver shoulder and showed similar finding of supraspinatus as the commonly affected tendon and the incidence and degree of tear increased with age[8]

MRI findings in Tendon injuries:
In our study most commonly involved tendon was supraspinatus, followed by subscapularis, infraspinatus, biceps tendon and Teres minor was least commonly affected (0%). This is consistent with literature [8,9].

Correlation of USG findings with MRI findings in Tendon Injuries:

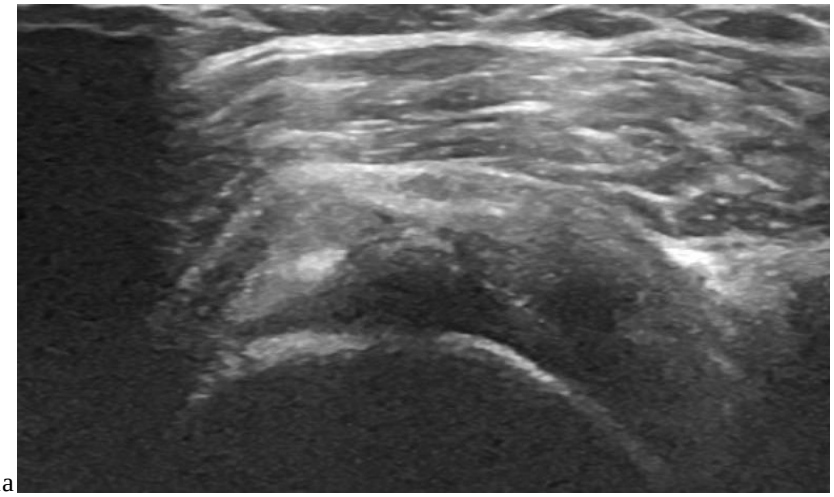
USG findings in comparison to MRI findings showed that Sensitivity of USG was high in detecting the Tendon injuries of supraspinatus (97.83%), infraspinatus (75%) and subscapularis muscle (75%). Highest

sensitivity was observed for supraspinatus tendon injuries (97.83%) and specificity was 90% . Diagnostic accuracy for Supraspinatus and Subscapularis tendon (96.43%).

The agreement between USG and MRI findings was measured by Kappa and highest agreement was observed for Supraspinatus (0.878). 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%)[10].

IMAGES:

