

## Analysis of Magnetic Resonance Imaging and Arthroscopic Findings in Diagnosing Shoulder Pathologies

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### Abstract

**Introduction:** Shoulder pain is a common cause of musculoskeletal disability. Shoulder joint pathologies are commonly diagnosed using MRI and arthroscopy<sup>1</sup>. Arthroscopy is gold standard diagnostic investigation in obtaining definitive diagnosis of abnormalities but many studies have reported MRI to be sensitive, accurate and noninvasive tool for investigation.<sup>7</sup> The aim of study is to compare MRI and arthroscopy in diagnosing shoulder pathologies.

**Material and Methods:** The prospective study included 41 patients between January 2020 and July 2021, presented to our institute with chronic shoulder pain after applying selection criteria. MRI followed by shoulder arthroscopy was performed for all patients. The data was statistically analysed using SPSS v 26.

**Results:** Synovitis (65.9%) was most common pathology. MRI reported high specificity (100%) for full thickness rotator cuff tear, rotator cuff tendinitis, sub acromial bursitis, and Bankart's Lesion followed by SLAP lesion (96.6%), and bicep tendinitis (95.8%) while moderate specificity for synovitis (78.6%) and partial rotator cuff tear (66.7%). MRI reported to have high sensitivity for Hill Sachs lesion, sub acromial bursitis and partial thickness rotator cuff tear and Bankart's lesion and low sensitivity for full thickness rotator cuff tear, synovitis, SLAP lesions and bicep tendinitis. MRI detected subacromial bursitis (0.807), Bankart's lesion (0.792) and Hill Sachs lesion (0.707) with substantial correlation whereas it detected synovitis (0.064) with only slight correlation. The accuracy of MRI was highest in diagnosing subacromial bursitis (0.90) and Bankart's lesion (0.90) and lowest for synovitis (0.46).

**Conclusion:** MRI is effective technique for diagnosis of rotator cuff tears, sub acromial bursitis, synovitis and rotator cuff tendinitis, but was less effective in detecting SLAP lesions and less in differentiating the partial or complete rotator cuff tear.

**Keywords:** MRI, Shoulder Arthroscopy, Bankart's, SLAP, Rotator Cuff Pathology.

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## Introduction

The shoulder pain is the third most common cause of musculoskeletal consultation and approximately 1% of adults receive consultation from a general practitioner with the new onset shoulder pain every year.[1] The prevalence of shoulder pain among adults is estimated to be between 18 -26 % at any point in time according to population surveys. [2,3] Both intra-articular and extra-articular disturbances lead to shoulder pathologies like rotator cuff tears, labral injuries, adhesive capsulitis, impingement syndrome and instability.

The symptoms of shoulder disorders can be persistent and disabling, adversely affecting the capability of individual both at home and work-place to perform daily activities. [4] The shoulder pain can lead to increased demands on health care, reduced work performance, significant sickness absence, and early retirement or job loss.[5] Consequently, the accurate diagnosis and treatment of shoulder pain is necessary.

For the evaluation of pathological conditions of shoulder joint, multiple imaging modalities are used currently including conventional radiography, sonography, fluoroscopy, nuclear medicine, and MRI. MRI being sensitive, accurate and non-invasive tool is often used for diagnosis of shoulder pathologies. MRI accurately detects the abnormalities of the rotator cuff, capsule, and labrum with glenohumeral instability and osseous structures including Bankart and Hill-Sachs lesions. MRI is contraindicated in patients with cardiac pacemaker, ferromagnetic foreign body, and patients with extreme claustrophobia.[6]

Arthroscopy is currently gold standard investigation for shoulder pathologies, and it improves the direct visualization of shoulder joint by providing a 20- power magnification.[7] Although, arthroscopy has diagnostic and therapeutic values, it also has

few disadvantages. The laxity of the joint is altered through the process of arthroscopy, making it difficult to determine the capsule's flaccidity. The procedure being invasive, carries risk of few complications such as infection, injury to adjacent structures and fluid extravasation. The anaesthetic agent can also cause complications.[8]

However few studies comparing accuracy of MRI and arthroscopy reported MRI to be not an accurate and effective technique for assessment of shoulder pathologies, especially in patients with ambiguous clinical picture.9-10 Thus the present study was conducted to evaluate the correlation between MRI and arthroscopy for the assessment of shoulder pathologies and to compare efficacy of MRI and arthroscopy in diagnosis of shoulder pathologies.

