Original Research Article

Correlation between MRI and arthroscopy findings inrotator cuff tears

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Abstract

Introduction: Rotator cuff tears are one of the most common causes of shoulder pain causing significant disability[1]. 86% of patients with shoulder pain are due to the abnormality of rotator cuff disorders[2]. MRI has revolutionized the diagnosis of shoulder pathologies. MRI is a proved sensitive, accurate, cost-effective and a non-invasive tool in investigating shoulder pathology[3]. Currently, Arthroscopy is considered as the "reference standard" for the diagnosis of shoulder pathologies. **Aim/purpose:** The purpose of this study attempted to assess the sensitivity and specificity of MRI with gold standard of direct visualization under arthroscope for **individual** rotator cuff tendons injury. **Materials and methods:** This is a hospital based prospective and comparative study conducted in the department of Radio diagnosis, Apollo Hospitals, Jubilee hills, Hyderabad between march 2019 to September 2020. 75 patients of both sexes and age groups > 18years (minimum and maximum age of the patient seen in my study are 20 years and 86 years respectively) with history of shoulder pain, restricted movements, instability and injuries who underwent MRI investigation and subsequently underwent ARTHROSCOPY.Data was collected on a pre-designed proforma by detailed history, thorough radiological investigations followed by arthroscopy findings. The data was collected analysed and reported as Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) and Accuracy of MRI for each type of rotator cuff tendon tears. Correlation between MRI and Arthroscopy was done using Kappa statistics and p value. The whole data obtained was analyzed using Statistical Package for Social Sciences, version 23.0. **Results:** MRI examination showed all 75 patients had supraspinatus tears of which 43 are full thickness tears and 32 are partial thickness tears, 19 out of 75 patients had infraspinatus tears of which 14 are full thickness tears and 5 are partial thickness tears and 15 out of 75 patients had subscapularis tendon tears. There is no teres minor tendon tears reported in the present study. Supraspinatus tendon tears: In the present study arthroscopically proven supraspinatus tendon tears are 39(F) full thickness tears and 22 partial thickness tears (P_1 16 + P_2 6). The sensitivity, specificity, PPV, NPV and accuracy of MRI in full thickness supraspinatus tears is 79.6%, 84.6%, 90.7, 68.8 and 81.3 respectively. Kappa value is 0.609(substantial) and p value was <0.001, highly significant. The sensitivity, specificity, PPV, NPV and accuracy of MRI in supraspinatus partial articular surface tears is 80.0%, 83.6%, 64.0, 92 and 82.6. Kappa value is 0.589(moderate) and p value is <0.01, highly significant. The sensitivity, specificity, PPV, NPV and accuracy of MRI in supraspinatus partial bursal surface tears are 100%, 98.6%, 85.7, 100.0. and 98.6 respectively. Kappa value is 0.916(almost perfect) and p value is <0.01, highly significant. Infraspinatus tendon tears: Out of 19 (F 14 + P 5) cases arthroscopically proven infraspinatus tendon tears are 10 full thickness tears and 5 partial thickness tears (P). The sensitivity, specificity, NPV and accuracy value of MRI in full thickness infraspinatus tears are 100 % ,93.8%, 71.4,100 and 94.7. Kappa value is 0.803(almost perfect) and p value is <0.001, highly significant. The sensitivity, specificity, PPV, NPV and accuracy value of MRI in partial thickness infraspinatus tears are 55.6%, 100%, 100, 94.3. and 94.7. Kappa value is 0.687(substantial) and p value is <0.001, highly significant. Subscapularis tendon tears: Out of 15 cases in the present study arthroscopically proven subscapularis tendon tears are 11 partial thickness tears (P). The sensitivity specificity, NPV and accuracy of MRI in the detection of subscapularis tears is 100%, 93.8%, 73.3, 100 and 94.7. Kappa value is 0.815(almost perfect) and p value is <0.001, highly significant. **Conclusion:** In the present study accuracy in detecting full thickness and partial thickness tears in infraspinatus and subscapularis and partial tears of supraspinatus is high as compared to supraspinatus full thickness tears. On comparing results of individual tendon tears in our study suggests, that Magnetic resonance imaging has high sensitivity, specificity and accuracy in diagnosing full thickness and partial thickness tears of supraspinatus tendon tears, subscapularis tears and full thickness tears of infraspinatus tendons. Sensitivity in detecting infraspinatus tendon partial thickness tears was lower, however it has high specificity and accuracy

Keywords: supraspinatus tendon tears, infraspinatus tendon tears, subscapularis tendon tears, teres minor tendon tears.