1a



1b

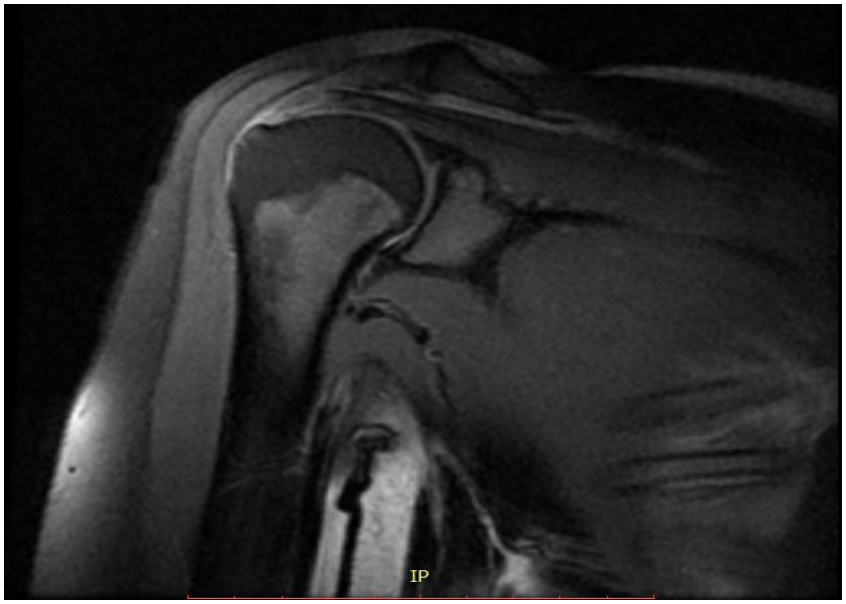
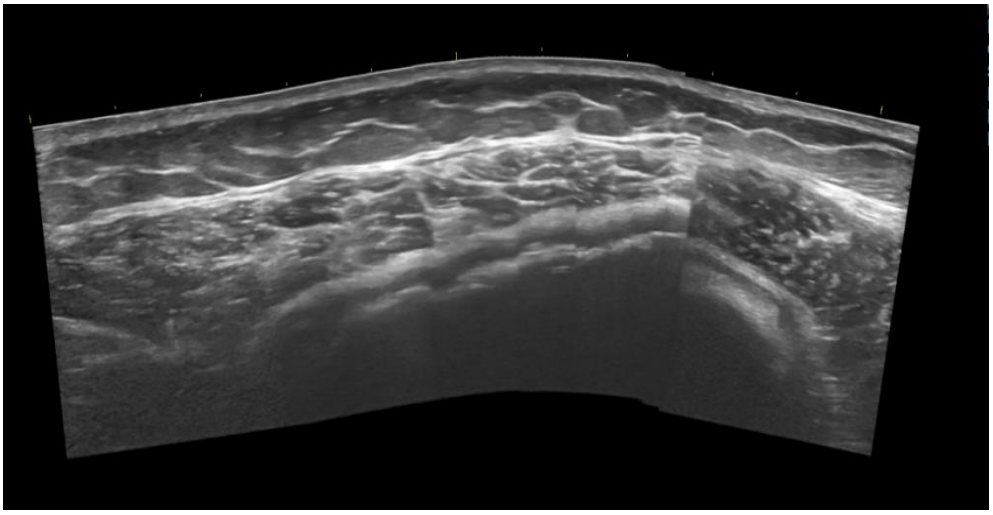
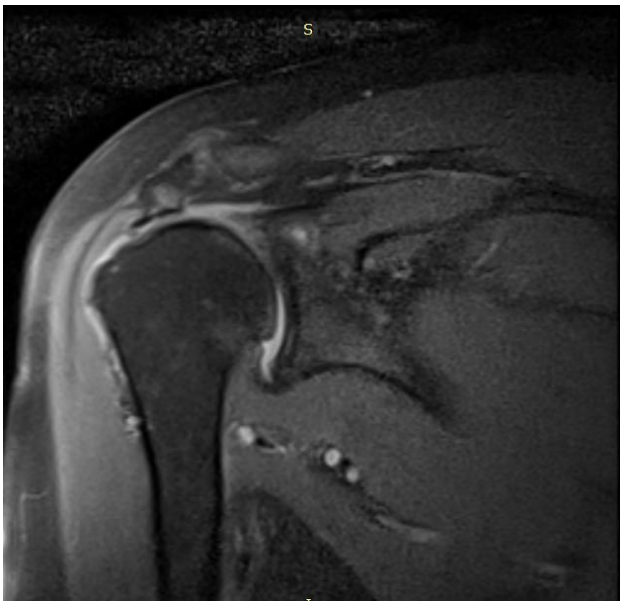


Fig1a. USG : Partial thickness tear along the articular surface of supraspinatus with intact superior tendon fibres

Fig 1b. MRI coronal PDFS sequence coronal section showing corresponding articular surface tear

