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COMPARISON OF MRI AND MR ARTHOGRAPHY IN DIAGNOSIS OF SHOULDER LABRAL INJURIES

Radiodiagnosis

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ABSTRACT

Introduction: Use of MR arthrography to evaluate the pathological conditions of the shoulder is becoming widespread(1,2,3). Direct MR arthrography is the standard of care for assessment of shoulder instability in patients younger than 40 years. Shoulder stabilization transfers from the labrum to the rotator cuff with advancing years, limiting the value of arthrography in older patients(1). Thus, this study is conducted to assess the MRI and MR arthrogram findings in patients with suspected rotator cuff injury and/or labral injury and to compare and measure the agreement in findings from MRI and MR arthrogram.

Aim: To compare the findings of MRI and MR arthrogram in patients with suspected labral injury.Objectives:To study the MRI and MR arthrogram findings in patients with suspected labral injury

Material and methods: The present study was carried out as a prospective cross-sectional comparative study at a tertiary care teaching hospital in North India for a period of two years from Jun 2017 to Jun 2019. The inclusion and exclusion criteria were predefined. Necessary interventions were carried out under strict aseptic technique after obtaining written consent from the patient.

Conclusion: We conclude that magnetic resonance arthrography (MRA) is well suited for detecting rotator cuff injuries. The presented diagnostic results of MRA are superior to the results of magnetic resonance imaging. Therefore, MRA can act as a reliable diagnostic tool prior to arthroscopic or surgical intervention.

KEYWORDS

MR arthrography, Shoulder labral injuries Shoulder instability Labroligamentous Glenohumeral instability

INTRODUCTION:

Use of MR arthrography to evaluate the pathological conditions of the shoulder is becoming widespread(1,2,3). Direct MR arthrography is the standard of care for assessment of shoulder instability in patients younger than 40 years. Shoulder stabilization transfers from the labrum to the rotator cuff with advancing years, limiting the value of arthrography in older patients(1).

In patients younger than 40 years, labral injuries have been described in 39% of patients suffering of shoulder instability and in 19% without instability. MR arthrography is the most accurate method for diagnosing the labral tears, reaching a specificity of 93% and sensitivity of 88% based on an arthroscopic reference standard(1). It reliably shows subtle lesions of the labroligamentous complex as well as rotator cuff, providing information essential to the surgeon concerning the surgery or arthroscopic repair(2). Accurate preoperative classification of the labroligamentous injuries is important, as the type of surgical intervention is dependent on the type of injury(3). Glenohumeral instability has been classified into several groups: traumatic (anterior or posterior), atraumatic and minor shoulder instability(1,3,4).

Shoulder Arthroscopy:

Arthroscopy is the current gold standard in diagnosing shoulder pathologies. Shoulder arthroscopy is a common orthopedic procedure. The evolution of shoulder arthroscopy has directly led to the expansion of surgical intervention from a purely diagnostic tool to the ability to perform minimally invasive, but complicated repair and reconstructive procedures (5,6).

Arthroscopy provides a 20-power magnification, which enhances the direct visualization of the shoulder joint.[12] Despite being the gold standard investigation, arthroscopy does have its disadvantages. The flaccidity of the capsule can be difficult to determine due to the process of the arthroscopic examination itself altering the laxity of the joint. The procedure is invasive and thus carries small risks of complications such as infection, damage to adjacent structures (e.g. musculocutaneous nerve or articular cartilage) and fluid extravasation. Complications may also arise from the anaesthetic (6,7,8).

Thus, this study is conducted to assess the MRI and MR arthrogram findings in patients with suspected rotator cuff injury and/or labral injury and to compare and measure the agreement in findings from MRI and MR arthrogram.

Aim and Objectives

Aim:

To compare the findings of MRI and MR arthrogram in patients with suspected labral injury

Objectives:

- To study the MRI and MR arthrogram findings in patients with suspected labral injury
- To compare and measure the agreement in findings from MRI and MR arthrogram.

