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Original Research Paper

Clinical Research

CONVENTIONAL MAGNETIC RESONANCE IMAGING AND MR ARTHROGRAPHIC EVALUATION OF GLENOHUMERAL INSTABILITY DUE TO LABRAL-LIGAMENTOUS COMPLEX LESIONS AND ROTATOR CUFF TENDINOPATHIES

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ABSTRACT Shoulder joint is one of those synovial joints which allow greatest degrees of range of motion; this comes with a cost however-greater chances of instability. Glenohumeral instability causes significant morbidity and loss of productivity. Definitive treatment is dependent upon comprehensive delineation of the pathoanatomical features by conventional MRI.MR Arthrography can add to the sensitivity and specificity of conventional MRI significantly. We focus in the present study to evaluate the role of MR Arthrography in comparison to conventional MRI in patients of glenohumeral instability.

KEYWORDS : MRI, MR Arthrography, glenohumeral instability

INTRODUCTION

The glenohumeral joint has the greatest range of motion of any major articulation in the human body(1).As a side effect,joint stability is comparatively less. Dynamic and passive mechanisms together provide glenohumeral stability, maintaining rotation of the humeral head over the center of the glenoid fossa. Dynamic stabilizers include the rotator cuff and long head of biceps as well as pectoralis major, latissimus dorsi, and periscapular muscles (2). Passive stabilizers include the glenoid rim and concave glenoid fossa and labral-ligamentous complex structures(2).

The glenohumeral joint is the most most commonly dislocated joint in the body, and shoulder instability is a common clinical problem, especially in young active individuals(3). A substantial amount of unstable shoulders demonstrate characteristic abnormalities of the labral-ligamentous complex on magnetic resonance (MR) images(4).

Glenohumeral instability can be classified in various ways:a)single vs multiple episodes.b)anterior,posterior or multidirectional.c) traumatic or non-traumatic,etc.

Anteroinferior dislocation is the most common type seen in recurrent dislocations and is the most frequent cause of shoulder instability. The glenohumeral ligaments, especially the inferior glenohumeral ligament constitue the major passive stabilizers of the shoulder. The glenoid labrum functions more as a site of ligamentous attachment than by providing increased depth to the glenoid fossa, and hence stability, as previously believed(5,6,7,8).

In the acute setting MR helps in the exact delineation of the structural damage incurred in the form of marrow edema, joint effusion or hemarthrosis and obvious labro-capsular injury. In the setting of recurrent dislocations, MR imaging can show osseous and soft-tissue abnormalities which help in planning the treamnt protocol:surgical vs conservative.

MR arthrography has a distinct role in case of recurrent dislocations which lead to instability.It increases the diagnostic confidence in detecting labro-capsular injuries.MR arthrography has the most important use in the assessment of young,active individuals with suspected instability.In these patients, subtle labral-ligamentous abnormalities have substantial influence on shoulder function,future management plan, and prognosis(9).Hence detecting them is of utmost importance,and MR arthrography has an immense role here.

MR arthrography enhances the diagnostic accuracy of conventional MR imaging in the form of distension of joint capsule by contrast solution,which helps in outlining intraarticular structures, and delineating abnormalities(10).

OBJECTIVE

The purpose of this study is to evaluate and correlate the efficacy of conventional MRI and MR arthrography in diagnosing labro-capsular ligament complex lesions and rotator cuff tendinopathies in clinically diagnosed cases of glenohumeral instability.

METHODOLOGY:

In this study 45 patients were studied from January 2015 to June 2016. Patients attending the Orthopaedic/Physical Medicine and Rehabilitation (P.M.R) O.P.D of I.P.G.M.E&R and SSKM Hospital,a tertiary care hospital in West Bengal were thoroughly examined and clinically diagnosed to be cases of shoulder instability referred to the Dept. of Radiodiagnosis. In the Dept of Radiodiagnosis, the patients were explained in details about the study process. A written consent was taken.The patients then underwent MRI examination of shoulder in the departmentl 3T MRI machiene.An IITV(Image Intensifier Television) guided arthrogram from anterior approach was thereafter performed using:

i. 22gauge 3.5 inch spinal needle.
ii. 2% lignocaine solution for anaesthesia.
iii. Normal saline.
iv. Iodinated contrast medium.
v. MR contrast medium.
vi. Povidone Iodine scrub.
vii. Gauze pieces,gloves,etc.