2a 



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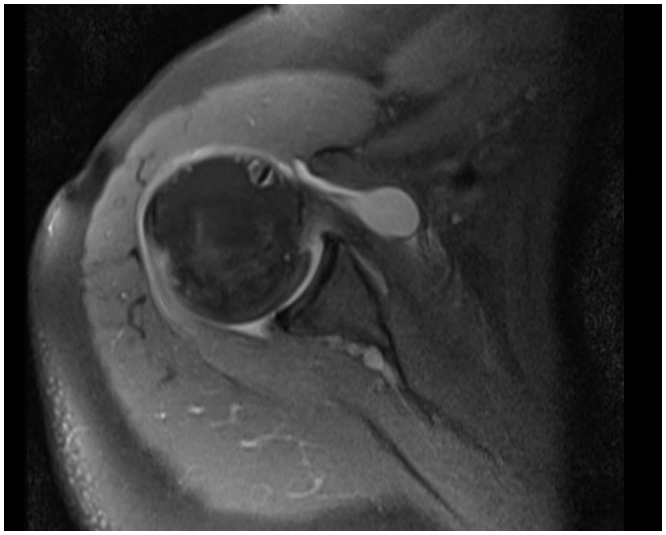
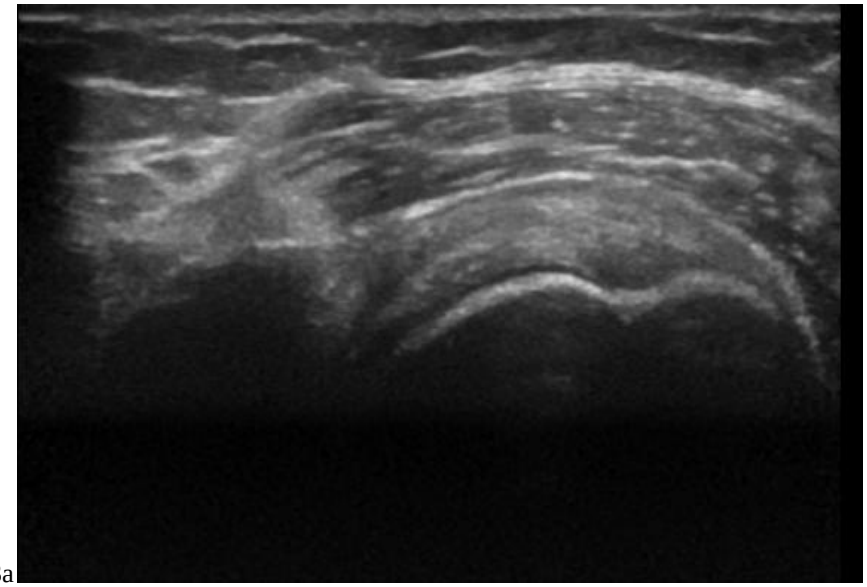


2c

Fig 2a: USG panoramic view shows full thickness supraspinatus , subscapularis tears and partial thickness tear of infraspinatus

Fig 2b,2c: MRI coronal and axial PDFS sequences showing corresponding full thickness supraspinatus tear with retraction till the humeral head , full thickness tear of subscapularis and partial thickness tear of infraspinatus

3a 

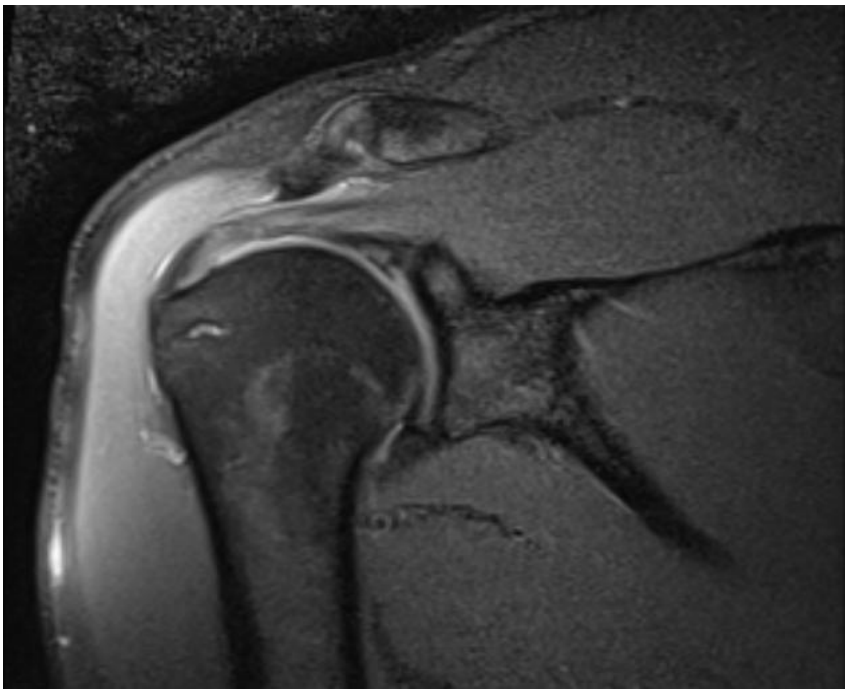
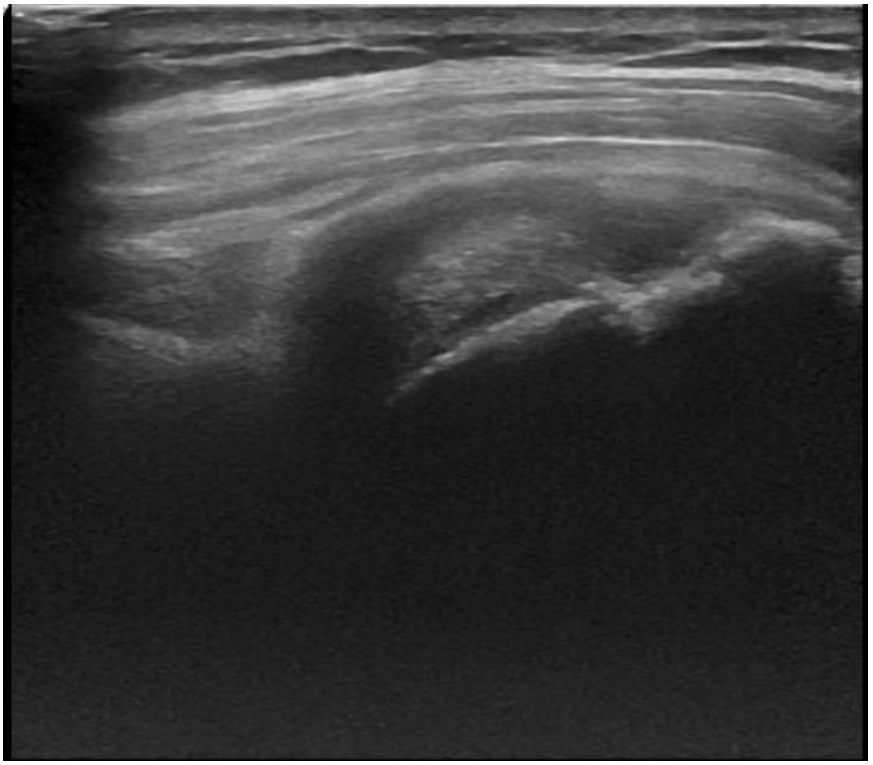
3b 