Introduction

The shoulder joint is a ball and socket joint have a wide range of motion.The Rotator cuff is a group of four muscles and tendons that help to stabilize the shoulder joint and aid in movement.

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Shoulder joint pathologies which includes a spectrum of intra-articular and extra-articular disturbances like rotator cuff tears, labral injuries, adhesive capsulitis, impingement syndrome and instability[3]. Rotator cuff tears are one of the most common causes of shoulder pain causing significant disability[1]. 86% of patients with shoulder pain are due to the abnormality of rotator cuff disorders[3]. Spectrum of aetiologies causing shoulder pain is acute trauma to a gamut of degenerative disorders. The tendons are subject to "wear and tear" during the day-to-day activities. Repetitive active and passive forces cause these tendons susceptible to degeneration

leading to swelling of the tendon and a minor degree of subluxation. The space between the humeral head and the acromion is sufficiently restricted that mild swelling of the interposed tendon with or without minor superior subluxation of the humeral head leads to impingement syndrome and rotator cuff tears.Rotator cuff injury is a different spectrum, which is of the nature of chronic injury because of the intrinsic nature of the Musculo-tendinous and osseus-tendinous part of the rotator cuff and the anatomically narrow subacromial space.The radiological diagnosis of rotator cuff tears has traditionally been performed with arthrography, computed tomography, ultrasonography and MRI[4].

Evaluation of a patient with rotator cuff tears often involves history and physical examination, assessment of the rotator cuff with a diagnostic test such as high-resolution ultrasonography or MRI[5]. The sensitivity and specificity of USG is less as compared to MRI in inexperienced hands. Therefore, the choice of investigation is MRI.Currently magnetic resonance imaging with the advent of surface coils is becoming the modality for the imaging of soft tissues around the shoulder joint.

MRI gives valuable information on regions that can be symptomatic and that are not fully assessed on arthroscopy. In the rotator cuff pathologies, intra-substance pathology such as partial thickness tearing is better visualised on MRI than arthroscopy, which bases most of its evaluation, at least, on surface pathology[6]. MRI has become the "gold standard" for detecting both subtle and obvious internal derangement and assessing overall shoulder joint structure. MRI can provide information about rotator cuff tears such as tear depth or thickness, tear dimensions and tear shape, involvement of adjacent structures (e.g., rotator interval, long head of biceps brachii tendon etc) and muscle atrophy, all of which have implications for rotator cuff management and prognosis. Information about coracoacromial arch and impingement as it relates to rotator cuff tears can also be obtained with MRI[7]. MRI can determine the treatment approaches for the surgeon.MRI has good spatial resolution for assessment of soft tissue, to identify tendon edema& tear in the muscle cuff. Classification of tears is also more conspicuous using MR.

MRI is a proved sensitive, accurate, cost-effective and a non-invasive tool in investigating shoulder pathology[3]. MR Arthrography has the advantage of providing excellent delineation of ligaments,labrum and the rotator cuff tears. But it is invasive and highly dependent on the operator's skill.

Currently, Arthroscopy is considered as the "reference standard" for the diagnosis of shoulder pathologies. Arthroscopy is quite accurate in detecting complete tears but it is an invasive procedure with some associated risk and discomfort and it is insensitive to partial tears involving superficial surface or substance of the cuff.

The diagnosis of partial tears, however, is important because many orthopaedic surgeons will operate to relieve impingement of supraspinatus tendon before it progresses to full thickness tear. The relative ease with which they are seen on MRI suggests that MRI has a definite role in their diagnosis[4].

Justification for the study and gaps in literature

MRI plays an important role as a triage tool in rotator cuff pathology due to its ability to non-invasively display of high-definition anatomy images with un-paralleled soft tissue contrast[8]. Numerous studies have shown a good radiological-surgical correlation enough to guide on the treatment pathway for the patient[9].

Summary of Results

[Tables, graphs and Figures]

MRI is the preliminary investigation of choice in rotator cuff tears before treatment /arthroscopy. It is extremely beneficial both to the surgeon /clinician and the patient if the radiologist can accurately diagnose the rotator cuff tears. There is lack of validated methods in diagnosing shoulder pathology particularly individual rotator cuff tendons tear, even though it is one of major health care concerns.