20ml of a solution was prepared using 10ml lignocaine solution,5ml normal saline,5ml iodinated contrast medium and 0.2ml MR contrast medium.About 12-15ml of the solution was injected intrarticularly afted proper dressing, draping and local anaesthesia.MR arthrographic examination was performed within 30 minutes of the arthrogram.The results of conventional MR imaging and MR arthrographic imaging were then compared.

SAMPLE SIZE:

45 patients.

INCLUSION CRITERIA:

1. Patients with recurrent shoulder dislocation who have subsequently been clinically diagnosed to be cases of glenohumeral instability and have given their informed consent to this study..
2. Patients above the age of 18 years.

EXCLUSION CRITERIA:

1. Patients with fracture in the shoulder area.
2. Patients with overlying skin or articular infection.
3. Patients with coagulation defects or undergoing anticoagulant therapy.

4. Patients with history of allergy to contrast material.
5. Patients with general contraindications to MRI examination viz,metal implants,metallic foreign bodies in their eyes,pacemaker,etc.
6. Patients with previous surgery of shoulder.
7. Patients who have not given consent for this study.

STUDY TOOLS:

- IITV (image intensifier television) for guidance during intra-articular contrast injection.
- Materials for arthrogram(as described above)
- 3.0 Tesla MRI machiene,GE Healthcare,Signa 3T HDxt with shoulder coil over the affected shoulder
- Informed consent form.

MRI EXAMINATION:

The patient was made to lie in a supine position,with external rotation of the affected hand with the help of a sand bag.Shoulder coil was placed in the affected shoulder. Standard T2 and T2/PDFS images were taken in axial ,coronal(parallel to the suprasinatus tendon) and sagittal planes.Axial GRE images were taken for better delineation of bone.Sagittal image inT1 palne was also taken.

MR ARTHROGRAM:

The patient was made to lie in a similar position as in the conventional MRI examination.

RESLUTS

TABLE1:AGE DISTRIUTION OF PATIENTS:

AGE(yrs)	NO.OFPATIENTS	%
11-20	9	20
21-30	28	62.2
31-40	5	11.1
41-50	3	6.7
TOTAL	45	100

MEAN AGE-25.3yrs

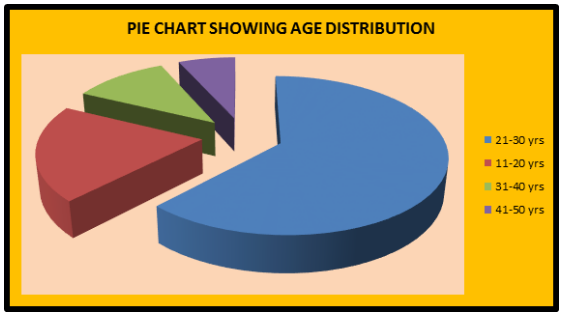


TABLE 2:SEX DISTRIBUTION OF PATIENTS:

SEX	MALE	FEMALE	TOTAL
	41	4	45
%	91.1	8.9	100

PIE CHART SHOWING SEX DISTRIBUTION

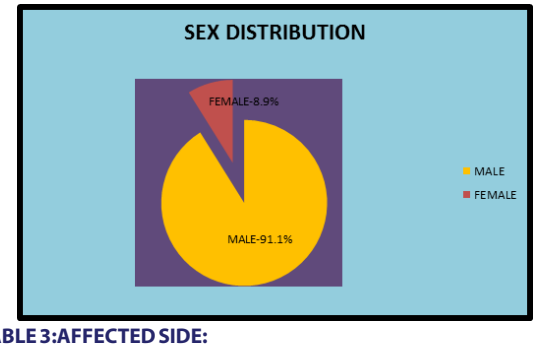


TABLE 3:AFFECTED SIDE:

SIDE	RIGHT	LEFT	TOTAL
	34	11	45
%	75.6	24.4	100

PIE CHART SHOWING DISTRIBUTION OF AFFECTED SIDE

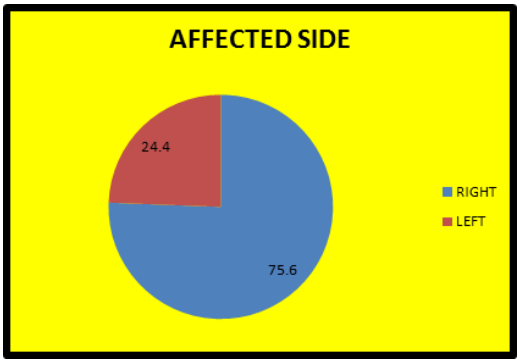


TABLE 4:CONVENTIONAL MRI IN TENDON PATHOLOGY:

LEGEND:P-PARTIAL THICKNES TEAR F-FULL THICKNESS TEART-TENDINIOPATHYN-NORMAL

TENDONS n=45	P %	F %	T %	N %				
SUPRASPINATUS	5	11.1	10	22.2	27	60	3	6.7
INFRASPINATUS	0	0	0	0	8	17.8	37	82.2
SUBSCAPULARIS	3	6.7	0	0	8	17.8	34	75.6
TERES MINOR	0	0	0	0	0	0	45	100

CHART SHOWING DISTRIBUTION OF TENDON PATHOLOGY IN CONVENTIONAL MRI:

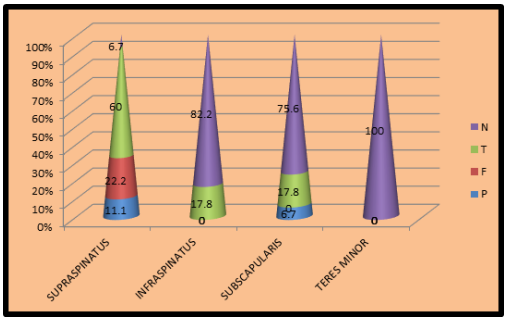


TABLE 5:MR ARTHROGRAM IN TENDON PATHOLOGY:

TENDONS n=45	P %	F %	T %	N %				
SUPRSPINATUS	14	31.1	11	24.4	17	37.8	3	6.7
INFRASPINATUS	0	0	0	0	8	17.8	37	82.2
SUBSCAPULARIS	2	4.4	0	0	9	20	34	75.6
TERES MINOR	0	0	0	0	0	0	45	

CHART SHOWING DISTRIBUTION OF TENDON PATHOLOGIES IN MR ARTHROGRAM(%):

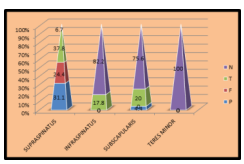
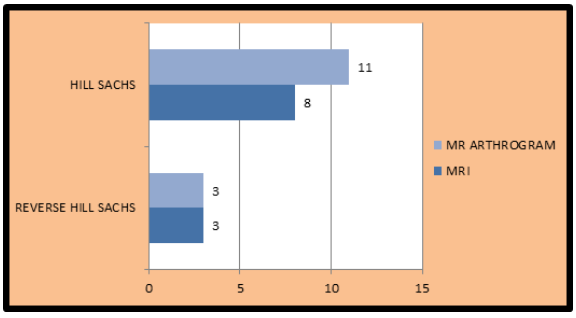


TABLE 6:OSSEOUS HUMERAL PATHOLOGY:

	HILL SACHS	%	REVERSE HILL SACHS	%
MRI	8	17.8	3	6.7
MR ARTHROGRAM	11	24.4	3	6.7

BAR DIAGRAM SHOWING COMPARISON OF MRI AND MR ARTHROGRAPHY IN DELINEATION OF HUMERAL LESIONS:



LABRAL PATHOLOGIES:

TABLE7: SHOWING DISTRIBUTION OF BANKART LESIONS IN MRI AN MR ARTHROGRAM:

	BANKART	%	REVERSE BANKART	%
MRI	8	17.7	4	8.9
MR ARTHROGRAM	19	42.2	5	11.1

BAR DIGRAM SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINETING BANKART LESIONS(n=45):

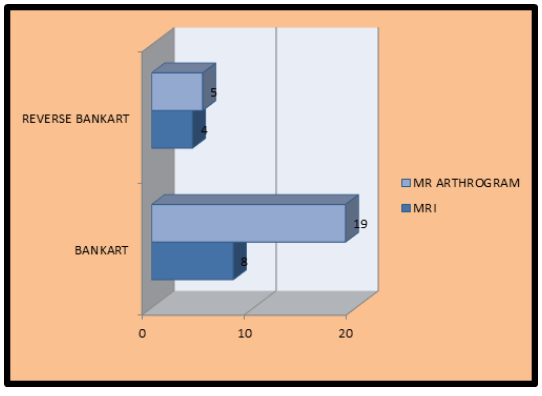


TABLE8: SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINEATING BANKART VARIANTS(n=45):

BANKART VARIANT	ALPSA	%	GLAD	%	PERTHES	%
MRI	1	2.2	0	0	1	2.2
MR ARTHROGRAM	2	4.4	0	0	2	4.4

BAR DIAGRAM SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINEATING BANKART VARIANTS(n=45):

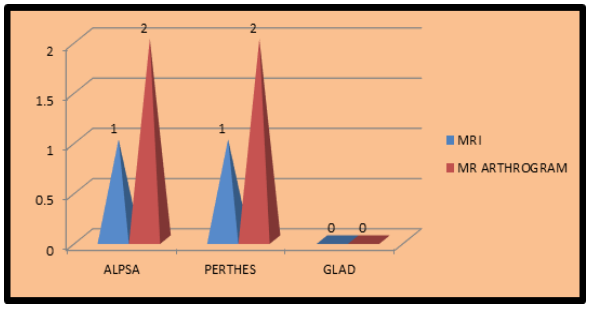


TABLE9: SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINEATING SLAP TEARS(n=45):

SLAP TEAR	NUMBER	%
MRI	10	22.2
MR ARTHROGRAM	14	31.1

BAR DIAGRAM SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINEATING SLAP TEARS:

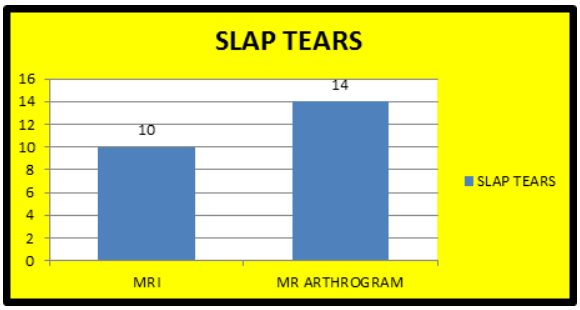
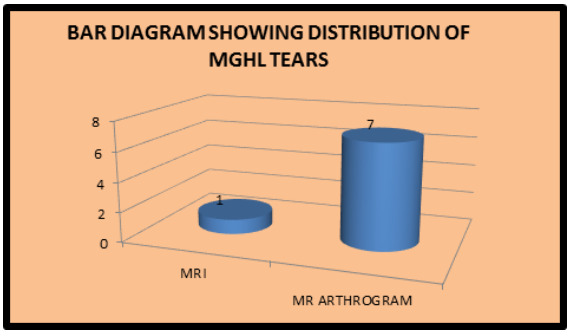


TABLE10: SHOWING COMPARISON OF MRI AND MR ARTHROGRAM IN DELINEATING CAPSULAR LIGAMENTOUS PATHOLOGY(N=45):

	MGHL	%
MRI	1	8.9
MR ARTHROGRAM	7	15.56



Two patients had SGHL tear in conventional MRI imaging.However they were found to have intact SGHL's in MR arthrogram image.

None of the patients were found to have IGHL tear,HAGL or GAGL lesions in both conventional and MR arthrogram images in the present study.