MATERIAL AND METHODS:

Study Setting & design & period:

The present study was carried out as a prospective cross-sectional comparative study at a tertiary care teaching hospital in North India for a period of two years from Jun 2017 to Jun 2019.

Study Population:

Patients referred from the Orthopedics to the department of Radiodiagnosis with suspect rotator cuff pathology for diagnostic imaging.

Inclusion Criteria:

Patients who are clinically suspected to have a rotator cuff pathology, both acute and chronic.

Exclusion Criteria:

- Patients with metallic implants, cardiac pacemakers, cochlear

implants.
- Post treatment patients.
- Post-surgery patients.
- Patients who are claustrophobic.
- Patient who are unwilling for imaging.

Intervention:
Imaging: MRI and MRA of shoulder of the enrolled patients.

Sample Size
The study of El-Liethy N et al, observed that sensitivity and specificity of MRI was 72% and 78% respectively and of MRA was 78% and 100% respectively(9). Taking these values as reference, the minimum required sample size with desired precision of 20%, 90% power of study and 5% level of significance is 38 patients(10,11). To reduce margin of error, total sample size taken is 50.

Formula used is for testing sensitivity and specificity of single diagnostic test: For sensitivity

N=((Zα/2*sqrt(Se*(1-Se))+Zβ*sqrt(Se1*(1- Se1)))2)/(difference)^2
n=(Z_α×√(Se×(1-Se))+Z_β×√(〖Se〗 _1*(1- 〖Se〗 _1)))^2/ 〖difference〗 ^2 where Se is sensitivity

Zα/2 is value of Z at two sided alpha error of 5% and Zβ is value of Z at power of 90% For specificity

n=(Z_α×√(Sp×(1-Sp))+Z_β×√(〖Sp〗 _1*(1- 〖Sp〗 _1)))^2/ 〖difference〗 ^2 where Sp is specificity

Zα/2 is value of Z at two sided alpha error of 5% and Zβ is value of Z at power of 90%.

Calculations:- Sensitivity of MRI
H0:Se=72 versus Se≠72 (Se1)

With 95% confidence level and 90% power for detection of difference of 20% from a Se of 72%, sample size calculated is:-

N =((1.96*sqrt(.72*(1-.72))+(1.28*sqrt(.92*(1-.92))2/(.20*.20)
=37.66=38(approx.)**Specificity of MRI**

H0:Sp=78 versus Sp≠78 (Sp1)

With 95% confidence level and 90% power for detection of difference of 20% from a Sp of 78%, sample size calculated is:-

N =((1.96*sqrt(.78*(1-.78))+(1.28*sqrt(.98*(1-.98))2/(.20*.20)
=24.56=25(approx.) **Sensitivity of MRA** H0:Se=78 versus Se≠78 (Se1)

With 95% confidence level and 90% power for detection of difference of 20% from a Se of 78%, sample size calculated is:-

N =((1.96*sqrt(.78*(1-.78))+(1.28*sqrt(.98*(1-.98))2/(.20*.20)
=24.56=25(approx.)

Specificity of MRA
H0:Sp=100 versus Sp≠100 (Sp1)

With 95% confidence level and 90% power for detection of difference of 20% from a Sp of 100%, sample size calculated is:-

N =((1.96*sqrt(1*(1-1))+(1.28*sqrt(.8*(1-.8))2/(.20*.20)
=6.55=7(approx.)

Sampling technique:
Universal sampling, since the study includes all the reporting eligible patients.

Data Collection
All the eligible participants based on the predetermined inclusion and exclusion criteria referred to the department of radio diagnosis were included in the study. Informed consent was taken from all the patients (Annexure). The demographic, clinical and imaging characteristics were recorded in the study proforma (Annexure).