Fig3a. USG shows hypoechoic area along the articular surface of the supraspinatous – s/o tendinosis
Fig 3b. MRI coronal PDFS sequence shows corresponding hyper intensity along the articular surface of the supraspinatous tendon- tendinosis

4a 

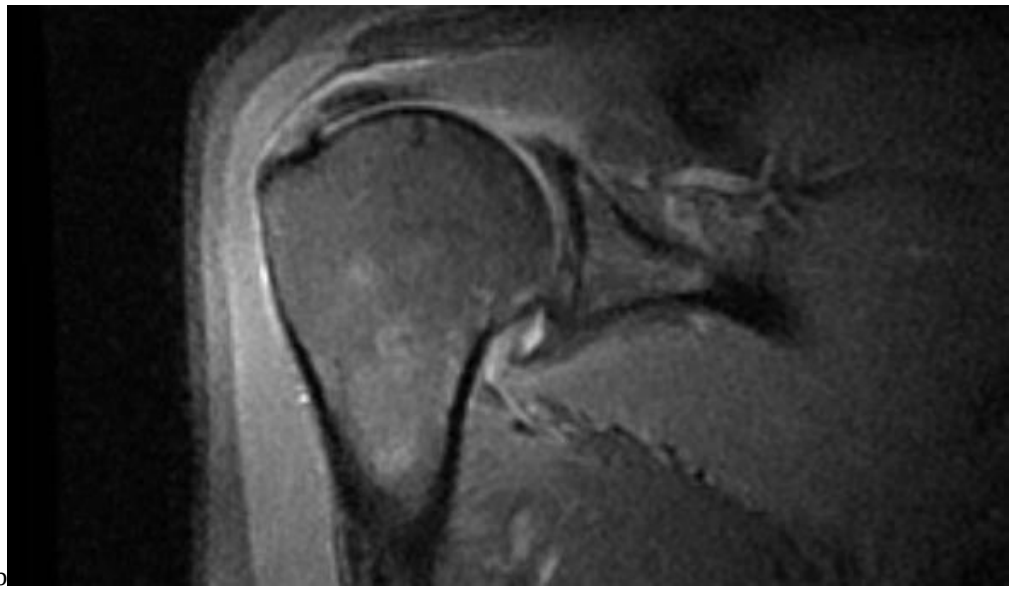
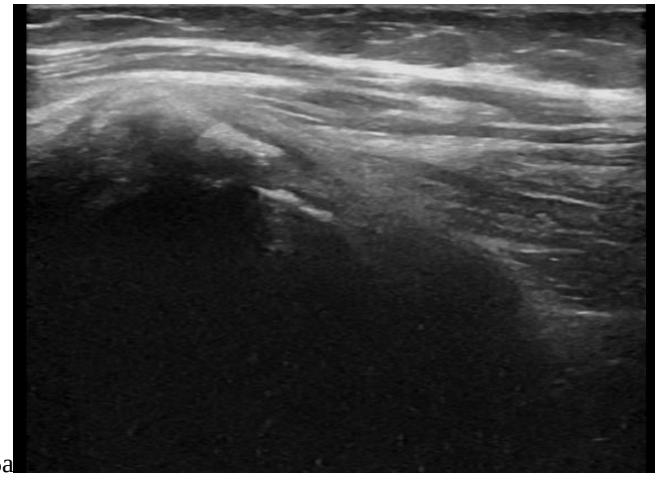
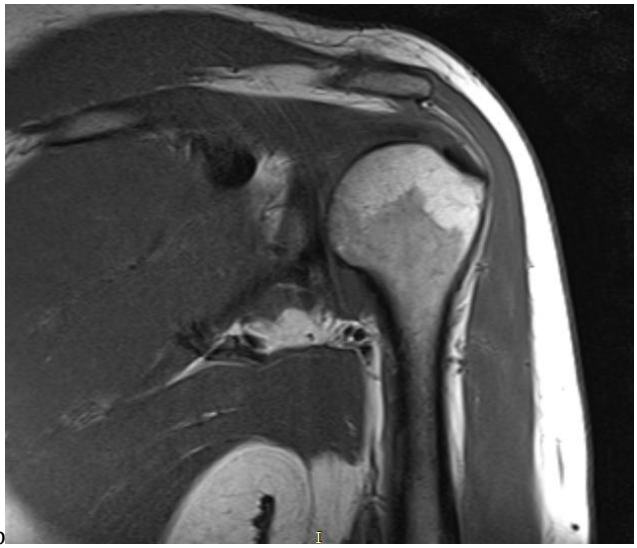
4b 