## Material and Methods

The prospective, comparative study was conducted at department of orthopaedics and traumatology from January 2020 to July 2021 after approval of Institutional Ethical Committee. A total of 41 patients were included in the study. All the patients in the age group of 18 to 70 years, who visited with the chief complains of shoulder pain and decreased range of motion and having symptoms of instability, adhesive capsulitis, impingement syndrome, rotator cuff injuries were included in the study. While the patients with infective pathologies, malignancy of shoulder joint and those contraindicated to MRI were excluded from the study.

All the patients were informed about the study and informed consent was taken. After detailed history, clinical examination, and initial radiographic evaluation by x-ray, all the patients were advised for MRI of affected shoulder joint and according the findings of shoulder MRI, patient were planned for diagnostic arthroscopy after required investigations and fitness. All patients were

evaluated using 1.5 T MRI scanner (Signa HDxt; GE Medical systems). The images of MRI were obtained in the axial, coronal oblique, and sagittal oblique planes with fast spin echo sequence and Fat Saturated Proton Density (FSPD) sequence. All images were acquired with a slice thickness of 3 mm and field of view of 140mm to 160 mm.

The arthroscopy system was used that included camera assisted arthroscope an integrated motor-ized shaver system, an arthroscopic pump. The diagnostic arthroscopy was performed using a 2-circle approach based on the Southern California Orthopedic Institute "15-point system" for a complete diagnostic examination of the shoulder.[11] The first 9 positions were used to examine glenoid aspect of the joint, position 10 to 13 for the humeral aspect of the joint space and position 14 for subacromial space.

Comparison was made between MRI and arthroscopy. Data collected from the MRI and arthroscopy results was presented in the form of tables and charts. Data was analysed for the significant correlation between USG and MRI findings of shoulder joint by kappa statistics. The diagnosis of MRI was categorized into four based on arthroscopic findings:

1. True positive (TP): If the MRI diagnosis was confirmed by arthroscopy.
2. True negative (TN): If the MRI was negative for any lesion and same was confirmed by arthroscopy.
3. False positive (FP): If MRI was positive for lesion but arthroscopy was negative

4. False negative (FN): If arthroscopy was positive but MRI showed negative findings.

The statistical analysis was performed using IBM SPSS Statistics for Windows, Version 26.0 (Released 2019, IBM Corp., Armonk, New York) to calculate sensitivity, specificity, negative predictive value (NPV), positive predictive value (PPV), and accuracy of MRI as compared to arthroscopy. Kappa coefficient was used to calculate the level of agreement between MRI and arthroscopic findings pertaining to various shoulder pathologies and interpreted using guidelines outlined by Landis and Koch. [12]

## Result

The study cohort comprised of 41 patients with the symptoms of shoulder joint pain. The mean age of study participants was  $39.02 \pm 12.99$  years and majority of patients belonged to the age group of 18-29 years and 30-39 years. Males (70.7%) were affected more than females (29.3%). 20 patients were involved in occupation requiring significant overhead activity such as labourer, farmers, housekeeping, drivers, housewife. Right shoulder joint (61%) was more frequently involved than left shoulder joint (39%). Majority of patients had previous history of trauma (58.5%) due to fall, assault or sudden jerk and 10% reported history of chronic pain in other joints also. On X-Ray, 78% of patients had no obvious findings relating to shoulder pain, while 5 patients had osteophytes, 3 had Hill Sachs lesion and 1 was reported with calcific tendinitis. (Table 1)

**Table 1: Descriptive statistics of demographic profile and clinical characteristics (n=41)**

Demographic Characteristics	Frequency	Percentage(%)
<b>Age Groups</b>		
18-29 Years	12	29.30
30-39 Years	12	29.30
40-49 Years	8	19.50
50-59 Years	5	12.20
60-69 Years	4	9.80

<b>Sex</b>		
Male	29	70.70
Female	12	29.30
<b>Occupation</b>		
High Demand (Requiring overhead activity)	20	48.70
Low Demand	21	51.20
<b>Clinical Characteristics</b>		
<b>Side Involved</b>		
Right	25	61
Left	16	39
<b>Past History</b>		
Direct Trauma	24	58.50
Seizure	3	7.30
Chronic Pain	4	9.80
None	8	19.50
Others	2	4.80
<b>XRAY Findings</b>		
Hill Sachs Lesion	3	7.30
Calcific Tendinitis	1	2.40
Osteophytes	5	12.20
None	32	78

Synovitis (65.9%) was the most common shoulder joint pathology followed by rotator cuff tendinitis (58%) among the study participants.