DISCUSSION:

This study involved 45 patients ,who were clinically diagnosed to be cases of glenohumeral instability.In the study design,patients with clinical diagnosis of glenohumeral instability were referred for MRI examination of the shoulder .A 3T MR machiene was used. First conventional MRI examination as done, followed by IITV guided arthrogram and thereafter MRI arthrogram.

Interpretation was done in the following way:

The glenoid rim was treated as a clock face, with the superior labrum occupying the 11- to 1-o'clock position; the posterior labrum, the 2- to 6-o'clock position; and the anterior labrum, the 6- to 11-o'clock position. These three areas were scored separately, and thus a shoulder could have a tear in more than one location,as we have seen in our study. The diagnostic criterion for a labral tear included the presence of high signal within the labrum extending to the articular surface. An additional criterion on MR arthrography was contrast material within the substance of the labrum. The labrum was considered to be detached if it was separated from the glenoid or from the remaining labral tissue. A labrocapsular injury was diagnosed if there was high signal or contrast material at the junction of the joint capsule and labrum. Labral contour irregularity or fraying of the free edge was designated as degeneration.

Superior labral anteroposterior tear (SLAP) was defined as a superior labral irregularity with high signal on T2-weighted images or as fluid extending into the superior labrum on postarthrographic images.The radiologist did not attempt to classify superior labral anteroposterior (SLAP) tears. For the purposes of data analysis, normal labra or degenerated labra were considered to be "normal," whereas torn or detached labra or labrocapsular injuries were designated to be "labral tears."

For rotator cuff,high T2 signal within the tendons were designated to be tendinopathies,fluid intensity/extension of contrast(in articular surface tears) within the tendon not traversing the entire thickness of the tendons were designated partial tears,fluid/ extension of contrast(in articular surface tears) within the tendon traversing the entire thickness of the tendons were designated full thickness tears..

The 45 conventional MRI and MR arthrography shoulder examinations were analyzed for statistical significance using the chi squared test,with Yates' continuity correction ; a $p < 0.05$ was considered statistically significant.

AGE DISTRIBUTION:

Among 45 patients, majority of the patients were in the age group of 21-30yrs(28 patients,62.2%).20% of patients(9pts) were in the age group of 10-20 yrs,11.1%(5 pts) in 31-40 yrs and 6.7%(3 pts) in 41-50 yrs respectively. The mean age was 25.3 years. This is consistent with similar other studies as shown below:

TABLE 11 showing comparison of age distribution:

Study(year)	No. of cases	Age Range	Mean age
Flannigan et al(1990)	23	16-68	45
Magee et al(2004)	20(study group)	18-39	24
Waldt et al(2005)	104(study group)	16-67	28.2(tudy group)
Major et al(2011)	42	-	33
Present study(2016)	45	17-43	25.3

SEX DISTRIBUTION:

Of the total examined,91.1%(41 pts) were male while the rest(4 pts,8.9%) were female. . Increased incidence in males was probably due to more involvement in outdoor activities, riding vehicles and heavy manual labour,hence increasing chances of injury.

TABLE 12 showing sex distribution:

Study(year)	No. of cases	No. of males	No. of females
Flannigan et al(1990)	23	18	5
Waldt et al(2005)	104(study group)	74	30
Major et al(2011)	42	28	14
Present study(2016)	45	41	4

SIDE INVOLVEMENT:

In 75.6%(34 pts) the right side was involved while the left side was involved in the rest(24.4%,11 pts).

ROTATOR CUFF PATHOLOGIES:

Conventional MRI detected partial tear of the supraspinatus tendon in 11.1%(5 pts).while MR arthrogram detected them in 31.1%(14 pts).

Conventional MRI detected full thickness tear of supraspinatus tendon in 22.2% (10 pts) while MR arthrogram detected the same in 24.4%(11 pts).