Hence our study attempted to assess the sensitivity and specificity of MRI with gold standard of direct visualization under arthroscope for individual rotator cuff tendons injury.

Research question

The research question which my study intends to answer are:

1. Attempt to assess the sensitivity, specificity, PPV, NPV and accuracy of MRI with gold standard of direct visualization under arthroscope for individual rotator cuff tendons injury.
2. Compare the findings of individual rotator cuff tendons injury.
3. To know the role of MRI how accurately diagnose in correlation with arthroscopy.
4. How accurately diagnose the rotator cuff tears in our hospital and to compare and interpret the findings with other studies.

Materials and methods

This was a hospital based Prospective and Comparative study conducted in the Department of Radiology and Imaging at Apollo Hospital, a tertiary care hospital in Hyderabad, Telangana. Total 75 Patients admitted to Apollo Hospital, Jubilee hills, Hyderabad with history of shoulder pain, restricted movements, instability and injuries who underwent MRI INVESTIGATION and subsequently ARTHROSCOPY during a period of 17 months from April 2019 to August 2020. (Minimum and Maximum age of the patient seen in my study are 20 years and 86 years respectively). MR imaging in our institution was performed with a PHILIPS ACHIEVA 1.5T MR Scanner and dedicated surface coil.Patients given consent for the study were referred for MRI shoulderand subsequently underwent arthroscopic examination / therapeutic procedurewere included in the study. Patients with contraindications for MRI and prior arthroscopically operated cases were excluded. For the purpose of the study an informed consent and study proforma was obtained for every patient.

Data was collected on a pre-designed proforma by detailed history, thorough radiological investigations followed by arthroscopy findings. The data collected was analyzed and reported as Sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) and Accuracy of MRI for each type of rotator cuff tendon tears. Correlation between MRI and Arthroscopy was done using Kappa statistics and p value. The whole data obtained was analyzed using Statistical Package for Social Sciences, version 23.0.

Results

MRI examination showed all 75 patients had supraspinatus tears of which 43 are full thickness tears and 32(P_1 25 and P_2 7) are partial thickness tears, 19 out of 75 patients had infraspinatus tears of which 14 are full thickness tears and 5 are partial thickness tears and 15 out of 75 patients had subscapularis tendon partial tears. There is no teres minor tendon tears reported in the present study.

Arthroscopically proven supraspinatus tendon tears are 39(F) full thickness tears and 22 partial thickness tears ($P_1$16+P_2 6), Infraspinatus tendon tears are 10 full thickness tears and 5 partial thickness tears (P) and subscapularis tendon tears are 11 partial thickness tears (P).

Table 1: MRI vs Arthroscopy Correlation values for TSP, TISP, TSUB, and TTM

Structure		Sensitivity	Specificity	PPV	NPV	Accuracy
Supraspinatus tendon	Full thickness tear- F	79.6%	84.6%	90.7	68.8	81.3%
	Partial articular surface tears- P1	80.0%	83.6%	64.0	92.0	82.6%
	Partial bursal surface tears-P2	100.0%	98.6%	85.7	100.	98.6%
Infraspinatus	Full thickness tear- F	100.0%	93.8%	71.4	100.	94.7%
	Partial articular surface tears- P1	55.6%	100.0%	100.	94.3	94.7%

Subscapularis	Partial tears	100.0%	93.8%	73.3	100.	94.7%
Teres minor					100	

Table 2: Kappa statistics for MRI vs Arthroscopy

Structure		Kappa Value	Level of agreement
Supraspinatus tendon	Full thickness tear- F	0.609	Substantial
	Partial articular surface tears- P1	0.589	Moderate
	Partial bursal surface tears-P2	0.916	Almost perfect
Infraspinatus	Full thickness tear- F	0.803	Almost perfect
	Partial articular surface tears- P1	0.687	Substantial
Subscapularis	Partial tears	0.815	Almost perfect

F- full thickness tears, P1- partial thickness articular surface tears, P2- partial thickness bursal surface tears.