Fig4a. USG shows hypoechoic area along the bursal surface of the supraspinatous – s/o bursal surface tear

Fig 4b. MRI coronal PDFS sequence shows corresponding hyper intensity along the bursal surface of the supraspinatous tendon

5a 

5b 

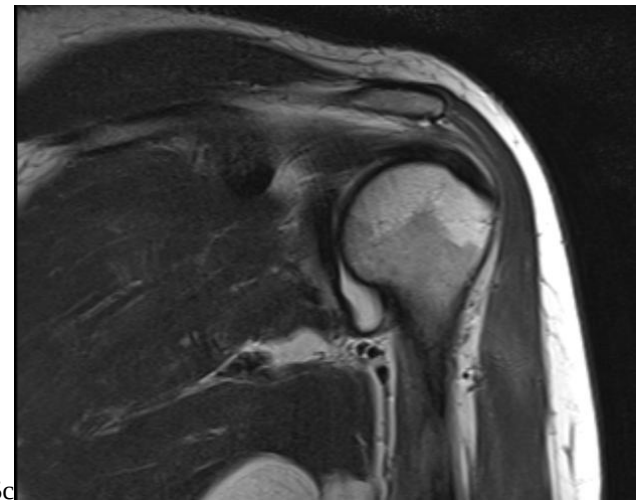
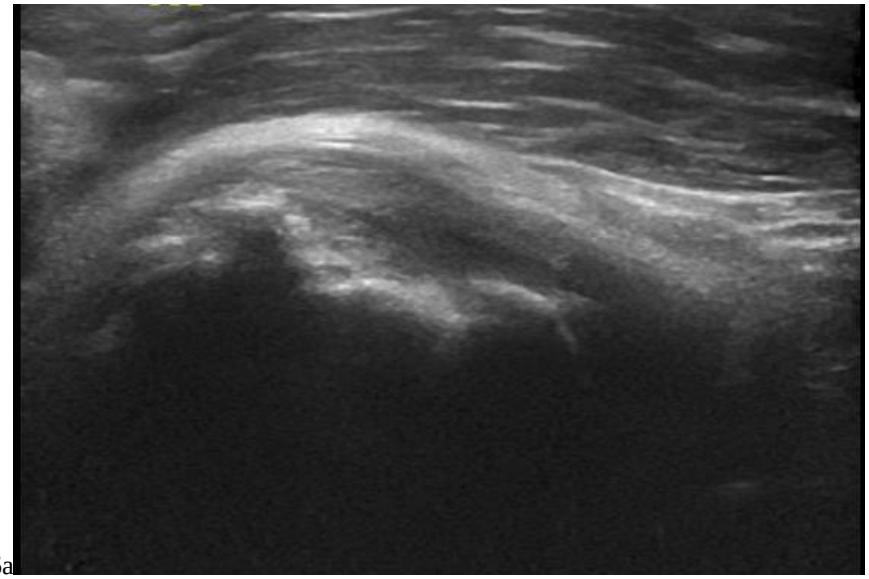
5c 