Brief Procedure
All patients who are clinically suspected of a rotator cuff pathology and referred to the department of Radiodiagnosis, were evaluated with clinical history and MR imaging. The characteristics of different rotator cuff disorders were described. Subsequently the patients were subjected to Magnetic resonance arthrography.

A surface coil is used, with patient in supine position with the arm at the side in neutral position or slight external rotation for a standard examination. MRI was performed using a GE- Wipro Signa HDxt 1.5T MRI Scanner. Axial, Coronal & Sagittal T1, T2, PD & STIR images were taken.

Patients were placed in a supine position on the fluoroscopy table with the shoulder in external rotation. Rigorous aseptic measures were applied. A marker plate with radiopaque coordinates was used to select the injection site with for fluoroscopic guidance. A 22-gauge, 1.5-inch (4-mm) spinal needle was used for injections to the upper third of the medial part of the humeral head close to the glenohumeral joint space. The needle insertion was performed in an anteroposterior direction, progressively and slowly, until the needle came into contact with the humeral head. A spot radiograph was then obtained to confirm the localization of the tip of the needle. Next, a small quantity of contrast based injection was given to confirm the position of tip. If the needle is in the articular space, there will be little resistance to the injection; a small quantity of iodinated contrast material must be injected to verify intraarticular needle placement. Presence of contrast in inferior axillary fold was taken as confirmatory. Around 0.2 mL of Gad-based contrast was diluted in 20 mL of sterile saline and mixed with around 5 ml of iodine based contrast. Around 10 ml of the solution was slowly injected until the joint capsule was appropriately distended. After the needle was removed, a dressing was placed over the injection site.

Statistical Analysis
Categorical variables were presented in number and percentage (%) and continuous variables were presented as mean ± SD and median. Diagnostic test was used to calculate sensitivity, specificity, NPV and PPV. Chi square test was used to compare diagnostic accuracy of MRI and MRA. A p value of less than .05 was considered as significant. The data was entered in MS EXCEL spreadsheet and analysis was done using Statistical Package for Social Sciences (SPSS) version 21.0.

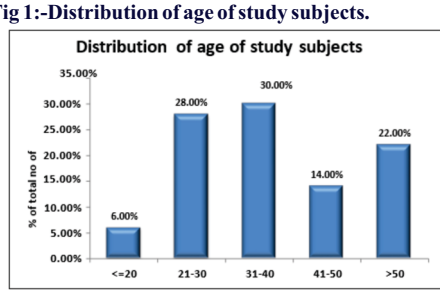
Ethical Considerations:
Informed written consent was obtained from all the eligible patients before including them in the study. Procedures involved and the implication of the study were explained to the patients in the language that they can understand before obtaining consent. Institute ethical committee clearance and certification was obtained for the study.

Financial Implication - Nil

Outcome measures
1. Diagnostic accuracy of MRI diagnosing labral injuries
2. Diagnostic accuracy of MRA diagnosing labral injuries
3. Comparison of diagnostic accuracy of MRI vs MRA for diagnosing shoulder injuries.

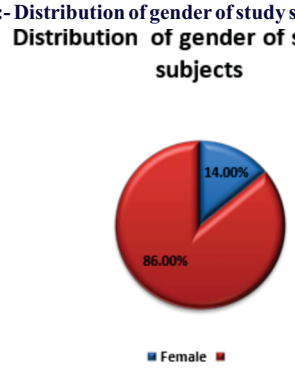
OBSERVATION AND RESULTS
This study was conducted at a tertiary center at New Delhi from Jun 2017 to Jun 2019. A total 50 patients were included in study, which were referred from the Orthopedics to the Department of Radiodiagnosis with suspected rotator cuff pathology for diagnostic imaging. Patients were evaluated with clinical history and MR imaging. The characteristics of different rotator cuff disorders were described. The patients were subjected to Magnetic resonance arthrography. Arthroscopy was considered as a gold standard for diagnostic accuracy. Results pertaining to study were as follows:

Table/Fig 1:-Distribution of age of study subjects.