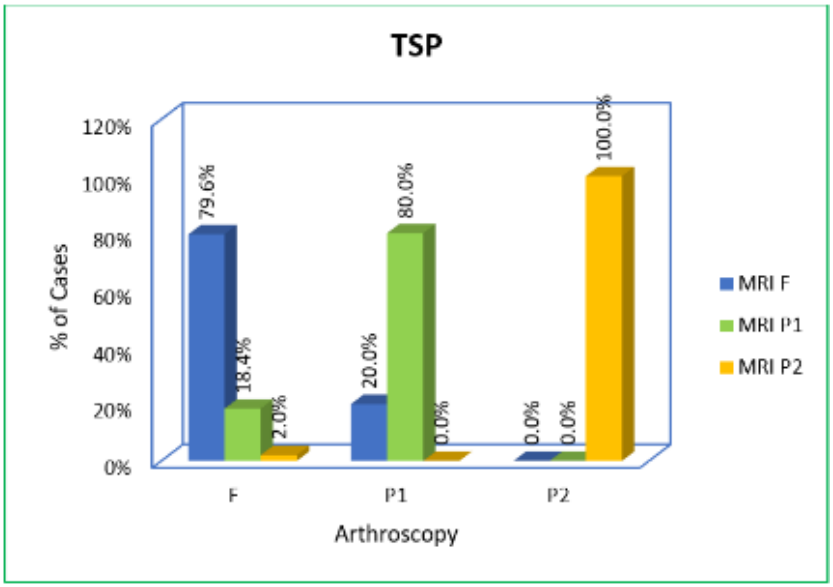


Figure 1: showing accuracy between MRI and Arthroscopy findings for supraspinatus tendon tears

TSP- supraspinatus tendon, F- full thickness tears, P1- partial thickness articular surface tears, P2- partial thickness bursal surface tears.

Out of 43 supraspinatus full thickness tears on MRI, 39(79.6%) cases confirmed as full thickness tears and 4cases (20%) as partial tears in arthroscopy. Out of 25 supraspinatus partial thickness articular surface tears on MRI ,16 cases (80%) as P1 in arthroscopy and 9(18.36%) cases as full thickness tears on arthroscopy.Out of 7 supraspinatus partial thickness bursal surface tears on MRI ,6 cases (100%) as P2 and 1(2%) case as full thickness tears in arthroscopy.

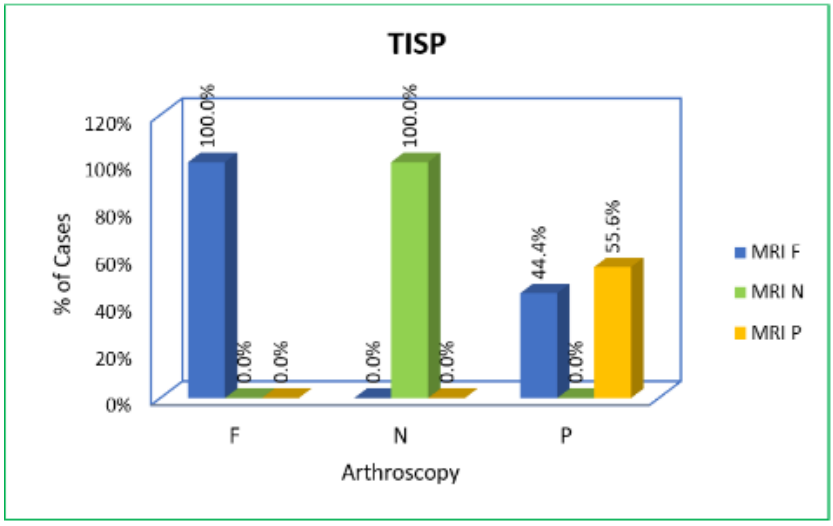


Figure 2: showing accuracy between MRI and Arthroscopy findings for infraspinatus tendon (TISP) tears

Out of 14 infraspinatus full thickness tears on MRI , 10 (100%) cases as full thickness tears and 4 (44.4 %) as partial tears in arthroscopy. However all partial tears 5 cases on MRI confirmed on arthroscopy (55.6%).