Fig 5a. USG shows hyper echogenicity along the distal supraspinatus
Fig 5b,c. T1 and T2 coronal sequence shows hypo-intensity in the distal supraspinatus – s/o calcification



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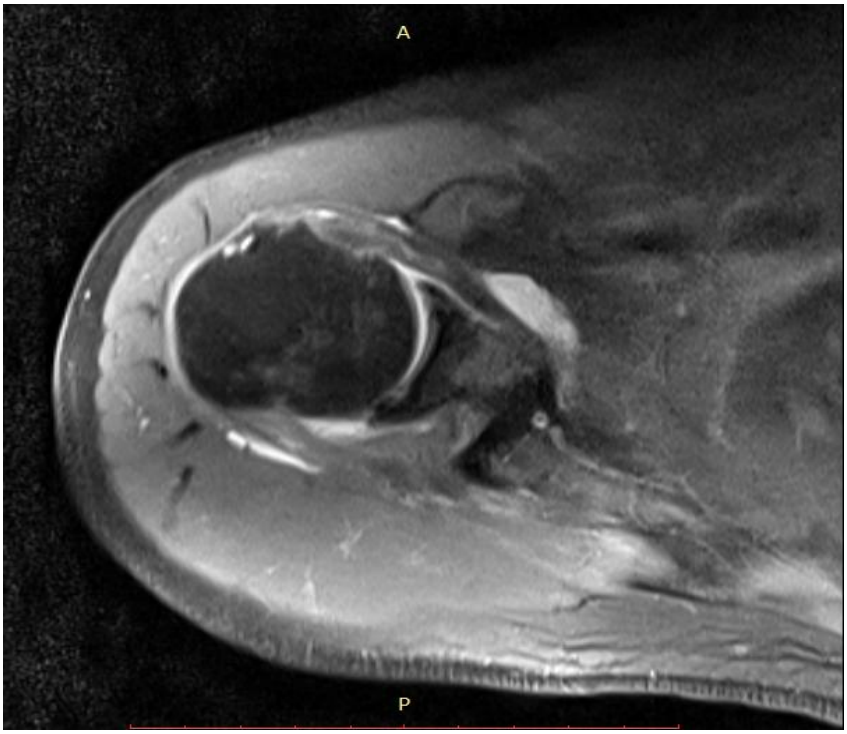
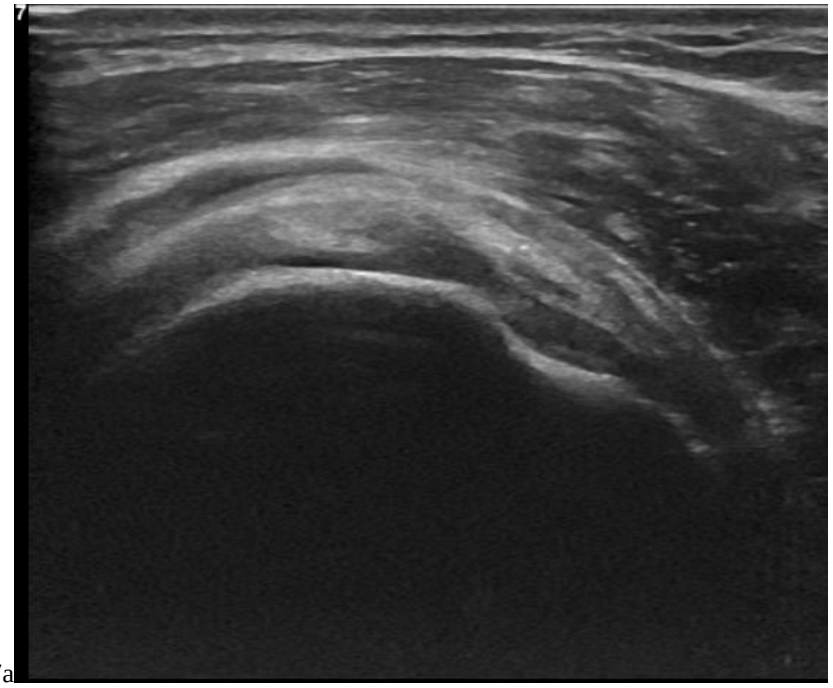