Conventional MRI found supraspinatus tendinopathy in 60%(27 pts) while MR arthrogram found the same in 37.8%(17 pts),as conventional MRI had found tendinopathy in 10 pts ,out of whom MR arthogram detected 9 partial and 1 full thickness tears respectively, instead of tendinopathy(The detection rate of Mr arthogram for patial tears was found to be significantly higher than that of conventional MRI:$p<0.05$).

TABLE 12 showing comparison of full thickness tears: The results are consistent with the other groups.

Study(year)	Full thickness tear(MRI)	Full thickness tear(MR Arthogram)
Flannigan et al(1990)	7	9
Magee et al(2004)	0	2
Present Study(2016)	10	11

Conventional MRI found partial tear and tendinopathy of the subscapularis tendon in 6.6%(3 pts) and 17.8%(8 pts) respectively, while MR arthrography found partial tear and tendinopathy in 4.4%(2 pts) and 20%(9 pts) respectively.1 patient ,categorised to have partial tear in MRI, was found to have tendinopathy in MR arthrogram.

MR and MR arthrography had similar detection rates with regards to infraspinatus and teres minor tendon pathologies.

OSSEOUS HUMERAL LESIONS:

Conventional MRI detected Hill Sachs lesion in 17.8%(8 pts) while MR arthrogram detected the same in 24.4%(11 pts) of cases.

Detection rate for reverse Reverse Hill Sachs lesion were same for both the modes of examination.

LABRAL-LIGAMENTOUS PATHOLOGIES:

Bankart lesion was found in 17.7%(8 pts) and 42.2%(19 pts) in MRI and MR arthrographic examination respectively. Detection rate of MR arthrogram was significantly higher than conventional MRI:$p<0.05$). Detection rate for Reverse Bankart lesions 8.9%(4 pts) in conventional while it was 11.4%(5 pts) in MR arthrogram examination.The results are consistent with other study groups with regard to the higher detection rates of MR arthrogram.

Detection rates for ALPSA and Perthes lesions were 2.2%(1 pt) and 4.4%(2 pts) respectively in MRI and MR arthrographic examiations. No GLAD lesions were found in the present study.

MR arthrography found SLAP tears in 31.1%(14 pts) as compared to 22.2% (10 pts) in conventional MRI.Findings are consistet with that of Magee et al,who had similar findings in their study.

MR arthrography detected MGHL tears in 15.6%(7 pts) as compared to 2.2% (1 pt) in conventional MRI9 Detection rate of MR arthrogram was significantly higher than conventional MRI:$p<0.05$).

2 patients had SGHL tear in conventional MRI imaging. However they were found to have intact SGHLs in MR arthrogram image. None of the patients were found to have IGHL tear.
Limitation of this study is mainly the lack of arthroscopic

correlation.

The results of the present study were compared to other similar previous studies and were consistent with them in saying that MR arthrogram is better in delineating and accurately demonstrating labral-ligamentous and rotator cuff pathologies in comparison to conventional MRI, as seen in cases where conventional MRI has failed to detect a pathology or has misdiagnosed the severity of the pathology or even has overdiagnosed pathologies in comparison to MR arthrogram.As per Major(13) et al,their results showed that fewer labral tears were missed with MR arthrography and thus justify its use in patients with suspected labral tears.It also can be safely concluded that certain abnormalities may be better

evaluated with intraarticular contrast material MR arthrography findings may alter the treatment plan for patients by providing more accurate information for the orthopedic surgeon, thereby resulting in accurate diagnosis and appropriate patient care.

CONCLUSION:

- The present study,comprising of 45 patients reveal the following:
- The labral-ligamentous pathologies were more common in young adults(21-30 yrs).
- Males were more commonly affected than females.
- The right side was more comonly involved than the left
- MR arthrography performed significantly better than conventional MRI in accurately evaluating:
- Rotator cuff pathologies
- Bankart lesions(inclusive of soft tissue and osseous lesions).
- MGHL tears.
- MR arthrography had a higher accuracy in differentiating partial tears from tendinopathies,as seen in subscapularis tendon pathologies.
- MR arthrography had a higher detection rate for Hill Sachs,Reverse Bankart,SLAP,ALPSA and Perthes lesions in comparison to conventional MRI.

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