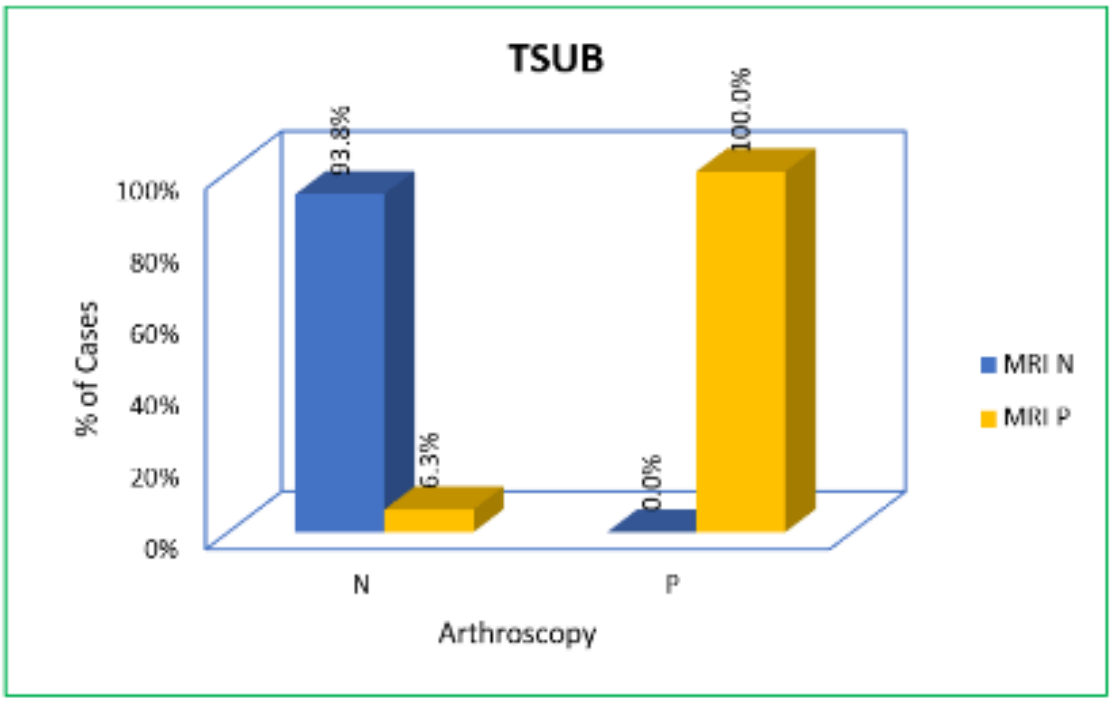
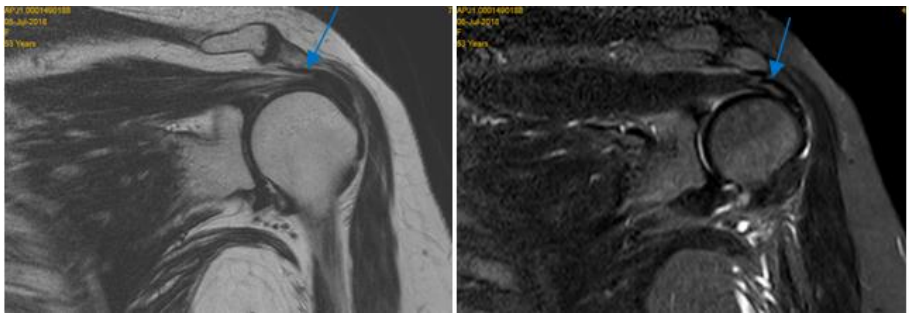


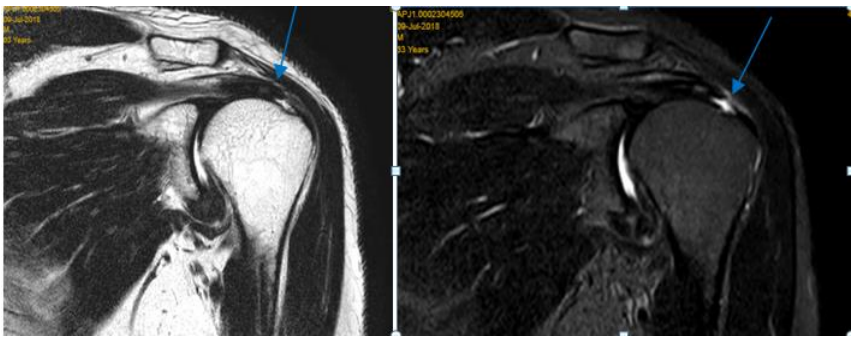
Figure 3: showing accuracy between MRI and Arthroscopy findings for subscapularis tendon (TSUB) tears

Out of 15 subscapularis partial tears on MRI 11cases (100%) confirmed but 4 cases are normal in arthroscopy findings.
All the Teres minor tendons are normal as in MRI and NPV is 100%