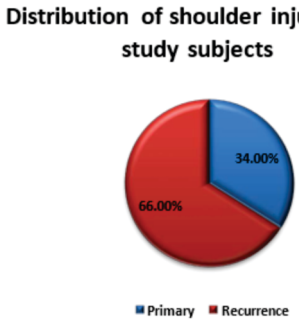
% of total no of patientsDistribution of age of study subjects:The mean age of the patients in our study was 37.32 years. Majority i.e. 30% patients were in the age group 31-40 years followed by 28% in 21-30 years.

Table/Fig 2:- Distribution of gender of study subjects.



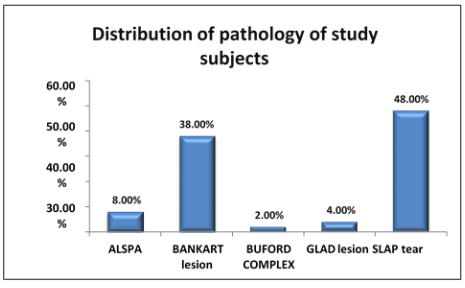
Distribution of gender of study subjects: In our study, there were 43(86%) males and 7(14%) females.

Table/Fig 3:- Distribution of shoulder injury of study subjects.



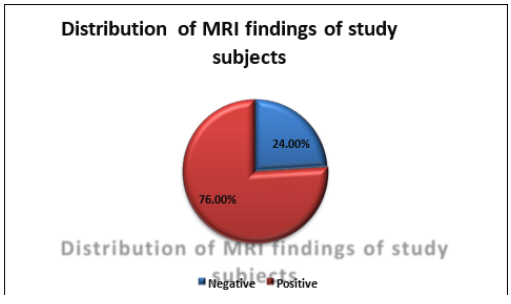
Distribution of shoulder injury of study subjects:-The shoulder injury was recurrent in 66% patients and primary in only 34 % patients.

Table 4:- Distribution of pathology of study subjects.



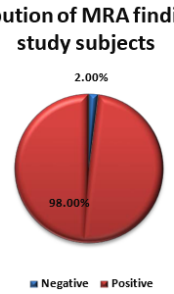
Distribution of pathology of study subjects: Among the various pathologies, SLAP tear was the commonest as seen in 24(48%) patients, followed by BANKART lesion in 19(38%) patients. Other lesions were ALSPA in 4(8%), PASTA lesion in 2(4%) and BUFORD lesion in 1(2%) patients.

Table 5:- Distribution of MRI findings of study subjects.



Distribution of MRI findings of study subjects : MRI was positive in 38(76%) patients.

Table 6:- Distribution of MRA findings of study subjects.



Distribution of MRA findings of study subjects :MRA was positive in 49(98%) patients.

Figure 7:- Distribution of arthroscopy findings of study subjects.

Arthroscopy was positive in all patients as it was the gold standard investigation for the study.

Table 8:-Diagnostic power of MRI and MRA findings taking arthroscopy findings as gold standard in total study subjects.

Diagnostic test	Sensitivity (95 % CI)	Specificity (95% CI)	PPV(95 % CI)	NPV (95% CI)	Diagnostic accuracy	P value
MRI findings	76.00%(61.83 % to 86.94%)	-	100.00%(90.75% to 100.00%)	0.00%(0.00 % to 26.46%)	76.00%	0.003
MRA findings	98.00%(89.35 % to 99.95%)	-	100.00%(92.75% to 100.00%)	0.00%(0.00 % to 97.50%)	98.00%	
For diagnosing the shoulder injury, The Sn, PPV, and NPV of MRI was 76%, 100%, 0% respectively; and for MRA was 98%, 100%, 0% respectively. Compared to MRI, MRA had significantly higher diagnostic accuracy (98% vs 76%, P=0.003).						

Table 9:- Diagnostic power of MRI and MRA findings taking arthroscopy findings as gold standard in BANKART lesion study subjects.