6b

Fig 6a. USG : Partial thickness tear along the articular surface of sub-scapularis with intact superior tendon fibres

Fig 6b. MRI PDFS sequence axial section: Partial thickness tear with edema at the insertion of subscapularis tendon.



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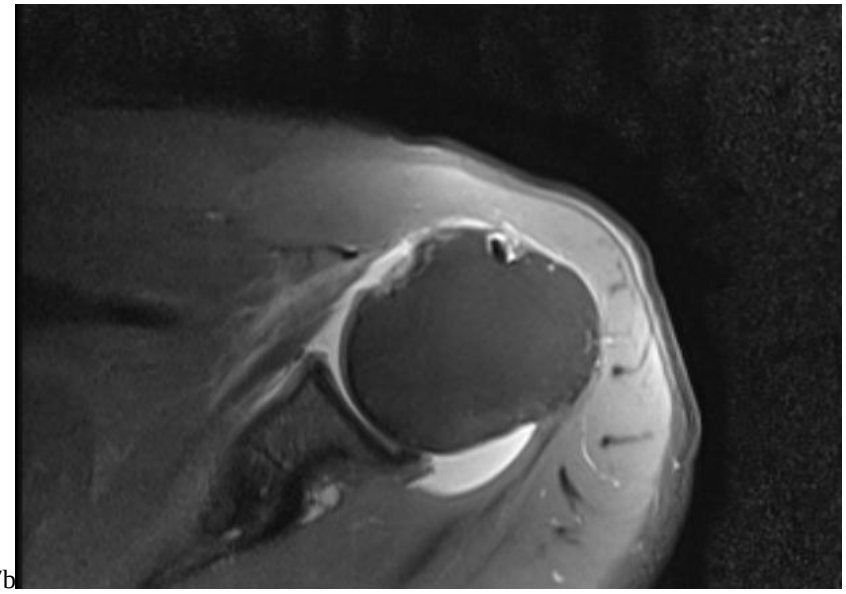

7b

Fig 7a. USG shows hypo-echogenicity in the distal supraspinatus
Fig 7b. MRI axial PDFS sequences show PDFS hyper intensity of the distal sub-scapularis with mild retraction of fibres

V. Conclusion

From the study it can be concluded that increasing age, male gender and history of trauma are predisposing factors for rotator cuff tears.

Pain is the most common presenting complaint with decreased range of motion a common manifestation of rotator cuff tears.

Most commonly involved tendon is supraspinatus. Partial tears are more common than the full thickness tears. Among the partial tears most common are articular surface tears.

USG is a reliable diagnostic technique in detecting Tendon injuries with high sensitivity and specificity of full thickness tear as compared to partial thickness tears

The study recommends for effective use of USG as a reliable diagnostic test in Rotator cuff tendon injuries especially in settings of non availability of MRI scan.

USG can be an effective screening tool for rotator cuff injuries in developing country like India with limited resources at peripheral health care centres. To increase in accuracy of USG diagnosis, training programs or fellowship programs can be conducted.

LIMITATIONS:

1.In the study various factors contributing to Rotator cuff injuries (etiology) was not assessed.
2.Intra Observer Bias or Inter observer bias was not measured and it role cannot be ruled out
Purposive sampling was done. As it was a hospital based study. Random sampling techniques can allow the generalizability of results

Abbreviations:

SS: Supraspinatus
INF: Infraspinatus
SUB :Subscapularis
TM: Teres minor
BT:Bicipital tendon

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