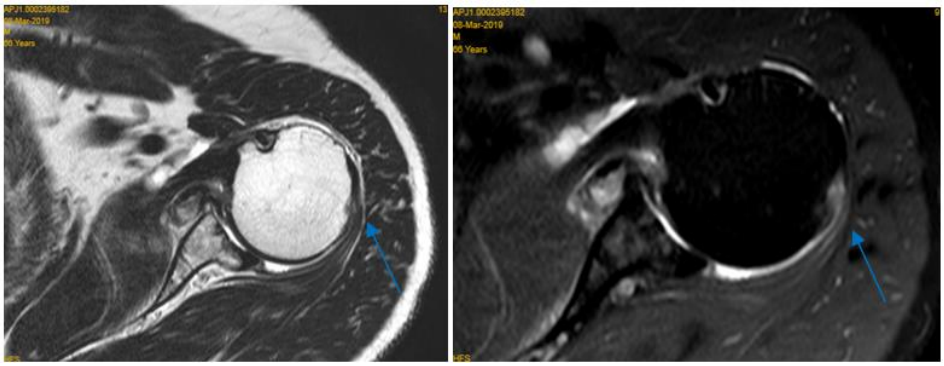
Sample cases



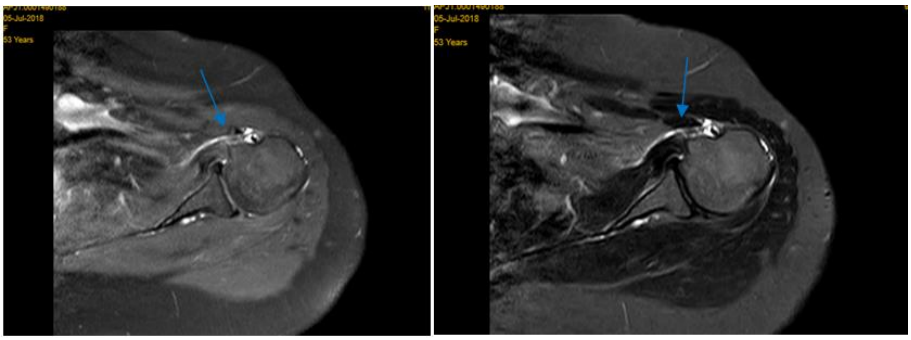
Case 1: Figure 4: Coronal T2 /STIR images showing a partial tear with edema in the musculotendinous structure of the supraspinatus



Case2: Figure 5: Coronal T2 /STIR images showing complete/full thickness tear of the supraspinatus tendon



Case 3: Figure 6: Axial T2W /PDW SPAIR images shows partial tear in the infraspinatus tendon



Case 4: Figure 7: Axial PD SPAIR / STIR images showing partial tear with edema in the Musculo tendinous structure of the subscapularis muscle.

Case 5: Figure 8: Coronal PD image showing focal high signal within the supraspinatus tendon fibres. Partial interstitial supraspinatus tendon tear.

Discussion

This was a prospective and comparative study, in which 75 patients referred to the department of Radio diagnosis, Apollo hospitals, Jubilee hills Hyderabad with clinically suspected rotator cuff injuries were subjected to undergo MRI after thorough history taking and clinical examination.

The age of the patients with rotator cuff disorders ranged from 20 to 86 years with a mean of 48.91 years and a standard deviation of 13.685. Majority of Rotator cuff tears were observed in patients above 40 yrs. of age (74.6%).

In our study rotator cuff tears were seen in 47 male patients (62.7%) and 28 female patients (37.3%) thus showing male preponderance among the study population correlating with study of David W.S et al which concludes that there is male predominance among patients with tears[1].

MRI findings in Tendon injuries

Table 3: Comparison similar studies in detecting Full and Partial thickness tears of supraspinatus tendon on MRI and its correlation with arthroscopy findings

	Supraspinatus full thickness tears					Supraspinatus partial thickness tears				
	Sn	SP	PPV	NPV	Acc	Sn	SP	PPV	NPV	Acc
Shailaja et al	100%	96%	93.7%	100%	97.5%	100%	89%	33.3%	100%	90%
Khanduri et al	95.2%	98.4%	95.2%	98.4%	97.6%	88.6%	96.0%	93.09%	92.3%	92.9%
Saikia et al	100	100	100	100	-	92.3	88.9	92.3	88.9	-
our study	79.6%	84.6%	90.7%	68.8%	81.3%	86.67	86	81.25	90.70	86.67

In a study conducted by **Shailaja[11]**, out of 40 patients, MRI revealed 15 full thickness tear and 5 partial thickness tears, on Arthroscopy confirmed 14 full thickness tear and 1 partial tear. The sensitivity and specificity for full thickness tears are 100 and 96% and partial thickness tears showed 100 % and 89%.