**Table 2: Pathologies affecting shoulder joint**

S. No.	Pathologies	MRI (%)	Arthroscopy (%)
1	Partial Thickness Rotator Cuff Tear	20 (48.8%)	14(34.1%)
2	Full Thickness Rotator Cuff Tear	1(2.4%)	7 (17.1%)
3	Sub Acromial Bursitis	18 (43.9%)	22 (53.7%)
4	Rotator Cuff Tendinitis	14 (34.1%)	24 (58%)
5	Bicep Tendinitis	6 (14.6%)	17 (41.5%)
6	Synovitis	11 (26.8%)	27 (65.9%)
7	SLAP Lesion	5 (12.2%)	12 (29.3%)
8	Bankart's Lesion	13(31.7%)	17(41.5%)
9	Hill Sachs Lesion	20 (48.8%)	20(48.8%)

MRI had high specificity (100%) for Full thickness rotator cuff tear, Rotator Cuff Tendinitis, Sub Acromial Bursitis, and Bankart's Lesion followed by SLAP lesion (96.6%), and bicep tendinitis (95.8%) while moderate specificity for synovitis (78.6%) and partial rotator cuff tear (66.7%). MRI reported to have high sensitivity for Hill Sachs lesion, Sub acromial bursitis and partial thickness rotator cuff tear and Bankart's lesion and low sensitivity for Full thickness Rotator Cuff tear, synovitis, SLAP lesions and bicep tendinitis. (Table 3) Table 3 Interpretation of the statistical findings.

**Table 3: Interpretation of the statistical findings**

Pathologies	Sensitivity	Specificity	PPV	NPV	Kap-	Accura-	P
Partial Thickness Ro-	78.6%	66.7%	55.0	85.7%	0.41	0.70	0.006
Full Thickness Rotator	14.3%	100%	100%	85%	0.217	0.85	0.26
Sub Acromial Bursitis	81.8%	100%	100%	82.6%	0.807	0.90	0.00
Rotator Cuff Tendinitis	52.4%	100%	100%	59.3%	0.486	0.70	0.00
Bicep Tendinitis	29.4%	95.8%	83.3	65.7%	0.279	0.68	0.24
Synovitis	29.6%	78.6%	72.7	36.6%	0.064	0.46	0.57
SLAP Lesion	33.3%	96.6%	80%	77.8%	0.360	0.78	0.00
Bankart's Lesion	76.5%	100%	100%	85.7%	0.792	0.90	0.00
Hill Sachs Lesion	85.0%	85.7%	85.0	85.7%	0.707	0.80	0.00

(PPV – Positive predictive value, NPV – Negative predictive value)

MRI detected subacromial bursitis, Bankart's lesion and Hill Sachs lesion with kappa score of 0.807, 0.792 and 0.707 respectively suggestive of substantial correlation whereas it detected syn-ovitis with kappa score of 0.064 depicting only slight correlation. The accuracy of MRI was highest in diagnosing subacromial bursitis (0.90) and Bankart's lesion (0.90) and lowest for syn-ovitis (0.46) (Table 3/Figure 1)

Figure 1 Accuracy and kappa score of MRI in comparison to arthroscopy in detection of shoulder joint pathology

### Discussion

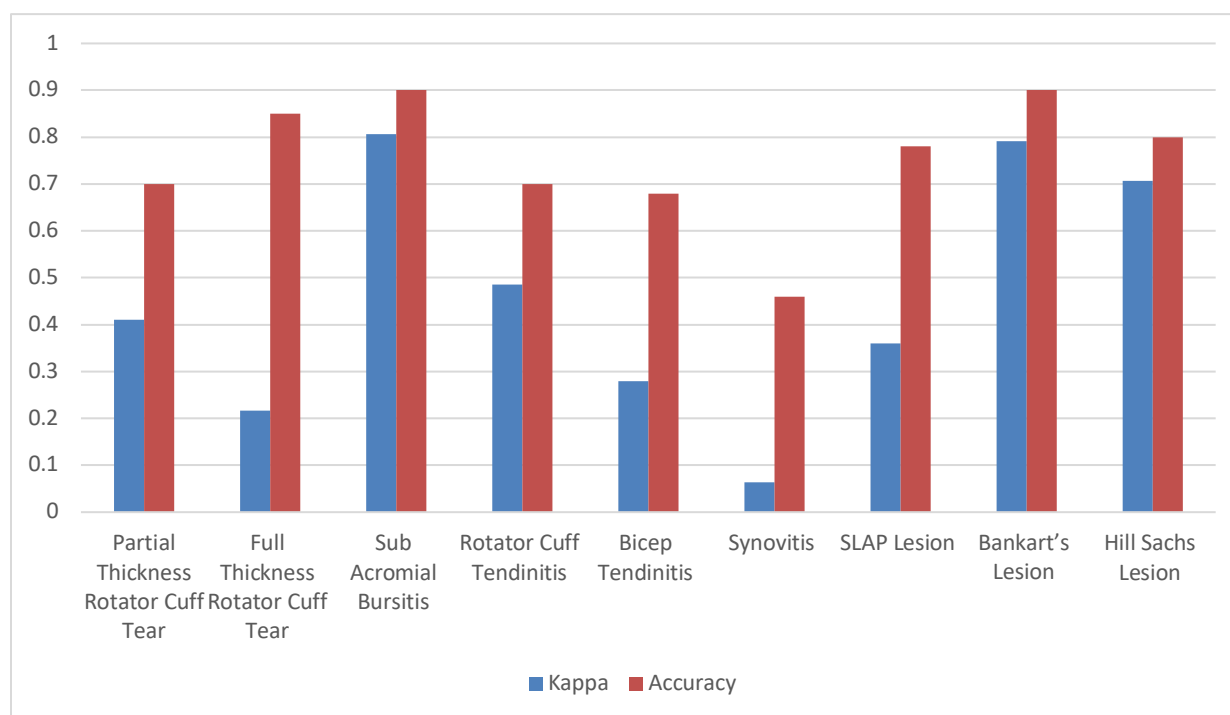
In the present study, maximum number of patients were in third and fourth decade of