Diagnostic test	Sensitivity (9 5% CI)	Specificity (95% CI)	PPV(95 % CI)	NPV(95 % CI)	Diagnostic accuracy	P value
MRI findings	78.95% (54.4 3% to 93.95%)	-	100.00% (78.20 % to 100.00%)	0.00% (0.00% to 60.24%)	78.95%	0.113
MRA findings	100.00% (82.35% to 100.00%)	-	100.00% (82.35% to 100.00%)	-	100.00%	
The Sn, PPV, and NPV for diagnosing BANKART lesion was 78.95%, 100%, 0% for MRI; and for MRA, Sn was 100% and PPV was 100% respectively. Compared to MRI, MRA had higher but statistically similar diagnostic accuracy (100% vs 78.95%, P=0.113) .						

Table 10:- Diagnostic power of MRI and MRA findings taking arthroscopy findings as gold standard in SLAP tear study subjects.

Diagnostic test	Sensitivity (95% CI)	Specificity (95% CI)	PPV(95 % CI)	NPV (95% CI)	Diagnostic accuracy	P value
MRI findings	79.17% (57.85% to 92.87%)	-	100.00% (82.35% to 100.00%)	0.00% (0.00% to 52.18%)	79.17%	0.059

MRA findings	100.00% (85.75% to 100.00%)	-	100.00% (85.75% to 100.00%)	-	100.00%	
The Sn, PPV, and NPV for diagnosing SLAP tear was 79.17%, 100%, 0% for MRI; and for MRA, Sn was 100% and PPV was 100% respectively. Compared to MRI, MRA had higher but statistically similar diagnostic accuracy (100% vs 79.17%, P=0.059)						

DISCUSSION

Thus this study was done to evaluate the findings of MRI and MR arthrogram in patients with suspected rotator cuff injury and/or labral injury and to compare and measure the agreement in findings from MRI and MR arthrogram. This study was conducted at Department Of Radiodiagnosis at a tertiary center of New Delhi from Jun 2017 to Jun 2019. Total 50 patients were included in study. Clinical history was taken and patients were subjected to MRI and MRA.

We found that Sn, PPV, and NPV of MRI was 76%, 100%, 0% respectively; and for MRA was 98%, 100%, 0% respectively. MRA had significantly higher diagnostic accuracy as compared to MRI (98% vs 76%, P=0.003). Arthroscopy was considered as the gold standard investigation for comparison.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) played an important role as a non-invasive investigation due to its non-invasive nature, high degree of resolution, lack of contrast exposure and non-ionizing radiation, multiplanar capability, and excellent soft tissue resolution. MRI of the shoulder joint has achieved wide acceptance due to the sensitivity and specificity of MR in detection of rotator cuff pathologies(13,14).

In our study, MRI was positive in 38(76%) patients. For all the study subjects with various shoulder injuries, For diagnosing the shoulder injury, the Sn, PPV, and NPV of MRI was 76%, 100%, 0%, respectively. The Sn, PPV, and NPV for diagnosing BANKART lesion was 78.95%, 100%, 0% for MRI. The Sn, PPV, and NPV for diagnosing SLAP tear was 79.17%, 100%, 0% for MRI. The sensitivity and specificity of conventional MRI in detection rotator cuff tears and labral tears compared favorably with previously published results.

Magnetic Resonance Arthrography

MR arthrography is increasingly recognized as the examination of choice in glenohumeral instability providing demarcation of complex anatomic structures of the joint and demonstration of subtle abnormalities, along with excellent delineation of associated intra-articular lesions. MR arthrography extends the capabilities of conventional MR imaging because contrast solution distends the joint capsule, outlines intraarticular structures, and leaks into abnormal areas. MR arthrography is possible in any joint in which conventional arthrography is performed(14,15).