Khanduri[12]- in 85 cases of chronic shoulder pain showed full thickness tear of supraspinatus, MRI had a sensitivity, specificity, PPV, NPV, and accuracy of 95.2%, 98.4%, 95.2%, 98.4%, and 97.6%, respectively. For partial thicknesssupraspinatus tears MRI had a sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of 88.6%, 96.0%, 93.9%, 92.3%, and 92.9%, respectively.

In the prospective study conducted by Saikia **Lelin[13]** out of 22 patients, MRIshowed13 full thickness tears and 2 partial thickness tears confirmed in arthroscopy.

On comparison with the above studies supraspinatus partial tears has similar sensitivity and specificity results but full thickness tears have sensitivity and specificity lower in our study.

Table 4: Comparison similar studies in detecting Full and partial thickness tears of infraspinatus tendon on MRI and its correlation with arthroscopy findings

	Infraspinatus full thickness tears					Infraspinatus partial thickness tears				
	Sn	SP	PPV	NPV	Acc	Sn	SP	PPV	NPV	Acc
Our study	100.0%	93.8%	71.4	100.	94.7	55.6%	100.0%	100.	94.3	94.7
Shailaja et al	50%	97.2%	50%	97.2%	94.7%	-	-	-	-	-

In a study conducted by shailaja[11], out of 40 patients, on MRI showed 4 full thickness tear and 1 partial tear, on arthroscopy confirmed only 3 patients had full thickness tear.

In our study showed higher sensitivity and specificity for infraspinatus full thickness tendon tears and less sensitivity for partial tears. But both tears have high accuracy in our study.

Table 5: Comparison similar studies in detecting tears of subscapularis tendon tears on MRI and its correlation with arthroscopy findings

	Subscapularis tendon tears				
	Sn	SP	PPV	NPV	Acc
Our study	100.0%	93.8%	73.3	100.0	94.7
Momenzadeh et al	63.6	91.3	53.8	94	-
Gyftopoulos et al	80	91	51	98	90

In a study conducted by **Momenzadeh[14]** in 80 patients, on MRI showed 13 tears and on arthroscopy was 11.

Our study showed good sensitivity of 100% as compared to 63.6% in the above study.

Gyftopoulos[15] performed study in 244 patients of which total of 25 subscapularis tearspresent. Sensitivity of 80%, specificity of 91%, accuracy of 90%, positive predictive value of 51%, and negative predictive value of 98 %.

In our study subscapular tears has higher sensitivity, specificity and accuracy.

Teres minor tendon

Out of the 75 patients included in our study none of the patients had a tear of the teres minor tendon, neither on MRI nor on arthroscopy, Hence NPV is 100%.

MRI showed higher sensitivity and specificity for partial tears of supraspinatus tendon injury. Sensitivity and specificity for full thickness surface tears type of infraspinatus tendon tears is higher. MRI evaluation shows greatly increased sensitivity and specificity for subscapularis.

Conclusion

Our study results and statistical analysis showed supraspinatus partial thickness tears, full thickness tears of infraspinatus tendons and subscapularis tendons tears has high sensitivity and specificity, but significantly low sensitivity for partial thickness tears type of infraspinatus tendon. There is slightly lower sensitivity of full thickness type tears of supraspinatus tendons as compared to other tendons tears. MRI evaluation shows greatly increased sensitivity and specificity for subscapularis.

However, P value for MRI in detection rotator cuff tears in correlation to arthroscopy is highly significant.

In conclusion, our study results suggests that MRI has reasonable high sensitivity, specificity and accuracy in diagnosing rotator cuff

tears in correlation to Arthroscopy. The present study supports that MRI is effective in diagnosing and preoperative evaluation of Rotator cuff tears.

Limitations

Our study has limitations of potential selection bias as all patients with rotator cuff injury severe enough to undergo arthroscopy either diagnostic or repair were included in the study, missing out the people who could not undergo MRI in view of claustrophobia or metallic and pacemaker implants and patients who could not undergo arthroscopy in view of co morbidities.

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