life (18-29 years and 30-39 years) and mean age was 39.2 years with standard deviation of 12.99 years which is in contrast with the studies conducted by Saqib *et al.* and Malhi *et al.* where mean age is 29.9 years and 46.8 years respectively.[13,14] Out of total cases, majority were male (70.7%) in present study which is similar to study conducted by Sefidbakht *et al.*, Srinivas *et al.*, Saqib *et al.* and contrast to Bhatnagar *et al.* and Malhi *et al.* which found little difference with respect to gen-der of patient.[13-17] In present study right shoulder (61%) was more commonly involved which is similar to study conducted by Saqib *et al.* and Bhatnagar *et al.*, while Srinivas *et al.* re-ported both sides were equally affected. [13,16,17]

**Table 4: Comparison of different studies in diagnosis of shoulder pathology**

Partial Rotator Cuff Tear	Sensitivity	Specificity	PPV	NPV	Accuracy
Srinivas et.al. 2018 (n=12) [16]	100%	67%	90%	100%	0.92
Bhatnagar et.al. 2016 (n=39) [17]	91%	100%	100%	63%	0.90
Momemzadeh et.al. 2015(n=80) [18]	91%	92%	93%	89%	-
Muthami et.al. 2014 (n=34) [19]	46%	88%	71%	72%	-
Saqib et.al. 2017 (n=194) [13]	71%	86%	47%	95%	-
Present study 2021 (n=41)	78.6%	66.7%	55.0%	85.7%	0.70
Bicep Tendinitis	Sensitivity	Specificity	PPV	NPV	Accuracy
Momemzadeh et.al. 2015(n=80) [18]	80%	96.9%	85.7%	95.4%	-
Present study 2021 (n=41)	29.4%	95.8%	83.3%	65.7%	0.68
SLAP Lesion	Sensitivity	Specificity	PPV	NPV	Accuracy
Saqib et.al. 2017 (n=194) [13]	75%	98%	64%	88%	-
Saikia et.al. 2017 (n=22) [20]	40%	94.1%	66.7%	84.2%	-

Bhatnagar et.al. 2016 (n=39) [17]	15%	96%	67%	69%	0.70
Momemzadeh et.al. 2015 (n=80) [18]	74%	80%	78%	76%	-
Present study 2021 (n=41)	33.3%	96.6%	80%	77.8%	0.78
<b>Bankart's Lesion</b>	<b>Sensitivity</b>	<b>Specificity</b>	<b>PPV</b>	<b>NPV</b>	<b>Accuracy</b>
Bhatnagar et.al. 2016 (n=39) [17]	80%	100%	100%	89%	0.90
Momemzadeh et.al. 2015 (n=80) [18]	50%	84%	77%	60%	-
Saikia et.al. 2017(n=22) [20]	100%	85.7%	80%	100%	-
Present study 2021 (n=41)	76.5%	100%	100%	85.7%	0.90
<b>Hill Sachs Lesion</b>	<b>Sensitivity</b>	<b>Specificity</b>	<b>PPV</b>	<b>NPV</b>	<b>Accuracy</b>
Saikia <i>et al.</i> (n=22) [20]	100%	100%	100%	100%	-
Saqib et.al. (n=194) [13]	91%	91%	66%	98%	-
Present study(n=41)	85%	85.7%	85%	85.7%	0.80