In our study, MRA was positive in 49(98%) patients. For diagnosing the shoulder injury, the Sn, PPV, and NPV for MRA was 98%, 100%, 0%, respectively. For diagnosing BANKART lesion, Sn was 100% and PPV was 100% for MRA. The Sn and PPV for diagnosing SLAP tear was 100% and 100%, respectively for MRA.

Magee T et al(16), reported that on MR arthrography, sensitivities and specificities compared with arthroscopy were as follows: anterior labral tear, 98% sensitivity and 100% specificity; posterior labral tear, 95% and 100%; SLAP tear, 98% and 99%; supraspinatus tendon tear, 100% and 100%; partial-thickness articular surface tear, 97% and 100%; and partial-thickness bursal surface tear, 84% and 100%. MR arthrography showed a statistical improvement in sensitivity ($p < 0.05$) for detection of partial-thickness articular surface supraspinatus tears, anterior labral tears, and SLAP tears at 3 T.

MRI Versus MRA

In our study, as compared to MRI, MRA had significantly higher diagnostic accuracy (98% vs 76%, P=0.003). In case of detecting BANKART lesions, as compared to MRI, MRA had higher but statistically similar diagnostic accuracy (100% vs 78.95%, P=0.113). Compared to MRI, MRA had higher but statistically similar diagnostic accuracy for detecting SLAP tears (100% vs 79.17%, P=0.059).

In a similar study by de Jesus JO et al(3), no significant difference in sensitivity was observed among the MRI and MRA. MR arthrography was more specific than MRI for detection of full-thickness tears ($p < 0.0001$) and for partial-thickness tears, MR arthrography was more sensitive and more specific than either MRI or ultrasound ($p < 0.0001$). MR arthrography was found to have higher diagnostic accuracy than MRI and ultrasound in diagnosing rotator cuff tears.

Kavanagh M et al(17), mentioned that for the comparison between MRI, MRA and US for detecting full thickness tears, there was no statistically significant difference in diagnostic performance. For detecting rotator cuff tear, sensitivity and specificity were 94% and 93%, respectively for MRI, and 94% and 92%, respectively for MRA.

Thus, it can be concluded that diagnostic value of MR arthrography for detection of suspected rotator cuff tears is significantly higher than conventional MRI investigations.

CONCLUSION

We conclude that magnetic resonance arthrography (MRA) is well suited for detecting rotator cuff injuries. The presented diagnostic results of MRA are superior to the results of magnetic resonance imaging. Therefore, MRA can act as a reliable diagnostic tool prior to arthroscopic or surgical intervention.

MR arthrography showed a statistically significantly increased sensitivity ($P < 0.05$) compared with conventional MRI for detection of rotator cuff tears; our study also showed high sensitivity of MRA in diagnosis of SLAP tears and BANKART lesions. Overall, MRA showed significantly higher diagnostic accuracy as compared to MRI. Magnetic resonance techniques cannot replace arthroscopy; but it can be a good diagnostic tool for diagnosis of the main pathological condition of the shoulder joint. It can help to reduce arthroscopic interventions for purely diagnostic purposes and without any therapeutic consequences.

STRENGTHS OF OUR STUDY

1. Rotator cuff injury and labral injury in India are common causes of shoulder pain and disability. The patients with rotator cuff/labral injury have been categorized in to a different group and imaging modalities have been explored for the same.
2. There is a dearth of studies in India regarding the additional role of non-invasive imaging modalities as the diagnostic evaluation for rotator cuff injuries. Thus, our study can act as a stepping zone for further larger studies to find out effective diagnostic methods for rotator cuff in Indians.
3. Many of our results corroborated with other studies done at different times and in different places both in India as well as outside India. This study, thus, adds to the already existing literature about the competent method of diagnostic evaluation of patients with rotator cuff injuries and labral tears.
4. A fairly reasonable number of cases were studied. So, it gives a fair idea of the effectual method of diagnosis of rotator cuff/labral injury patients across various age groups and sex encountered in a hospital setting.
5. The results of this study show that, there is an urgent need to promote research and give greater importance in the medical curriculum to know the etiology and adopt preventive measures for the same.