**Figure 1: Accuracy and kappa score of MRI in comparison to arthroscopy in detection of shoulder joint pathology**

### Rotator cuff pathologies

In present study the sensitivity of MRI in detecting partial rotator cuff tears (Figure 2,3,4) was similar to study done by Saqib *et al.* while studies by Srinivas *et al.*, Bhatnagar *et al* and Mo-memzadeh *et al.* depicted higher sensitivity and Muthami *et al.* reported

lower sensitivity of MRI in reporting rotator cuff tears. The present study reported lower specificity as compared to studies conducted by Bhatnagar *et al*, Momemzadeh *et al.*, Muthami *et al.*, and Saqib *et al.* (Table 4)

MRI had shown low sensitivity (14.3%) and high specificity (100%) in diagnosing full

thickness rotator cuff tear in present study. While the sensitivity of MRI for diagnosis of rotator cuff ten-dinitis is 52.4%, and specificity of 100% with accuracy of 70%.(Table 3) Rotator cuff tears can be missed on MRI and identified on the spot arthroscopy. These lesions may be missed for a va-riety of reasons may be due to the difficulties in detecting undersurface tears due to mechanical restrictions among them delaminating tears and the supraspinatus are two examples. [21-23] Some-times tendon is obliquely orientated to the imaging plane. [23]

### **Biceps tendinitis**

In present study, MRI had shown the sensitivity of is 29.4%, and specificity of 95.8% in diag-nosis of biceps tendinitis (Figure 5,6) which is low as compared to sensitivity of 80% and specificity of 96.9% as shown in study conducted by Momenzadeh *et al.* in 2015.18

### **SLAP lesion**

The present study reported low sensitivity (33.3%) of MRI in detecting SLAP lesion as com-pared to other studies.13,18 Although study conducted by Bhatnagar *et al.*, reported lower sensi-tivity as and Saikia *et al.* reported similar sensitivity as compared to current study.17,20 There were 8 cases of superior labral tears which were missed on MRI and detected on arthroscopy, showing high false negatives in present study.

The probable reasons that the SLAP lesions were either missed or mischaracterized may be because the abnormalities are small, insufficient spa-tial resolution may cause them to go undetected and the glenoid labrum is curved along the gle-noid surface, coronal oblique images are typically not oriented along the long axis of the gle-noid, which can lead to partial volume averaging

with adjacent fluid and tissues, limiting accu-racy. [21-24]

### **Bankart lesion**

In present study, MRI is found to be more specific (100%) then sensitive(76.5%) for detecting Bankart lesion (Figure 7,8) and it shows the substantial agreement ( kappa value of 0.79) and diagnostic accuracy of 90%. Bhatnagar *et al.* reported similar finding, however Momenzadeh *et al.* reported lower sensitivity in detecting Bankart's lesion.[17,18] The sensitivity of MRI in detect-ing Bankart's tear could be limited due to the location of a Bankart's lesion vary greatly, and the close proximity and abutment of the labrum to the capsule and cortical bone, both of which have the same signal intensity, makes it difficult to separate them. [25] (Table 4)

### **Hill Sachs lesion**

In present study we found that MRI is extremely sensitive and specific for detecting Hill Sachs lesion which is similar to the studies conducted by Saqib *et al.*, and Saikia *et al.* MRI proved to be a good modality for diagnosing Hill Sachs lesions in our study.[13,20] (Table 4)

One of the strength of the study is that, it reported high accuracy of MRI in most of the shoulder pathologies which could be attributed to a detailed clinical examination preceding MRI and re-porting of clinical findings with radiologist for each case. Since the study was conducted at a single center with a sample of 41 patients , it can not be generalized to larger population. Hence a large study is recommended for a conclusion to be made. The continued interaction and collabo-ration among radiologists and shoulder arthroscopy surgeon will lead to better understanding of the pathologies and shall help in refinement and innovations in MRI techniques for diagnosis of shoulder pathologies.

## Conclusion

The present study conducted among 41 patients supports that MRI is an effective technique in diagnosing rotator cuff tears, sub acromial bursitis, synovitis and rotator cuff tendinitis, but was less effective in detecting SLAP lesions and less in differentiating the partial or complete rotator cuff tear. With the false positive or false negative results as high as 30 percent in various shoulder pathologies, it is concluded that arthroscopy still remains the gold standard modality in diagnosing shoulder pathology. Arthroscopy has an advantage of therapeutic intervention at same time, so in cases those clinically warrant for operative intervention arthroscopy is beneficial. But in patients where conservative treatment is anticipated, can benefit from undergoing a MRI first. Hence both MRI and arthroscopy have complimentary roles in the diagnosis of shoulder pathology.

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