LIMITATIONS OF THE STUDY

1. Our study was conducted in a setting which caters to patients belonging primarily to the lower or middle socio-economic strata and the data primarily reflects the situation in this cohort only. This study does not provide result of effectiveness of diagnostic measures in rotator cuff and labral injuries.
2. Being a single-center hospital-based study, its results cannot be extrapolated to study the diagnostic evaluation of rotator cuff tears in the general population.
3. We have not compared findings of magnetic resonance imaging and magnetic resonance arthrography with ultrasound as this is another emerging aspect of musculoskeletal imaging modality, that have recently shown promising accuracy as a musculoskeletal imaging modality in diagnosis of rotator cuff injuries.
4. One of the limitations was small sample size for individual type of pathology. Our study included only 50 patients, out of which BANKART and SLAP lesions were the most common and others were in very small numbers.

SUMMARY

This study was conducted at one of the tertiary care centers of New

Delhi from Jun 2017 to Jun 2019. Total 50 patients were included in study, which were referred from the Orthopedics to the Department of Radiodiagnosis with suspect rotator cuff pathology for diagnostic imaging. Patients were evaluated with clinical history and MRI. The characteristics of different rotator cuff disorders were described. The patients were subjected to Magnetic resonance arthrography. Arthroscopy was considered as a gold standard for diagnostic accuracy. Following results related to study were obtained:

- The mean age of the patients in our study was 37.32 years. Majority i.e. 30% patients were in the age group 31-40 years followed by 28% in 21-30 years.
- In our study, there were 43(86%) males and 7(14%) females.
- The shoulder injury was recurrent in 66% patients and primary in only 34 % patients.
- Among the various pathologies, SLAP tear was the commonest as seen in 24(48%) patients, followed by BANKART lesion in 19(38%) patients. Other lesions were ALSPA in 4(8%), PASTA lesion in 2(4%) and BUFORD lesion in 1(2%) patients.
- MRI was positive in 38(76%) patients. MRA was positive in 49(98%) patients. Arthroscopy was positive in all patients as it was the gold standard investigation for the study.
- For diagnosing the shoulder injury, The Sn, PPV, and NPV of MRI was 76%, 100%, 0% respectively; and for MRA was 98%, 100%, 0% respectively. Compared to MRI, MRA had significantly higher diagnostic accuracy (98% vs 76%, P=0.003).
- The Sn, PPV, and NPV for diagnosing BANKART lesion was 78.95%, 100%, 0% for MRI; and for MRA, Sn was 100% and PPV was 100% respectively. Compared to MRI, MRA had higher but statistically similar diagnostic accuracy (100% vs 78.95%, P=0.113)
- The Sn, PPV, and NPV for diagnosing SLAP tear was 79.17%, 100%, 0% for MRI; and for MRA, Sn was 100% and PPV was 100% respectively. Compared to MRI, MRA had higher but statistically similar diagnostic accuracy (100% vs 79.17%, P=0.059)

CONCLUSION

We conclude that magnetic resonance arthrography (MRA) is well suited for detecting rotator cuff injuries. The presented diagnostic results of MRA are superior to the results of magnetic resonance imaging. Therefore, MRA can act as a reliable diagnostic tool prior to arthroscopic or surgical intervention.

MR arthrography showed a statistically significantly increased sensitivity ($P < 0.05$) compared with conventional MRI for detection of labral tears; our study also showed high sensitivity of MRA in diagnosis of SLAP tears and BANKART lesions. Overall, MRA showed significantly higher diagnostic accuracy as compared to MRI.

Magnetic resonance techniques cannot replace arthroscopy; but it can be a good diagnostic tool for diagnosis of the main pathological condition of the shoulder joint. It can help to reduce arthroscopic interventions for purely diagnostic purposes and without any therapeutic consequences.

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